The Causes and Consequences of Economic Restructuring:
Evidence from the Early 21st Century

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THE CAUSES AND CONSEQUENCES OF ECONOMIC RESTRUCTURING: EVIDENCE FROM THE EARLY 21ST CENTURY

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Abstract

A number of industries underwent large and permanent reductions in employment growth at the beginning of this decade, a process we label as restructuring. We describe how restructuring occurred and what its consequences were for the economy. In particular, we find that restructuring stemmed largely from relative demand shocks (though technology shocks were important in some industries) and that elevated levels of permanent job destruction and permanent layoffs were distinguishing features of industries subject to restructuring. In addition, most workers displaced in restructuring industries relocated to other sectors. While this process of reallocation led to large increases in productivity (and a reduction in labor's share) in industries shedding workers, it also resulted in prolonged periods of unemployment for displaced workers. Moreover, relocating workers suffered sizable reductions in earnings, consistent with substantial losses in their specific human capital. Putting these pieces together, we estimate the cost of restructuring to have been between ½ and 1 percent of aggregate income per year.

I. Introduction

The influence of structural adjustment and labor reallocation on the cyclical behavior of employment and productivity has been a long-standing issue in economics.[1] More recently, the performance of the labor market in the early part of this century, which was characterized by a series of extended job losses from the beginning of the 2001 recession through 2003, has reignited this interest. One explanation that has been offered for the prolonged weakness in employment that followed the 2001 recession is that this period was characterized by an unusual amount of economic restructuring relative to that in previous recessions and early recoveries. Groshen and Potter (2003), for example, report that, by their metric, 79 percent of industries could be characterized as restructuring in the 2001 downturn and subsequent recovery, compared with 50 to 60 percent of industries in the previous three business cycles.[2] However, other researchers, notably Aaronson, Rissman, and Sullivan (2004), disagree with this assessment. In particular, these authors argue that the extent of restructuring between 2001 and 2003 was below that in previous episodes.

One problem with interpreting analyses of restructuring and labor markets is that the results are typically based on summary statistical measures that are derived from a particular set of assumptions about the way in which restructuring occurs. For example, Groshen and Potter measure the degree of restructuring as the percentage of industries that experienced either increases in employment both during the recession and early recovery or declines in employment in both periods, while Aaronson, Rissman, and Sullivan define restructuring as the deviation of changes in employment shares from

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[1] See, for example, the exchange between Lilien (1982) and Abraham and Katz (1986).
[2] In addition, Gordon (2003) and Oliner, Sichel and Stiroh (2007) argue that the large gains in productivity during this period were partly the result of economic restructuring.

"normal" cyclical behavior. As the differing conclusions of the aforementioned studies suggest, the results tend to be sensitive to the way in which these summary statistics are constructed.

In this paper, we take a different approach by digging beneath the summary statistics to identify the sectors that appeared to be most affected by restructuring. In particular, we look for industries that experienced unusually poor labor market performance in the early part of this decade and assess the behavior of these underperforming industries to characterize the process of restructuring. Specifically, after identifying a set of restructuring industries, we proceed to examine cross-industry correlations of changes in employment, productivity, and output to distinguish among some of the competing hypotheses concerning the source of permanent job losses during that period. We find that the primary cause of restructuring appears to have been a series of industry-specific demand shocks that amplified what was already a declining trend in demand in a number of important industries, although technological change also played a role in a few key sectors.

Next, we examine how restructuring took place. Perhaps not surprisingly, we find that the distinguishing feature of restructuring industries was a relatively heavy reliance on job destruction, although a reduced pace of job creation was also evident in these industries. In contrast, nonrestructuring industries relied exclusively on reduced job creation to slow employment growth. In addition, increases in job destruction in restructuring industries were accompanied by very large increases in permanent layoffs, and a large share of these permanently laid off workers needed to leave their previous

industries to become reemployed. Thus, our results suggest that labor reallocation was an important feature of the economic landscape in the first half of the decade.

We also examine some of the consequences of restructuring for overall economic activity. Reallocation of factor inputs is likely to have two effects. First, a reduction in the utilization of resources is likely to occur during the period required to move workers and capital out of restructuring sectors and into new employment; this lower utilization could be reflected either as low productivity growth or high unemployment. Second, some capital specific to restructuring industries may be destroyed if it loses its value when transferred elsewhere.

We find that utilization was indeed reduced during restructuring, but that this reduction showed up predominantly as high unemployment. Because firms in restructuring industries were quick to shed unneeded labor, worker displacements rose dramatically as did the time required for workers to find new employment. The slow transition of these displaced workers into expanding industries seems to have been an important reason for the slow recovery of the labor market following the 2001 recession. On the other hand, productivity, after an initial downturn, rose quite robustly in restructuring industries, and labor's share, after rising noticeable over the late 1990s, declined from 2001 to 2003. Thus, restructuring also appears to have been an important source of the robust gains in productivity and corporate profitability experienced during that period.

We also find that restructuring resulted in the destruction of significant amounts of specific capital. One indication of this is that displaced workers who were reemployed outside their original industries experienced a large drop in earnings, while displaced

workers able to remain in their previous industry of employment experienced relatively modest declines.

Putting these pieces together, we show how our estimates of utilization and income loss can be used to assess the welfare costs of restructuring. We estimate these costs to have been substantial—between 1/2 percent and 1 percent of aggregate income per year—suggesting that restructuring had an important influence on economic activity and well-being in the first years of the decade.

The rest of the paper is organized as follows. The next section describes our framework for identifying restructuring industries and presents the particular classification that results from implementing this framework. We then turn in section III to examine the sources of restructuring before describing in section IV how restructuring took place. Sections V and VI examine the implications of restructuring for the aggregate economy, and Section VII concludes.

II. Identifying Restructuring Sectors

To identify industries that experienced significant amounts of restructuring during the early part of this decade, we examine how employment patterns in the recent downturn differed across sectors.[3] In particular, for each industry we compute the difference between the average percent change in employment between 2000 and 2003 and the average percent change in employment from 1990 to 2000; the 1990s period is assumed to be a rough indicator of trend growth in each industry prior to the 2001 recession.

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[3] We adopt the industry breakdown used by the Bureau of Economic Analysis (BEA) in its publication of gross output by industry. For the private nonfarm sector, the BEA publishes annual data on output and employment for 59 industries.

We then use two criteria and some judgment to define persistently underperforming, or restructuring, industries. First, an industry must have experienced a large drop in its average percent change in employment between 1990-2000 and 2000-2003, relative to other industries, to be characterized as underperforming. In this sense, underperformance is measured by an industry's relative deviation from its previous employment trend. Second, trend employment growth in an underperforming industry after 2003 must have remained considerably below its 1990-2000 trend. Specifically, if an industry's average growth rate over 2003-2005 is less than the mid-point of its growth rates over the 1990-2000 and 2000-2003 periods, then it also satisfies the second criteria. In other words, an industry satisfies the second criteria if its post-2003 performance is more similar to its 2000-2003 performance than to its 1990-2000 performance.

Table 1 ranks industries according to the change in their performance from 1990-2000 to 2000-2003 (the third column; worst to best). Of the 29 industries with relative employment performance below the median (warehousing), 16 also had post-2003 employment growth that more closely resembled their 2000-2003 performances than their 1990-2000 performances. We amended this list of industries to include computer systems design and related services because it was near the borderline of qualification under our second criterion and it was the industry with the largest deterioration in relative performance from 1990-2000 to 2000-2003. We also included chemical manufacturing because it satisfied the second criteria and was close to satisfying the first. In contrast, we excluded the apparel and leather manufacturing industry from our list because its post-2000 declines looked little different from its trend over the late 1990s. The 17 remaining industries are highlighted in bold type in the table. Their employment

performances over the 1990-2003 period are also shown in figure 1. Because the post-2000 period was one of persistent underperformance for these industries, we label them as restructuring.

These restructuring industries accounted for 13.5 percent of employment in 2000 and experienced net job losses totaling 2,478,000 between 2000 and 2003—more than the decline in total nonfarm payroll employment over this period. Thus, in terms of aggregate employment loss, these industries were very important. Restructuring industries also accounted for a large share (37 percent) of the change in employment growth from 1990-2000 to 2000-2003. Nevertheless, three industries—administrative support, retail trade, and construction—that made large contributions to the change in employment growth from 1990-2000 to 2000-2003 were not restructuring industries according to our criteria because all experienced reasonably strong employment growth in 2004 and 2005. This suggests that while restructuring was an important part of the 2000-2003 deceleration in employment, temporary or cyclical employment losses also played a role.

Although restructuring industries are similar in terms of their persistent relative underperformance between 2000 and 2005, they differ considerably in some other respects. For example, the dispersion across industries in the average rates of employment growth during the 1990s is quite wide. A number of industries classified as restructuring in the early 2000s enjoyed employment gains in the 1990s at a pace well above the average rate for the private sector as a whole; indeed, computer systems design and related services was one of the fastest growing industries in the 1990s, and information and data processing services, broadcasting and telecommunications, and

motion pictures and sound recording all posted robust gains as well. In contrast, other industries, including paper products, chemical products, electrical equipment, primary metals, and textile mills, experienced below-average growth rates or outright employment declines over the 1990s. Finally, employment growth in some industries, including motor vehicle and parts production, publishing, and plastics and rubber products, was close to the average growth rate over the 1990s for the private sector as a whole.

By economic sector, restructuring industries can be reclassified into four broad groups: high-tech (both services and manufacturing); the information and entertainment sectors; nondurable and durable manufacturing excluding high-tech; and airlines and other miscellaneous industries. Each of these broad sectors has been associated anecdotally with restructuring activities, often with what seem to be idiosyncratic explanations.

With regard to the high-tech sector, for example, soaring investment in high-tech capital (computers, communications equipment, and software) in the second half of the 1990s provided substantial impetus both to computer electronics manufacturing and to the computer systems design and the information and data processing services industries. However, the economic environment for these industries changed abruptly with the onset of the 2001 recession, when investment in high-tech equipment and software dropped sharply and remained depressed through early 2004. As businesses reduced spending on IT capital, they also cut back on the purchases of IT services. In addition, some observers have speculated that demand for IT services shifted from U.S. to foreign

suppliers as improvements in international telecommunications reduced the price of imports of high-tech services.[4]

The late 1990s also witnessed an explosion in investment by telecommunications companies. The promise of the internet spurred many companies to invest in fiber optic cable and switching equipment in anticipation of huge increases in the demand for information transmitted electronically. However, the demand for information services did not grow as fast as anticipated, leaving some sectors in the industry suffering from overcapacity at the end of the decade. Other developments in the communications industry included a rapid shift to wireless and away from wired communications services, as well as changes in market regulation stemming from the 1996 Telecommunications Act. Developments in information technology also buffeted the broadcasting and sound recording industries, as the promise of new products and more efficient channels of distribution (online music sales, digital recording, and pay-per-click internet advertising) threatened to debase the value of existing products and distribution networks.

In contrast, restructuring in the manufacturing sector tended to be characterized as a continuation of the downward trend that originated in the late 1970s. Common explanations include the shift of manufacturing activity abroad and rapid technological progress.[5]

Finally, the September 11, 2001 terrorist attacks drastically reduced demand for air transportation services, at least temporarily. However, in the longer run it is difficult to separate this effect from other factors. In particular, the post-2000 period also saw an

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[4] For a discussion of this issue, see Mann (2003).
[5] See, for example, the discussion in Chapter 2 of the 2004 Economic Report of the President.

acceleration in the transfer of market share from so-called legacy airlines to lower-cost start-ups, with uncertain effects on the level of employment in the industry.

In sum, anecdotal evidence suggests that a broad array of factors may have caused employment in restructuring industries to exhibit a greater and more persistent deceleration than in other industries. With these explanations in mind, in the next section we assess the extent to which the performance of restructuring industries was driven primarily by supply or demand shocks. In particular, we use a very simple model to generate predictions about how the correlations between movements in employment, output, wages, prices, and productivity should be related to the nature of the shock experienced by an industry. We then compare these predicted correlations to those observed in the data.

III. Evidence on the Causes of Restructuring

To investigate the types of shocks affecting restructuring industries, we use a simple framework that assumes a constant returns to scale production function, a constant elasticity of demand curve for industry output and a constant elasticity of supply schedule for industry labor:

$$Q_t = A_t L_t$$
$$Q_t = \xi_t p_t^{-\varepsilon}$$
$$L_t = w_t^{1/r}$$

where Q refers to output, A is a technology parameter, ξ is a demand shift parameter, p is the price of output, L is labor, and w is the real wage. An industry will hire labor until the marginal revenue of an extra unit of labor equals the wage rate. This implies

$$L_t = \left(\frac{1}{r} \left(1 - \frac{1}{\varepsilon} \right) A_t^{\left(1 - \frac{1}{\varepsilon}\right)} \xi_t^{\frac{1}{\varepsilon}} \right)^{\frac{1}{r - 1 - \frac{1}{\varepsilon}}}$$

From this setup, we can derive the relationship between each of these variables and the industry-specific supply and demand shocks (A and ξ, respectively).

The implications of a permanent demand shock that reduces labor input are relatively straightforward. In particular, output and prices will both fall in response to the shock, so that the correlations of the change in labor input with changes in these variables will be positive. In contrast, the correlation between labor input and productivity is ambiguous (because L and Q both fall). If the decline in labor input associated with the negative demand shock is concentrated at relatively inefficient firms (a "shakeout" effect), then the correlation between changes in labor input and changes in productivity at the industry level would be negative. However, if the demand shock reduces average labor utilization (or effort) in the industry, then the correlation between changes in labor input and changes in productivity would be positive.

Conditional Comovements				
Shock	$c(Q, p)$	$c(Q, L)$	$c\left(L, \dfrac{Q}{L}\right)$	$c(w, L)$
Demand	+	+	?	+
Supply (with $|\varepsilon| < 1$)	-	+	+	+
Supply (with $|\varepsilon| > 1$)	-	-	-	+

The implications of a supply shock are somewhat more complicated. In general, supply shocks impart a negative comovement between prices and output. However, the

correlations between labor input and output and between labor input and productivity

depend on the price elasticity of product demand (-ε). If the absolute value of this

elasticity is greater than 1, then these comovements will be positive. If it is less than 1,

then these comovements will be negative. The table above summarizes the correlations

between output, prices, labor input, and productivity predicted by this model for demand

(ξ) and supply (*A*) shocks. In the absence of a labor supply shock, the correlation

between wages and employment will be positive regardless of whether the goods market

shock is one of demand or supply.

To measure these comovements in the data, we first calculate the change in the

growth rate of each variable from 1990-2000 to 2000-2003 by industry. We then

aggregate the relevant industry-level cross products using industry employment shares as

weights. For example, for a group of industries I:

$$c_I(Q,p) = \frac{\sum_{i \in I} sh_i \Delta Q_i \Delta p_i}{\sum_{i \in I} sh_i \sqrt{\Delta Q_i^2 \Delta p_i^2}}$$

where sh_i is the mean employment share for industry i from 1990 to 2000 and

$$\Delta Q_i = \sum_{t=2001}^{2003} \log\left(\frac{Q_{it}}{Q_{it-1}}\right) - \sum_{t=1991}^{2000} \log\left(\frac{Q_{it}}{Q_{it-1}}\right)$$

$$\Delta p_i = \sum_{t=2001}^{2003} \log\left(\frac{p_{it}}{p_{it-1}}\right) - \sum_{t=1991}^{2000} \log\left(\frac{p_{it}}{p_{it-1}}\right)$$

Table 2 shows these aggregated cross products for our set of restructuring

industries, as well as for the set of nonrestructuring industries. Taken as a whole, the

cross products suggest that adverse changes in relative demand were the primary cause of

restructuring: For restructuring industries as a group, the estimated comovements

between output and prices, output and employment, and employment and wages are all positive. Moreover, it appears that the shake out effect of demand changes outweighed the utilization effect, causing a negative comovement between productivity and employment changes. For the sake of comparison, we also report results for nonrestructuring industries, where cross products are consistent with supply shocks in output markets playing a more important role than in restructuring industries: Correlations between employment and output are positive, while those between output and prices and employment and productivity are negative.[6]

Table 3 shows the industry-specific cross products for the restructuring group of industries. Of the 17 restructuring industries, 12 exhibit correlations consistent with relative demand shocks, with output growth, inflation and employment growth all decreasing between 1990-2000 and 2000-2003.[7] In addition, 11 of these 12 industries experienced a "shakeout" effect, with productivity growth accelerating as labor demand declined.

IV. How did Restructuring Occur?

How restructuring occurred bears importantly on its economic effects and costs. If restructuring affected the demand for capital as well as the demand for labor, then its economic effects and costs likely extended beyond the labor market. Moreover, if

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[6] In particular, several industries—including ambulatory health care services and credit intermediation— appear to have benefited from positive supply shocks. Ambulatory health care services (a trend increasing industry) may have benefited from a looser labor market in 2000-2003, making it easier and less expensive to recruit new workers. Credit intermediation may have benefited from the sharp reduction in short-term interest rates over this period.

[7] Three industries exhibited cross products more consistent with positive supply shocks, with all three cross products negative. These cross products could also be consistent with positive technology shocks biased against labor if the elasticity of substitution between labor and other factors of production is greater than 1. For example, the comovements for information and data processing services are consistent with advances in telecommunications technology making possible the substitution of lower-priced labor overseas for domestic labor.

restructuring occurred primarily through the *destruction* of jobs and capital, then its costs were likely greater than if it occurred through a slowing in their *creation*.

To investigate whether restructuring affected the demand for capital, we examine data on establishment openings and closings for the private sector and data on plant capacity in the manufacturing sector. That is, we assume that the opening and closing of establishments and the creation and destruction of plant capacity involved changes in the demand for capital as well as jobs. Unfortunately, the data on plant openings and closings are available only at the one-digit NAICS level from the BLS's Business Employment Dynamics statistical program. However, most of the industries we identified as restructuring were in either manufacturing or information, and so we use those one-digit NAICS categories to approximate the restructuring sector.

If the amount of capital at a plant is proportional to its number of employees, then we can estimate the net change in plant capital by examining the net change in employment due to plant openings and closings from 1991:Q3 to 2000:Q4 and 2000:Q4 to 2003:Q4. The top panel of table 4 shows that the percent change in employment due to openings and closings in restructuring industries fell from about 0 in the 1990s to -0.3 percent per quarter from 2000:Q4-2003:Q4. This was only slightly larger than the change in the contribution of plant openings and closings to net employment growth in nonrestructuring industries over this period.

Data on changes in plant capacity from the Federal Reserve Board for two-digit manufacturing industries over the periods 1990 to 2000 and 2000 to 2003 are shown in the bottom panel of table 4. For all restructuring manufacturing industries, the average annual percent change in capacity was considerably smaller over the 2000-2003 period

than over the 1990-2000 period. But again, the decline in capacity growth was only slightly larger than for nonrestructuring industries.[8] Thus, data on plant openings and closings and plant capacity suggest that net capital creation in restructuring industries did decline significantly from 1990-2000 to 2000-2003. However, the fact that this behavior was not significantly different from nonrestructuring industries suggests that it was caused by weak aggregate demand, not weak relative demand, and, thus, may not have been closely tied to the restructuring process. One caveat to this last conclusion is that we lack good data on capital reallocation. For example, although plant closings and openings did not contribute importantly to the deceleration in employment in restructuring industries, capital reallocation at continuing plants may have been large.

It also is of interest to examine the gross components of the deceleration in employment and capital in restructuring industries. In particular, we are interested in whether restructuring led to the destruction of jobs and capital or was accomplished by a slowing in their creation. Restructuring that occurs through greater job destruction, plant closings, and capacity destruction suggests the destruction of plant-specific capital (physical, human, and organizational) and thus, likely, has higher costs than restructuring that occurs as reduced rates of job creation, plant openings, or capacity creation.

As shown in the top panel of table 5, from 1991:Q3-2000:Q4 to 2000:Q4-2003:Q4 job destruction in restructuring industries increased from an average quarterly rate of 2.56 percent to an average quarterly rate of 2.90 percent. In contrast, the average pace of job destruction in nonrestructuring industries fell between 1991:Q3-2000:Q4 and 2000:Q4-2003:Q4. Data on plant closings show a qualitatively similar pattern: Plant

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[8] Restructuring industries exhibited considerably larger capacity increases over both the 1990 to 2000 and 2000 to 2003 periods than nonrestructuring industries because computer manufacturing—an industry with especially large increases in capacity—is classified as a restructuring industry.

closings in restructuring industries increased slightly from 1991:Q3-2000:Q4 to 2000:Q4-2003:Q4, while closings decreased in nonrestructuring industries.

As indicated in the bottom panel, quarterly rates of job creation fell by about ½ percentage point from 1991:Q3-2000:Q4 to 2000:Q4-2003:Q4 in both restructuring and nonrestructuring industries. Data on plant openings are qualitatively similar, though declines were somewhat larger in nonrestructuring industries. Thus, restructuring industries adjusted employment along both job destruction and job creation margins. Importantly, this pattern was different than other industries, where the adjustment occurred exclusively on the creation margin. From these data, it appears that a distinguishing feature of restructuring from 2000-2003 was its reliance on job destruction. Further, the adjustment along the job destruction margin in restructuring industries appears to have occurred predominantly at continuing plants.[9]

The data on manufacturing capacity are aggregated to the industry level and thus do not allow us to measure gross plant reductions and increases in capacity. Nevertheless, we can look at whether individual industries experienced net reductions in capacity during 2000-2003. For six of the eleven restructuring manufacturing industries capacity declined from 2000-2003, and for five of the six, the decline was greater than 1 percent per year. In comparison, three of eight nonrestructuring industries reduced capacity in the 2000-2003 period, and two of those three industries reduced capacity by more than 1 percent per year. In sum, the capacity data together with data on plant closings suggest that restructuring industries relied more heavily on the destruction margin than did nonrestructuring industries—both for changes in jobs and in capital.

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[9] The importance of job destruction in restructuring industries relative to nonrestructuring industries is undoubtedly due, at least in part, to manufacturing being a trend declining industry with little scope to react to a reduction in demand by reducing job creation.

Finally, table 6 shows data on total and permanent layoffs for restructuring and nonrestructuring industries.[10] From 1994-2000 to 2001-2003, the average monthly layoff rate in restructuring industries increased from 0.89 percent to 1.18 percent, a noticeably larger increase than in nonrestructuring industries. Even more striking, the average monthly permanent layoff rate in restructuring industries increased from 0.41 percent to 0.63 percent over the same period, again a noticeably larger increase than in nonrestructuring industries.

In sum, the data suggest that a sizable portion of the decline in the rate of employment change from 1990-2000 to 2000-2003 in restructuring industries was accomplished by a destruction of both jobs and capital. This contrasts with nonrestructuring industries, which relied more on the creation margin to adjust employment and capital, and suggests that the costs of restructuring, in terms of the need to reallocate workers and capital across industries, were possibly quite large.

V. The Economic Impact of Restructuring

The reallocation of physical or human capital caused by restructuring is costly if some of this capital is specific to its original industry. Previous research suggests that this is the case. For example, Ruhm (1991), Topel (1991), and Neal (1995) all find that a significant fraction of workers' compensation derives from human capital specific to their firm or industry. Similarly, Ramey and Shapiro (2001) find in their study of the aircraft industry that a large portion of physical capital is industry specific. In addition, Bahk and Gort (1993) and Rapping (1965) argue that organizational capital is often acquired via

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[10] The industry classification scheme in the CPS switched from an SIC basis to a NAICS basis in 2002. We develop a concordance between the two classifications that yields a fairly consistent definition of industry pre and post 2002. This requires a less disaggregated classification than the BEA's (33 industries instead of 59). We label any CPS industry containing a BEA restructuring industry as restructuring. 13 of the 33 industries are restructuring and account for about 23 percent of employment.

learning through experience about specific production processes; when production processes are scrapped, much of this specific knowledge loses its value. Finally, Corrado, Hulten and Sichel (2004) point out that a firm's investments usually include intangible capital (e.g. brand recognition and loyalty through advertising, relationship building with suppliers and clients, and organizational capital) as well as tangible capital. By its nature, much of this intangible capital is also specific to the firm.

Because of the specificity of many types of capital investments to the firm or industry, it may take time for factors of production to become fully reemployed following a decline in the output previously produced with those inputs. As a result, one likely cost of restructuring is reduced resource utilization. Two manifestations of declines in resource utilization are reductions in productivity and increases in unemployment. How productivity responds to relative demand shocks depends on the speed at which the economy is able to move resources out of declining sectors. This, in turn, depends on the specificity of capital and on factors that impede the reallocation of resources.[11] Examples of such factors include policies that limit the ability of firms to reduce employment (Hopenhayn and Rogerson, 1993) or policies that subsidize inefficient firms (Caballero, Hoshi, and Kashyap, 2004). If capital is very specific to an industry and/or if significant inefficiencies exist, then the effect of restructuring on productivity can be prolonged, with persistent effects on the macroeconomy.

Figure 2 shows the behavior of labor productivity in restructuring and nonrestructuring industries after trends (as estimated by average productivity growth

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[11] In particular, Ramey and Shapiro (2001) find that the time required for reallocation is proportional to the specificity of capital, while Eisfeldt and Rampini (2003) find that liquidity in secondary physical capital markets is procyclical. This latter result suggests that the cost of moving resources out of restructuring industries will be higher if restructuring is concentrated in downturns.

from 1990 to 2000) are removed. Not surprisingly, given the relative shift in demand across sectors, productivity declined in 2001 in restructuring industries relative to the rest of the private economy. However, the subsequent recovery in productivity in restructuring industries after 2001 was very rapid, suggesting that an unduly slow movement of resources out of restructuring industries did not significantly hamper economic activity after the 2001 recession.[12]

Another potential manifestation of reduced resource utilization is higher unemployment. When human capital acquired in former industries is not easily transferred to new industries, workers losing jobs in restructuring industries may require considerable time and retraining before finding new job matches.[13] To examine the importance of this effect in the early 2000s, we use the 2000 and 2004 Displaced Worker Surveys (DWS) to see whether restructuring industries were a disproportionate source of displaced workers over the 2001-2003 period relative to the 1997-1999 period and whether nonemployment durations for these workers were noticeably longer than for workers displaced from nonrestructuring industries.[14]

Table 7 presents average displacement rates for the 1997-1999 and 2001-2003 periods. For the group of restructuring industries as a whole, the average displacement rate from 2001-2003, at 6.86 percent of employment, was nearly four times as high as the rate from nonrestructuring industries.[15] Moreover, displacement rates in restructuring

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[12] One caveat to this result is that our estimates of the recovery of productivity in restructuring industries may be biased upwards. By identifying restructuring industries as those with relatively larger and more persistent employment declines, we have introduced a selection bias against finding a sluggish response of productivity to a drop in relative demand.

[13] In support of this hypothesis, Loungani and Rogerson (1989) show that unemployment spells for workers who permanently change industries are longer lasting than other unemployment spells.

[14] Because displacement is defined as a job loss that occurred as a result of a plant closing, insufficient work, or a position being abolished, these job losses were likely involuntary.

[15] To compute displacement rates we use CPS measured employment in the denominator.

industries increased by 4.5 percentage points between the pre-2000 and post-2000

periods, while the displacement rate in nonrestructuring industries was essentially

unchanged over that period.[16]

In addition, we can use the DWS data to estimate the length of nonemployment

spells for workers displaced from their previous job. For workers reemployed at the time

of the DWS, we use the reported duration of post-displacement nonemployment as the

length of the spell. For workers who were not yet reemployed at the time of the DWS,

we calculate the observed duration of the incomplete nonemployment spell as the

reference date of the survey (the week of February 12) minus the midpoint of the reported

year of displacement and then adjust the spell to take account of the censoring of the

observed spells. More specifically, we estimate the completed duration of

nonemployment spells for the censored observations as the number of weeks of observed

nonemployment plus $\dfrac{1}{\mu}$, where μ is a constant hazard rate estimated from the observed

completed spells.[17] We then take the average of nonemployment durations for workers

with completed and uncompleted spells, where we substitute an estimate of expected

durations when actual durations are censored.

The middle panel of table 7 reports the estimated average nonemployment spell

for restructuring and nonrestructuring industries. According to these estimates, workers

displaced in the late 1990s averaged a little less than 20 weeks of nonemployment in both

sets of industries. In restructuring industries, nonemployment durations nearly doubled

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[16] Displacement rates in nonrestructuring industries rose noticeably in 2001, but they subsequently dropped
off, leaving the average 2001-2003 displacement rate little different from its 1997-1999 average.
[17] In fact, hazard rates appear to be slightly U shaped, decreasing from 0 to 50-75 weeks and then
increasing thereafter, though the limited number of completed long-duration spells increases the uncertainty
of the slope as duration increases. We also computed nonemployment durations without adjusting for
censoring. Results were qualitatively similar to the results adjusting for censoring that we report here.

during the 2001-2003 period to more than 35 weeks, a considerably larger increase than in nonrestructuring industries.

Because workers from restructuring industries suffered relatively high rates of displacement from 2001 to 2003 and because once displaced these workers incurred relatively long nonemployment spells, restructuring increased the level of aggregate nonemployment and thus reduced the utilization of resources in production during this period. To roughly quantify this effect, we can calculate steady state worker utilization rates using average displacement rates and hazard rates in the same two periods: 1997-1999 and 2001-2003. In particular, we define the steady state utilization rate $\bar{u}$ as:[18]

$$\bar{u} = 1 - \frac{d}{d+H}$$

where d is the average displacement rate and H is the average hazard rate out of nonemployment, computed as the inverse of the average nonemployment rate duration.[19] The steady state utilization rate of workers from restructuring industries fell from around 99.1 percent from 1997-1999 to 95.6 percent from 2001-2003. The decrease in nonrestructuring industries was much more modest, from 99.4 percent to 99.1 percent. Thus, while firms in restructuring industries appeared to shed unneeded resources fairly promptly, these resources required an extended period of time to find new employment.

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[18] The ratio $\frac{d}{d+H}$ is analogous to a steady state rate of unemployment. As shown by Shimer (2005), steady state unemployment rates track actual unemployment rates quite closely over the business cycle. Although exit rates from nonemployment for displaced workers are, on average, lower than exit rates from unemployment for all workers—leading to a larger discrepancy between actual and steady state rates—the steady state approximation is still informative.

[19] This equation follows from the steady state condition that $\dot{e}_t = H*(1-e_t) - d*e_t = 0$, where e represents employment. We implicitly assume that nonemployed displaced workers were available for work and thus contributed to reduced resource utilization.

A second type of cost associated with restructuring is the loss in income from capital specific to the restructuring industries. The flow of income lost includes both the lost earnings attributable to the labor and capital that are displaced from restructuring industries and the change in earnings for the labor and capital that remain. A measure of the lost income for human capital displaced from restructuring industries is available from the DWS. In particular, we can calculate the change in the average earnings of displaced workers as a percent of pre-displacement average earnings for these workers.[20]

Table 8 shows this calculation separately for displaced workers in restructuring and nonrestructuring industries and by whether the workers were reemployed in their original industry or in a different industry. As a group, displaced workers from restructuring industries experienced a decline in average earnings of 15½ percent. For the 70 percent of displaced workers switching industries, the decline in average earnings was larger (21.2 percent) than for workers not switching industries (3.3 percent). Thus, the implied loss of human capital is substantial, although it is important to note that the estimated magnitude of the loss depends critically on the assumption that changes in wages reflect changes in marginal products and not changes in rents. Displaced workers in nonrestructuring industries also saw a sizable drop in average earnings, although, as indicated in Table 7, the displacement rates in these industries were considerably lower.

To estimate the loss in earnings of nondisplaced capital, we compare price changes in restructuring industries with price changes in nonrestructuring industries. The basic intuition underlying this calculation is that the value-added price deflator for

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[20] Following the literature (see, for example, Katz and Murphy, 1992), we multiply topcoded earnings by 1.5, based on the assumption of a Pareto distribution for earnings above the topcode limit with Pareto parameter k=2. About 1.4 percent of the observations relevant to the calculations in table 8 were adjusted in this way.

restructuring industries represents the return to capital and labor in these industries, so that changes in earnings for capital and labor should be reflected in changes in the deflator. Of course, changes in the deflator will reflect general inflation trends as well, which we control for by subtracting out the average change in the price deflator for nonrestructuring industries. In addition, we control for differing trends in productivity and markups in restructuring and nonrestructuring industries using the average changes in the deflator between 1990 and 2000.[21] Thus, in essence, we use a triple differencing procedure to estimate the losses.

The loss in earnings of nondisplaced specific capital in restructuring industries can be equal to, greater, or smaller than the loss in earnings of displaced specific capital. If specific capital is homogeneous within restructuring industries, then the decline in earnings of displaced capital will equal the decline in earnings of capital not displaced. In contrast, if capital is heterogeneous with respect to specificity, and demand shocks are identical across firms within restructuring industries, then the decline in earnings of displaced capital should provide a lower bound for the loss in earnings of capital that remains in the restructuring sector because it is the relatively less specific capital that will be displaced. Finally, heterogeneous demand shocks increase the likelihood that displaced capital suffers greater earnings losses than nondisplaced capital because such shocks make it more likely that workers suffering large declines in specific human capital (or more-specific capital more generally) will be displaced and switch industries. In this context, the larger loss in earnings for workers switching out of restructuring industries

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[21] As shown in section IV, correlations between real value added and the price deflator suggest that shocks that affected restructuring industries post 2000 were largely demand shocks. Thus, comparing average deflator changes from 1990-2000 to 2000-2003 should primarily reflect the relative change in demand for restructuring industries.

relative to those remaining in the sector suggests that heterogeneous demand shocks have been an important source of restructuring.

Table 9 shows that the average rate of price change in restructuring industries fell from -0.8 percent over the 1990-2000 period to -2.5 percent over the 2000-2003 period, a difference of -1.7 percentage points. In contrast, in nonrestructuring industries, the average change in prices was about the same in the two periods. The estimated difference between the change in price inflation in the two sectors is -1.73 percentage points and is statistically significant. If we exclude computer manufacturing from restructuring industries, the results are similar, with a relative decline in the inflation rate of -2.30 percentage points. These difference-in-differences estimates of the relative changes in average prices over the two periods suggest that income for factors of production specific to restructuring industries fell significantly in the post 2000 period, even if these factors remained in their original industry.

It is also interesting to consider whether the declines in earnings were similar for human and nonhuman (physical or organizational) capital. Although we lack data on changes in the price of nonhuman capital displaced from restructuring industries, we can use the behavior of labor's share of total income to assess how changes in the total returns to capital remaining in restructuring industries were distributed between human capital and other capital. In this regard, Figure 3 indicates that from 1997 (the first year of published data) through 2001, labor's share rose rapidly in restructuring industries, both in absolute terms and relative to labor's share in nonrestructuring industries. Since 2001, however, labor's share has fallen in restructuring industries in both absolute and relative terms,

Possible explanations for the rise and decline in labor's share in restructuring industries include greater relative specificity of human capital, changes in technology, and shifts in bargaining power between human and nonhuman capital. With regard to the first possibility, theory suggests that a greater share of the change in income resulting from a change in demand will be borne by the factor that has a greater proportion of specific capital. Thus, the movements in labor's share could be explained if human capital is more specific than nonhuman capital. However, Ramey and Shapiro's (2001) study of the aircraft manufacturing industry suggests that the specificity of physical capital is quite large, making it unlikely that human capital is even more specific.

Regarding the other possible explanations, although technology changes have been ongoing over the 1990s, the 2001 recession may have increased the incentives or lowered the costs of labor-saving technology adoption for firms. For example, employers in restructuring industries may not have taken advantage of opportunities to increase efficiency through reductions in labor input in the late 1990s, either because the cost of reorganization, in terms of foregone output, was too high (Koenders and Rogerson, 2005), or because profits were above some threshold reference level (Rabin, 1998), so that managers or owners of non-human capital had little incentive to increase efficiency at that time. If so, these incentives likely changed abruptly after 2000, when profitability dropped sharply. Spurred to action, managers may have instituted changes in production processes to eliminate organizational inefficiencies and reduce labor's share.[22] At the same time, improvements in the global transportation and telecommunications infrastructure may have raised the bargaining power held by the owners of physical and

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[22] For an analysis of the large increases in productivity during this period, see Gordon (2003) and Oliner, Sichel and Stiroh (2007).

organizational capital by increasing the value of their outside opportunities. For example, many companies at that time began to outsource their customer support services, data entry work, and software writing, as well as other tasks, to countries with lower wages and a significant number of educated English speakers.

VI. The Economic Costs of Restructuring

To estimate the overall economic costs of restructuring, we rely on a framework provided by a simple two-sector model with sector-specific capital.[23] This model, which is described in the appendix, shows that the welfare cost of a relative demand shock can be decomposed into two components. The first component is the cost of transferring specific capital out of restructuring industries and into other industries. This cost includes the lost income from specific capital for factors of production transferred across sectors, as well as the time needed for these factors to become reemployed. The second component is the misallocation of resources that results from the cost of transferring sector-specific capital across sectors in response to a relative demand shock. As shown in the appendix, unless the elasticity of demand in restructuring industries is very high, the second component is likely to be negligible. Thus, we report costs only for the first component.

We first consider the reduction in earnings from the lost specific capital of workers displaced from restructuring industries. For this piece, we use the results reported in table 8, which show a 17.9 percentage point difference in earnings loss between displaced workers switching out of restructuring industries and displaced

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[23] Tapp (2008) takes a somewhat different approach to estimating the costs of restructuring. He calibrates a modified Mortensen and Pissarides (1994) style model to include industry-specific human capital and uses simulations from the model to calculate the welfare cost of a relative demand shock favoring resource-producing industries in Canada.

workers remaining in their original restructuring industry. However, as shown in the appendix, to capture the welfare loss associated with destroyed specific capital, we need to adjust this estimate to account for the difference in marginal utilities across industries induced by the presence of specific capital.

More precisely, we assume that the marginal product of capital is constant, but that when capital moves from restructuring to nonrestructuring industries, it is reduced by the amount $k^D = k_r^T - k_n^T$, where k_r^T is the amount of capital transferred out of restructuring industries and k_n^T is the amount of this capital reemployed in nonrestructuring industries (because part of the capital transferred is specific to restructuring industries, $k_r^T > k_n^T$). Thus, we would like to measure $p_n * mp_k * (k_r^T - k_n^T)$, where p_n is the price in the nonrestructuring sector (and under the assumption of perfect competition also marginal utility) and mp_k is the marginal product of capital. However, what we measure in table 8 is $p_r * mp_k * k_r^T - p_n * mp_k * k_n^T$. Because the cost of transferring specific capital across industries prevents equalization of the marginal utility product of capital across sectors, p_n will be greater than p_r (there is an excess of capital in restructuring sectors and a dearth in nonrestructuring sectors). As a result, the calculations in table 8 are downward biased estimates of $p_n * mp_k * (k_r^T - k_n^T)$. However, we can use the estimates of changes in prices in restructuring and nonrestructuring industries to correct for this bias. The calculations shown in table 9 imply that the average difference between p_n and p_r over 2000-2003 is 3.46 percent.[24] Thus, we adjust

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[24] This figure is the average difference in the price levels in the two sectors resulting from the estimated cumulative relative decline in prices in the restructuring sector (1.73 percent per year for three years).

the estimate in table 8 of the income loss from destroyed specific capital upward by 3.46

percentage points to 21.36 percent.[25]

To compute a cost we must make an assumption about how persistent the

reduction in specific human capital is. We make two extreme assumptions: that the

reduction is permanent and that the reduction lasts one year. Under the first assumption

we compute the reduction in income in a year as the *cumulative* number of displacements

times the reduction in human capital per displacement. Under the second assumption we

compute the reduction in income in a year as the number of displacements per year times

the reduction in human capital per displacement. The average cumulative number of

displacements that switch industries over 2001-2003 is 1.75 percent of aggregate

employment, while the average number of displacements per year was 0.875 percent. [26]

Multiplying the relevant number of displacements by the loss in earnings per

displacement times labor's share of income (0.7) yields the total loss in income per year.

As shown in the first two entries in table 10, we estimate this to be 0.26 percent of

aggregate income per year if the loss in specific human capital is permanent and 0.13

percent if it is temporary. If reallocated specific physical capital experienced a loss in

income of a similar magnitude, the total income loss would increase to about 0.37 percent

per year if the reduction in specific capital is permanent and 0.18 percent of aggregate

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[25] As new specific human capital is acquired in the worker's new industry, earnings should move back up toward previous levels. However, this reacquisition of capital may take some time and, for some workers (e.g. older workers) the costs of acquiring this new capital may exceed the benefits. As a result, the earnings loss from destroyed specific capital may extend beyond 2003.

[26] The total number of workers displaced in restructuring industries from 2001-2003 was 5.1 million. Total employment (including self employment and government workers) over these years averaged 136.2 million. Dividing 5.1 by 136.2 yields 3.74 percent. Assuming that that displacement rates occurred approximately uniformly across 2001-2003, the average displacement rate per year was 1.25 percent and the average cumulative displacement rate was 2.5 percent. Multiplying each number by 0.7 (the share of displacements switching industries) yields 0.875 and 1.75, respectively.

income per year if it is temporary, where we compute the cost for physical capital to be

$\frac{\alpha}{1-\alpha}$ times the cost for labor and α equals capital's share of income.

We next consider the time cost of finding new employment for workers displaced from restructuring industries. Table 7 shows that displaced workers who eventually found employment outside their original industry were nonemployed for an average of a little over 35 weeks (or 68 percent of a year). Multiplying this figure by labor's share, the proportion of workers displaced from restructuring industries each year, and the proportion of displaced workers who switch industries yields an estimate of the time cost of finding new employment for workers displaced from restructuring industries. As indicated in the third row of table 10, we estimate this to be about 0.41 percent of annual income per year. If the transfer of physical capital across industries was subject to a similar time cost, the total time cost of restructuring would increase to 0.6 percent of annual income.

The total cost, which is estimated to be between ½ and 1 percent of aggregate income per year, is large and suggests that restructuring had an important effect on economic welfare during the 2000-2003 period. However, movements of displaced workers across industries occur all the time, and thus an important question is how much of our estimated cost represents the effects of restructuring and how much is a continuation from previous levels. To answer this question we can compare the 2000-2003 period to the 1997-2000 period. In particular, the number of displaced industry switchers in the earlier period was much smaller; similarly, both the difference in wage changes between displaced workers switching industries and displaced workers remaining in their original industry and the difference in the average duration of

unemployment for these two groups was noticeably less.[27] As a result, we believe that almost all of the cost of restructuring during the 2000-2003 period represented an added burden to the economy.

A second question is whether our estimate of the cost of restructuring captures all of the effects of the relative demand shocks that led to restructuring. The answer is likely no. One reason is that such a large relative demand shock could have also acted as an aggregate demand shock depressing activity in industries other than restructuring.[28] In that case, the full cost of restructuring should include not only the cost of moving resources from restructuring to nonrestructuring industries but also at least some of the decline in aggregate resource utilization. In addition, because the average rate of permanent layoffs is considerably higher than rates of displacement, we may not be counting all the workers affected by restructuring, directly or indirectly. On the other hand, if, as suggested by Koenders and Rogerson (2004), the process of restructuring helped to eliminate unusually large inefficiencies in restructuring industries, then we may be overstating the cost of restructuring.

VII. Conclusion

In the 2001 recession and its aftermath, a number of industries suffered large and permanent reductions in employment consistent with what previous researchers have characterized as restructuring. In this paper, we have taken a closer look at developments in these industries to assess the causes and consequences of this restructuring.

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[27] In an environment where demand is increasing and worker displacement is limited, it is likely that only workers with relatively small amounts of specific capital will choose to find new employment outside their original industries. This selection effect reduces differences in earnings changes between workers remaining in and workers switching out of restructuring industries relative to environments where demand is declining and displacement rates are high.

[28] See, for example, Ramey and Shapiro (2001) and Phelan and Trejos (2000).

In principle, restructuring could occur in response to either supply or demand shocks. We find that for most industries, the pattern of correlations between prices, value added, wages, and productivity are more consistent with relative demand shocks being the predominant cause. In particular, in the typical industry, the relative demand shock led to a decline in labor demand and an increase in productivity, suggesting that the effects of the shock were concentrated in the less efficient segments of the industry. However, in a few industries, technology shocks (perhaps biased against labor) appeared to be the source of restructuring.

With regard to the consequences of restructuring, our evidence suggests that the economic costs were significant. Restructuring industries suffered more job destruction and greater permanent layoffs than other industries, leading to a significant loss of capital (human, physical, or organizational) specific to these industries. And, while the economy appeared to react relatively efficiently in moving unneeded resources out of restructuring industries, it took a considerable amount of time for these resources to be reemployed elsewhere. As a result, the costs of restructuring were large. In particular, we estimate that the cost to the aggregate economy, in terms of lost specific capital and the time needed to transfer resources from restructuring industries to other sectors, was on the order of between ½ percent and 1 percent of annual income per year from 2001 to 2003.

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Appendix

In the model there are two industries (restructuring denoted by subscript *r* and nonrestructuring denoted by subscript *n*) and two time periods. In the first period capital can be allocated without cost. We view this as approximating the mid to late 1990s, when both restructuring and nonrestructuring industries were expanding, and there was limited need to transfer resources across sectors. As a result, capital in each industry earns its marginal revenue product. At the start of the second period, the economy experiences a relative demand shock favoring nonrestructuring industries. This causes the economy to shift resources from restructuring to nonrestructuring industries. However, because capital is specific, only a fraction, *b*, of each unit of capital can be transferred across industries. This reduces welfare in two ways (relative to either the absence of the relative demand shock or the absence of specific capital). First, specific capital is lost when transferred across sectors. Second, because of the cost of transferring resources across sectors, the transfer is incomplete, and capital is misallocated.

We assume production is constant returns to scale in each industry and that there is one input, capital.

$$y_{i,t} = k_{i,t}, \ t = 1,2, \ i = n,r$$

Preferences over the two goods take the following form.

$$U_t = a_{n,t} \log\left(c_{n,t}\right) + \left(1 - a_{n,t}\right) \log\left(c_{r,t}\right)$$

where *c* represents consumption. In the first period, $a_{n,1} < .5$, and its value is expected to remain the same in period 2. The first period resource constraint is

$$K = k_{n,1} + k_{r,1}$$

Since we assume perfect competition, we can solve the central planner's problem to find the economy's allocation of capital across sectors.

$$\underset{k_{n,1}}{Max}\left\{a_{n,1} \log\left(k_{n,1}\right) + \left(1 - a_{n,1}\right) \log\left(K - k_{n,1}\right)\right\}$$

The solution is

$$k_{n,1} = a_{n,1}K; \ k_{r,1} = \left(1 - a_{n,1}\right)K$$

and utility is

$$U_1 = a_{n,1} \log\left(a_{n,1}K\right) + \left(1 - a_{n,1}\right) \log\left(\left(1 - a_{n,1}\right)K\right)$$

At the beginning of period 2, there is a relative demand shock that increases $a_{n,1}$. To make the change in relative demand utility-neutral (and thereby abstract from changes in relative demand directly affecting welfare) we assume

$$a_{n,2} = 1 - a_{n,1}$$

As a result, in a frictionless economy, $k_{n,2}$ would equal $k_{r,1}$, and $k_{r,2}$ would equal $k_{n,1}$. Utility in period 2 would be unchanged from period 1. But when there exists specific capital, transferring capital across sectors reduces the transferred capital by a fraction b.

$$k_{n,2} = k_{n,1} + b\left(k_{r,1} - k_{r,2}\right), \; if \; k_{n,2} > k_{n,1}$$

Thus, in the second period, the central planner's problem becomes

$$\underset{k_{n,2}}{Max}\left\{ a_{n,2}\log\left(k_{n,2}\right) + \left(1 - a_{n,2}\right)\log\left(k_{r,1} - \frac{1}{b}I\left(k_{n,2} - k_{n,1}\right)\right)\right\}$$

where I is an indicator variable equaling 1 if the expression in the succeeding parentheses is greater than 0 and equaling 0 otherwise. The first order condition is

$$\frac{a_{n,2}}{k_{n,2}} - \frac{1 - a_{n,2}}{bk_{r,2}} \leq 0$$

This expression will hold as an equality if capital is transferred from restructuring to nonrestructuring industries, which will be the case if the cost of transferring capital is not too great. That is, the condition will hold as an equality as long as

$$b > \frac{a_{n,2}^{2}}{\left(1 - a_{n,2}\right)^{2}}$$

If capital is transferred, then

$$k_{n,2} = \left(\frac{\left(1 - a_{n,2}\right)a_{n,2}}{b} + \left(1 - a_{n,2}\right)\left(1 - a_{n,1}\right)\right)K, \; k_{r,2} = \left(a_{n,1} + b\left(1 - a_{n,1}\right)\right)a_{n,2}K$$

Denoting the level of capital in the absence of specific capital as $k_{j,2}^{f}$, $j = n, r$, one can show that

$$\frac{k_{n,2}}{k_{n,2}^f} = b + a_{n,1}\left(1-b\right) < 1, \quad \frac{k_{r,2}}{k_{r,2}^f} = 1 + a_{n,1}\left(\frac{1}{b}-1\right) > 1$$

Thus, capital is misallocated with too little capital in nonrestructuring industries and too much capital in restructuring industries.

The amount of capital destroyed is equal to $(1-b)*\left(k_{r,1}-k_{r,2}\right)$. Substituting for $k_{r,2}$ and $k_{r,1}$, one gets the following expression for capital destroyed, k^D

$$k^D = (1-b)*\left(1-2a_{n,1} - a_{n,1}^2\left(\frac{1-b}{b}\right)\right)K$$

We compute the welfare cost of restructuring as the difference between the utility obtained when there is no change in preferences (i.e. no restructuring) and the utility obtained when there is restructuring; equivalently, this is the difference between utility obtained when capital is not specific and when it is. We can decompose this welfare loss into two terms: (1) the utility value of the destroyed capital, and (2) the utility loss from the misallocation of capital across the two sectors (relative to an economy that did not experience a preference shock or does not have specific capital).

Figure 4 describes these two components graphically. The x axis measures the proportion of total capital (K) allocated to each sector. The two curves represent the demand for output in the restructuring and nonrestructuring industries. Because the nonrestructuring sector is much larger, a given increase (decrease) in capital results in a much smaller decrease (increase) in price than in the restructuring sector. In the absence of specific capital, the demand curves would meet at point z, the frictionless optimum, where the marginal utility product of capital in restructuring industries equals the marginal utility product of capital in nonrestructuring industries. With specific capital, the economy is instead at points c and d. The amount of capital utilized at c and d do not sum to K because some capital has been destroyed during its transfer from restructuring to nonrestructuring industries. In addition, the economy has too much capital in the restructuring sector (relative to the socially optimal level)—c is to the right of z—because it is costly to transfer capital from restructuring to nonrestructuing industries. The economy has too little capital in nonrestructuring industries—d is to the right of z—both because of the excess capital in restructuring industries and because specific capital has been lost when it was transferred to nonrestructuring industries.

The difference in welfare between the economy's current state and the frictionless optimum is represented by the areas A and B. A is the area under the nonrestructuring demand curve as the economy moves toward the frictionless optimum by the amount of destroyed capital. It equals $\int_0^{k^D} p_n\left(k_{n,2}+i\right)di$, where p_n is the price (or marginal utility) of output in nonrestructuring industries, and $k_{n,2}$ is the amount of capital in the

nonrestructuring sector at point *d*. If, as in the figure, the amount of destroyed capital, relative to the amount of capital employed in nonrestructuring industries, is small and/or demand in nonrestructuring industries is not too inelastic, then this cost can be approximated by $p\left(k_{n,2}\right)*k^D$, or the current marginal utility product of capital in nonrestructuring industries times the amount of destroyed capital.

B is the loss in welfare due to the misallocation of capital. It is the space between the two demand curves as resources are transferred from restructuring to nonrestructuring industries and the economy moves toward the frictionless optimum. This area can be approximated as ½ the price difference between nonrestructuring and restructuring industries times the distance to the frictionless optimum. This latter distance depends importantly on the elasticity of demand in restructuring industries. Suppose the price difference between restructuring and nonrestructuring industries (the distance between c and f) is 3.5 percent (the average difference for the period 2001-2003 implied by the difference in differences calculation for the growth of the price deflator from 2000 to 2003 shown in table 9). Using the difference in differences calculation for the growth in real value added over the 2000-2003 period divided by the 3.5 percent change in relative price yields an estimated price elasticity that is close to -1. This implies that the distance to the frictionless optimum (segment ch) is 3.5 percent of restructuring industries' capital, or, given the restructuring sector's share of employment, about 0.45 percent of the economy's capital (assuming approximately equal capital to employment ratios in each sector). Area B is then estimated to be approximately equal to triangle fch, or $\frac{1}{2}*.035*.0045 = .000079$, or .0079 percent. Because of its small size, we ignore this component when computing the welfare cost of restructuring.

Table 1. Changes in Industry Employment Growth

Industry	Average Growth 1990-2000	Average Growth 2000-20003	Difference in Growth 1990-2000 to 2000-2003	Average Growth 2003 to 2005
Computer Systems Design and Related Services	**11.23**	**-5.26**	**-16.49**	**3.6**
Information and Data Processing Services	**6.97**	**-6.82**	**-13.79**	**-1.46**
Securities, commodity contracts, and Investments	4.88	-5.17	-10.04	2.13
Computer and Electronic Products	**-0.29**	**-9.27**	**-8.98**	**-1.6**
Apparel and Leather Manufacturing	-5.97	-14.35	-8.37	-7.8
Machinery Manufacturing	0.28	-7.77	-8.05	0.52
Electrical Equipment, Appliance and Components	**-0.22**	**-8.22**	**-8**	**-2.64**
Primary Metals	**-0.74**	**-8.69**	**-7.95**	**-1.06**
Textiles	**-1.81**	**-9.41**	**-7.61**	**-6.61**
Administrative and Support Services	4.92	-2.45	-7.37	4
Plastics and Rubber Products	**1.96**	**-5.2**	**-7.16**	**-0.92**
Motor Vehicles	**1.72**	**-5.42**	**-7.14**	**-0.72**
Fabricated Metal Manufacturing	1.23	-5.81	-7.04	1.34
Broadcasting and Telecommunications	**2.54**	**-4.49**	**-7.03**	**-2.86**
Furniture Manufacturing	**1.01**	**-5.84**	**-6.85**	**-0.61**
Other Transportation Services	4.61	-2.22	-6.83	1.73
Air Transportation	**2**	**-4.81**	**-6.82**	**-2.6**
Publishing	**1.92**	**-4.21**	**-6.13**	**-0.69**
Wood Product Manufacturing	1.45	-4.35	-5.8	2.23
Printing	**-0.14**	**-5.75**	**-5.6**	**-2.26**
Management of Companies and Enterprises	3.05	-2.16	-5.21	1.82
Paper	**-0.6**	**-5.32**	**-4.72**	**-3.15**
Truck Transportation	2.39	-2.12	-4.51	2.41
Nonmetallic Mineral Product Manufacturing	0.65	-3.82	-4.47	0.8
Miscellaneous Manufacturing	**0.85**	**-3.61**	**-4.46**	**-1.1**
Rental and Leasing Services	2.5	-1.79	-4.29	0.52
Motion Picture and Sound Recording	**2.81**	**-0.94**	**-3.75**	**0**
Miscellaneous Professional, Scientific and Technical Services	2.46	-1.26	-3.73	3.23
Funds, Trusts & other Fin. Vehicles	2.49	-1.16	-3.66	2.93
Warehousing	4.36	0.96	-3.41	4.85
Accomodation	1.65	-1.48	-3.13	1.16
Construction	2.63	0.02	-2.6	4
Chemicals	**-0.15**	**-2.75**	**-2.59**	**-1.72**
Legal Services	0.77	-1.19	-1.96	0.76

Industry	Average Growth from 1990-2000	Average Growth from 2000-20003	Difference in Growth 1990-2000 to 2000-2003	Average Growth from 2003 to 2005
Retail Trade	1.51	-0.4	-1.91	1.12
Wholesale Trade	0.65	-1.08	-1.74	1.46
Amusements, Gambling and Recreation Industries	4.46	2.83	-1.63	1.66
Other Transportation Equipment	-2.98	-4.41	-1.44	1.91
Mining Except Oil and Gas	-2.5	-3.78	-1.28	2.66
Food and Beverage Manufacturing	0.33	-0.93	-1.25	-1.31
Transit and Ground Passenger Transportation	2.32	1.18	-1.14	1.6
Performing Arts, Spectator Sports, Museums and Related Activities	1.69	0.61	-1.07	0.4
Ambulatory Health Care Services	3.89	2.95	-0.94	3.27
Food Services and Drinking Places	2.73	1.88	-0.85	2.7
Waste Management and Remediation Services	1.56	0.74	-0.82	2.77
Rail Transportation	-2.17	-2.97	-0.8	2.08
Pipeline Transportation	-3.15	-3.85	-0.7	-2.53
Insurance	0.81	0.45	-0.36	-0.41
Utilities	-1.97	-1.9	0.07	-1.67
Educational Services	3.23	3.35	0.12	2.7
Real Estate	1.25	1.5	0.26	2.4
Hospitals and Nursing and Residential Care Facilities	1.94	2.34	0.41	1.13
Other Services	1.24	1.96	0.72	0.07
Petroleum and Coal Products Manufacturing	-2.68	-1.95	0.72	-1.75
Water Transportation	-0.87	0	0.87	4.45
Social Assistance	4.88	6.23	1.34	2.67
Oil and Gas Extraction	-4.32	-1.59	2.73	2.43
Federal Reserve Banks, Credit Intermediation and Related Activities	0.34	3.07	2.73	1.54
Support Activities for Mining	-0.06	2.94	3	11.06
Memo:				
Total Restructuring	**1.47**	**-5.70**	**-6.47**	**-1.29**
Total Nonrestructuring	1.97	0.01	-1.96	1.92

Note. Restructuring Industries are in Bold.

Table 2. Correlations indicating supply or demand shocks

Correlation between	Restructuring	Nonrestructuring
Real Value Added/Prices	0.27 (<0.001)	-0.18 (0.374)
Employment/Real Value Added	0.71 (<0.001)	0.70 (<0.001)
Employment/Wages	0.45 (0.045)	0.33 (0.020)
Employment/Productivity	-0.32 (0.144)	-0.39 (0.061)

Note. To obtain p values (in parentheses) we bootstrapped a distribution, drawing 1000 samples after first expanding the original data set to make the number of (identical) observations for an industry proportional to the industry's share of employment.

Table 3. Types of Shocks Affecting Restructuring Industries

Industry	Correlation			Type of Shock
	(y, p)	(y, L)	(L, π)	
Motor Vehicle Manufacturing	+	+	-	Demand, shakeout
Furniture Manufacturing	+	+	-	Demand, shakeout
Electrical Equipment, Appliance, and Component Manufacturing	+	+	-	Demand, shakeout
Textiles Manufacturing	+	+	-	Demand, shakeout
Printing	+	+	-	Demand, shakeout
Paper Manufacturing	+	+	-	Demand, shakeout
Publishing	+	+	-	Demand, shakeout
Broadcasting and Telecommunications	+	+	-	Demand, shakeout
Primary Metal Manufacturing	+	+	-	Demand, shakeout
Air Transportation	+	+	-	Demand, shakeout
Computer Systems Design and Related Services	+	+	-	Demand, shakeout
Computer manufacturing	+	+	+	Demand, low utilization
Information and Data Processing Services	-	-	-	Positive Supply
Motion Picture and Sound Recording	-	-	-	Positive Supply
Chemical Manufacturing	-	-	-	Positive Supply
Miscellaneous Manufacturing	-	+	-	Negative Supply
Plastics and Rubber Manufacturing	-	+	-	Negative Supply

Note. Y represents output growth, p represents inflation, L represents employment growth, and π represents productivity growth.

Table 4. Changes in Plant Capital

Net Establishment Openings and Closings

Industry	Average rate 1991:Q3-2000:Q4	Average rate 2000:Q4-2003:Q4	Difference in average rates
Total restructuring industries	**-0.00**	**-0.3**	**-0.29**
			(<0.001)
Total nonrestructuring industries	0.24	0	-0.25
			(<0.001)
Difference	-0.25	-0.30	-0.05
	(<0.001)	(<0.001)	(0.43)

Changes in Plant Capacity

	Average rate 1990-2000	Average rate 2000-2003	Difference in average rates
Total restructuring industries	**4.65**	**2.34**	**-2.31**
			(0.015)
Total nonrestructuring industries	1.63	-0.58	-2.20
			(0.061)
Difference	3.02	2.91	-0.11
	(<0.001)	(0.025)	(0.94)

Note. Restructuring industries in bold. p values from least squares regressions are in parentheses. For establishment openings and closings, the unit of observation is industry/quarter, observations are weighted by employment, and the number of observations is 598. For plant capacity, the unit of observation is industry/year, observations are weighted by capacity, and the number of observations is 247.

Table 5. Changes in Job Creation and Job Destruction

Industry	Average rate 1991:Q3-2000:Q4	Average rate 2000:Q4-2003:Q4	Difference in average rates
Job Destruction			
Total restructuring industries	**2.56**	**2.90**	**0.35**
			(0.38)
Plant Closings	**0.95**	**0.98**	**0.04**
			(0.77)
Total nonrestructuring industries	4.07	3.94	-0.13
			(0.51)
Plant Closings	1.77	1.65	-0.13
			(0.03)
Difference	1.51	0.96	0.49
	(<0.001)	(0.01)	(0.28)
Plant Closings	-0.83	-0.66	0.16
	(<0.001)	(<0.001)	(0.24)
Job Creation			
Total restructuring industries	**2.64**	**2.12**	**-0.53**
			(0.21)
Plant Openings	**0.94**	**0.68**	**-0.26**
			(0.07)
Total nonrestructuring industries	4.44	3.9	-0.54
			(0.20)
Plant Openings	2.02	1.64	-0.38
			(<0.001)
Difference	-1.79	-1.77	0.02
	(<0.001)	(<0.001)	(0.97)
Plant Openings	-1.08	-0.96	0.12
	(<0.001)	(<0.001)	(0.78)

Note. Restructuring industries in bold. p values from least squares regressions are in parentheses. Observations are weighted by employment. The unit of observations is industry/quarter, and the number of observations is 598.

Table 6. Changes in Layoffs

Industry	Average monthly rate 1994-2000	Average monthly rate 2001-2003	Difference in average rates
Total Layoffs			
Total restructuring industries	**0.89**	**1.18**	**0.29**
			(0.023)
Total nonrestructuring industries	0.77	0.88	0.12
			(0.059)
Difference	0.12	0.29	0.18
	(0.13)	(0.013)	(0.22)
Permanent Layoffs			
Total restructuring industries	**0.41**	**0.63**	**0.22**
			(<0.001)
Total nonrestructuring industries	0.35	0.44	0.1
			(<0.001)
Difference	0.07	0.19	0.12
	(0.023)	(<0.001)	(0.027)

Note. Restructuring industries in bold. p values from least squares regressions are in parentheses. Observations are weighted by employment. The unit of observations is industry/year, and the number of observations is 328.

Table 7. Changes in Worker Utilization

Industry	Average 1997-1999	Average 2001-2003	Difference in Averages
Displacement Rates			
Total restructuring industries	**2.35**	**6.86**	**4.51**
			(<0.001)
Total nonrestructuring industries	1.64	1.75	0.10
			(0.87)
Difference	0.70	5.11	4.41
	(0.49)	(<0.001)	(0.003)
Nonemployment Duration (weeks)			
Total restructuring industries	**19.44**	**35.16**	**15.72**
			(<0.001)
Total nonrestructuring industries	18.80	27.97	9.16
			(<0.001)
Difference	0.64	7.19	6.56
	(0.43)	(<0.001)	(<0.001)
Estimated Utilization Rates			
Total restructuring industries	**99.2**	**95.6**	**-3.6**
Total nonrestructuring industries	99.4	99.1	-0.3
Difference	-0.2	-3.5	-3.3

Note. Restructuring industries in bold. p values from least squares regression are in parentheses. For displacement rates the unit of observation is industry/year, the number of observations is 193, and observations are weighted by employment. For nonemployment duration the unit of observation is individuals and the number of observations is 7340.

Table 8. Lost Income for Displaced Workers (2001-2003)

Average Earnings Change as Percent of Average Previous Earnings

Workers finding new employment in	Restructuring Industries		Nonrestructuring Industries	
	Percent of displaced workers	**Earnings change**	**Percent of displaced workers**	**Earnings change**
Any industry	**100**	**-15.62**	100	-11.77
Original industry	**29.8**	**-3.3**	37.7	-3.8
New industry	**70.2**	**-21.2**	62.3	-17.1
Difference between original and new		**17.9** **(0.001)**		13.3 (<0.001)

Note. Restructuring industries in bold. p values from least squares regression are in parentheses. The number of observations is 4,441.

Table 9. Lost Income for Capital and Workers Remaining in Restructuring Industries

Changes in Value Added Deflators

Industry	Average 1990-2000	Average 2000-2003	Difference in Averages
Total restructuring industries	**-0.81**	**-2.51**	**-1.70**
			(0.05)
Total nonrestructuring industries	2.56	2.59	0.03
			(0.96)
Difference	-3.37	-5.10	-1.73
	(<0.001)	(<0.001)	(0.016)

Changes in Value Added Deflators (excluding computers)

Industry	Average 1990-2000	Average 2000-2003	Difference in Averages
Total restructuring industries	**1.52**	**-0.75**	**-2.27**
			(0.002)
Total nonrestructuring industries	2.56	2.59	0.03
			(0.96)
Difference	-1.04	-3.34	-2.30
	(0.004)	(<0.001)	(0.009)

Note. Restructuring industries in bold. p values from least squares regression are in parentheses. The unit of observation is industry group/year, where industry groups are restructuring and nonrestructuring industries. Observations are weighted by value added, and the number of observations is

Table 10. Economic Cost of Restructuring

	Only human capital affected	Human and physical capital affected
Lost Income from Destroyed Specific Capital		
Loss in specific capital is Permanent	.2136*.7*.0175=0.26%	.2136*.0175=0.37%
Loss in specific capital is Temporary	.2136*.7*.00875=0.13%	.2136*.00875=0.18%
Lost Income from Time Cost of Finding New Employment	.68*.7*.00875=0.41%	.68*.00875=0.6%
Total Cost		
Loss in specific capital is Permanent	0.67%	0.97%
Loss in specific capital is Temporary	0.54%	0.78%

Note. Restructuring industries in bold. p values in parentheses.

Figure 1. Employment in Restructuring Industries
(Thousands)

Computer Systems Design and Related Services

Information and Data Processing Services

Computer and Electronic Product Manufacturing

Electrical Equipment, Applicance and Component Manufacturing
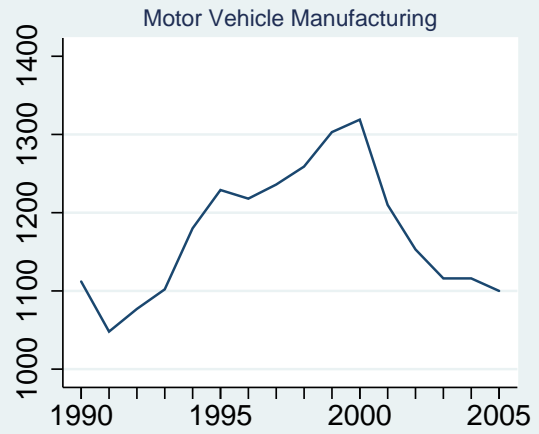
Primary Metal Manufacturing

Textiles Manufacturing

Figure 1 continued. Employment in Restructuring Industries
(Thousands)

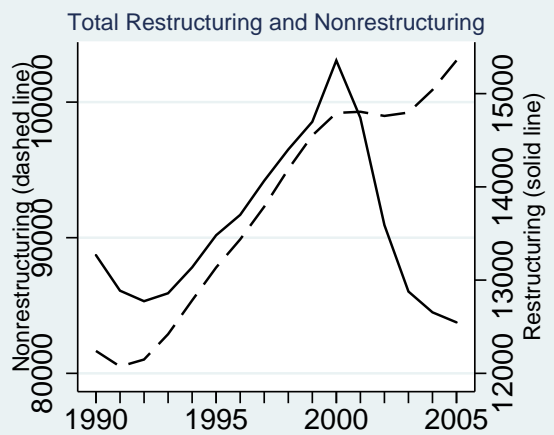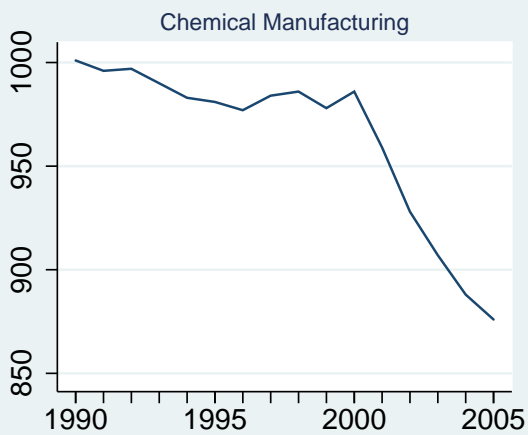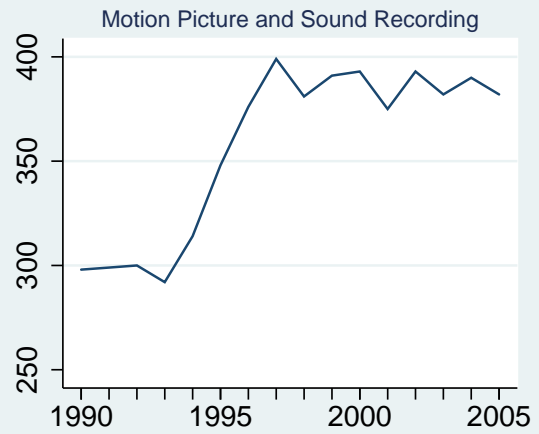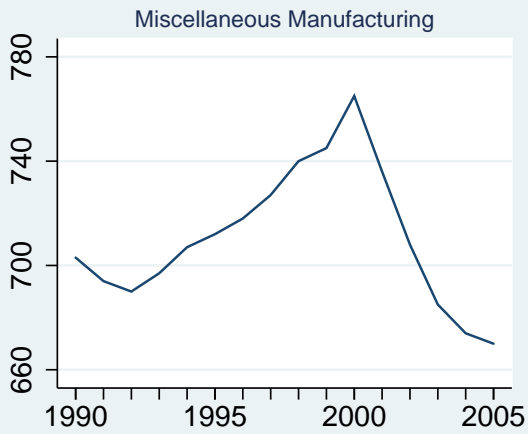
Plastics and Rubber Products Manufacturing

Motor Vehicle Manufacturing

Broadcasting and Telecommunications

Furniture Manufacturing

Air Transportation

Publishing

Figure 1 continued. Employment in Restructuring Industries
(Thousands)

Printing

Paper Manufacturing

Miscellaneous Manufacturing

Motion Picture and Sound Recording

Chemical Manufacturing

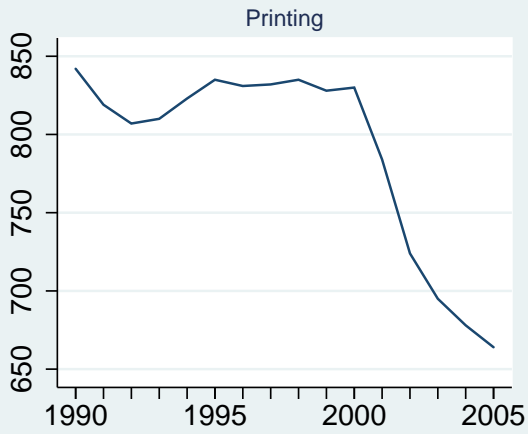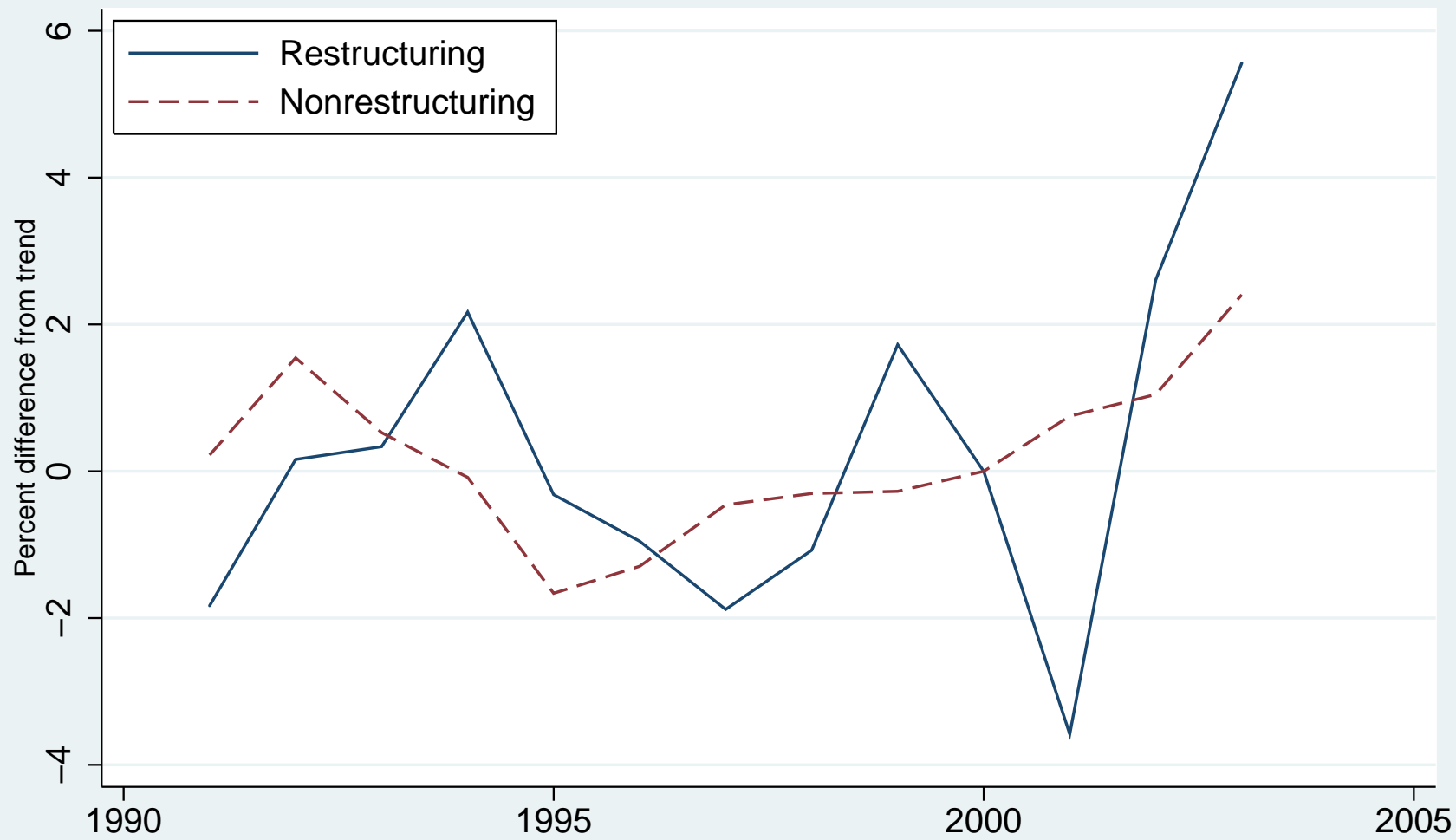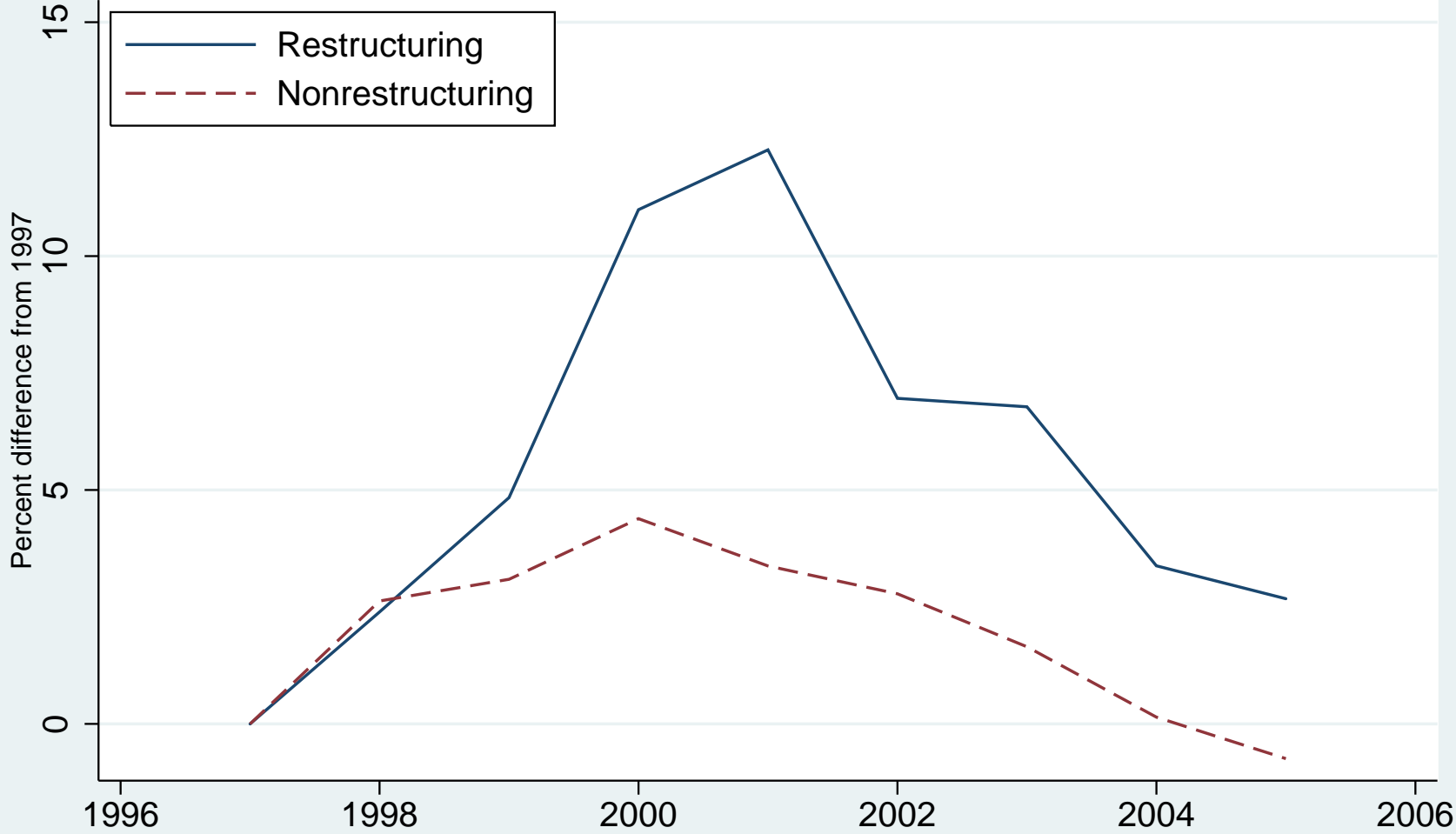Total Restructuring and Nonrestructuring

Figure 2. Productivity

Figure 3. Labor Share

Figure 4. The Economic Cost of Restructuring

Marginal
Utility

Restructuring

Nonrestructuring

f

d

z

g

B

A

h

c

A

0

K

Capital in restructuring industries increases

Capital in nonrestructuring industries increases