Defense Spending, Aerospace, and the California Economy

James Dertouzos and Michael Dardia
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PREFACE

RAND has a forty-year history of research on improving the process by which the Department of Defense develops and procures its major weapon systems. That research has frequently touched on issues involving the defense industrial base, but because most of the research has been sponsored by the federal government, the topics usually concerned national or international issues. In 1991, questions about the health and prospects of the defense industry in California raised by Representatives Julian Dixon (D-Cal) and Jerry Lewis (R-Cal) during a visit to RAND prompted this study. It has been financed by RAND's own funds.
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At RAND, we benefited from excellent programming assistance from Margaret Hwang, Laurie McDonald, and Loretta Verma. We are grateful to C. Richard Neu, Robert Roll, and Giles Smith for their valuable comments. Finally we thank Michael Rich for overall guidance, support, and help in sharpening the focus of our research. Of course, any remaining errors are our responsibility.
1. INTRODUCTION

Increasing budgetary pressures and the reordering of national priorities have led to significant declines in military procurement. These declines raise public policy concerns about the overall economy, the defense industrial base, and the economic well-being of regions, industries, and workers that are particularly dependent on procurement.

Clearly, the defense cuts could dampen an already sluggish economy. Estimates indicate that by the end of 1993 the total number of defense-related jobs will have fallen by 20 percent nationally from the 1987 peak, representing almost half a million jobs in the private sector. In addition, such job losses are likely to have a multiplier effect on other industries, particularly on businesses providing goods and services to defense firms and workers.

Despite their large absolute magnitude, it is important to keep such employment declines in perspective. Indeed, the direct job losses represent only one-half of one percent of total U.S. employment. In addition, layoffs account for only a fraction of the employment declines. Frequently, firms rely on early retirement programs and other forms of natural attrition for the majority of their reductions. To the extent that displaced workers find suitable positions elsewhere, the effect on aggregate unemployment rates will be quite small.

On the other hand, the microeconomic issues are likely to be of greater policy significance. One set of questions concerns the health of the defense industrial base. Will prime contractors survive the shrinking defense business base by effectively downsizing or by entering new commercial markets? How will the lower tiers of the defense industrial base be affected? Will the affected industries be capable of future expansion? In addition, high levels of regional, industrial, and occupational concentration means that defense cuts will have serious distributional consequences. A major goal of most "defense conversion"
proposals is easing the economic burden on those individual firms, communities, and occupational groups most heavily dependent on government procurement.

According to press accounts and several economic impact studies, declines in aerospace procurement have hurt California particularly, especially Los Angeles County. This attention stems from the heavy regional dependence on the aerospace industry and the fact that California is commonly believed to be more generally suffering from an overall economic malaise that is likely to be exacerbated by procurement cuts. Several recent studies have projected rather large employment losses in the state.\textsuperscript{2} Depending on underlying assumptions concerning national budgets, the regional allocation of subcontracts, and multiplier effects on ancillary business, the estimated declines range from 200,000 to 375,000 jobs by 1995.

Assessing the public policy implications of these aggregate employment declines is difficult in the absence of more information about the microeconomic consequences for California communities, firms, and workers. In this study, we endeavor to narrow the knowledge gap by providing answers to several questions.

- First, how important is the defense-dependent sector to California and Los Angeles?
- What has happened to this industry's firms and workers since 1987?
- What explains the declines in California?
- Are California employment declines consistent with the national employment pattern stemming from cuts in defense spending?
- Have changes in the composition of defense spending hurt or helped California?

\textsuperscript{2}For example, a 1991 McKinsey study projected a 250,000 to 375,000 job loss for California by the mid-1990s. Separate studies by the Atlanta Federal Reserve Bank and Data Resources Inc., also published in 1991, projected annual direct jobs losses of about 20,000 for the same period. The L.A. Aerospace Task Force estimated that job losses in Los Angeles alone could total 115,000 by 1995 if losses continued at the same rate as in 1990-91.
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- What role has the overall climate for doing business in California and Los Angeles had?
- Finally, to what extent have changes in defense procurement policies (e.g., the 1984 Competition in Contracting Act) affected the flow of business to California?

Given the answers to such questions, we draw policy implications for California and for the structure of so-called defense conversion programs designed to reduce the transitional burdens.
2. STUDY APPROACH

Estimating defense employment in a particular region is quite difficult. Establishment-level employment data do not distinguish between commercial and defense production. To circumvent this problem, many studies use the geographic distribution of prime awards as a proxy for employment. Unfortunately, awards may not be a very accurate measure. Even if the place of performance (as opposed to the location of the administrative headquarters) is identified, half or more of each award may be distributed to subcontractors, which are often located in other states (our own interviews of prime contractors suggest that at least 30-40 percent of this subcontractor work is performed outside California) and which belong to other industries. In addition, public accountings of prime awards exclude "black" or secret programs, often representing large portions of overall procurement activity. For example, the B-2 represented about 10 percent of California awards in the late 1980s. Even more sophisticated methods of estimating employment, such as the DEIMS (Defense Economic Impact Modeling System) input-output model used by DoD, rely on the distribution of prime awards for estimating shares of outlays for direct defense purchases. Thus, the same difficulties mentioned above plague these estimates.

Because of the problems in using prime award allocations to infer defense employment, we have chosen to analyze information provided by the Labor Department on employment in the aerospace industry,\textsuperscript{1} including the aircraft and parts sector, the missiles and space sector, and the electronics and communications sector. This industry had nationwide total sales of $134 billion in 1990 and employed 1.7 million workers--roughly two-thirds of all private sector defense industry employment. Although state- and county-level data fail to distinguish between defense and commercial employment, these sectors are heavily defense-dependent and their allocation to particular regions is

\textsuperscript{1}Throughout the study we use annual average employment figures, which may not be the same as year-end figures often quoted. Average figures avoid distortions created by the volatility of monthly data.
accurate. In addition, from a policy perspective we may care more about overall employment in related business activities, since this is the essence of the conversion issue.

Table 1 lists the aerospace sectors and the relevant SIC (Standard Industrial Classification) codes, and provides estimates of the percentage of revenues attributable to defense contracts. The Congressional Budget Office and the Department of Commerce studies refer to U.S. totals. These studies link defense budget items to specific industries to estimate final defense demand. The third set of estimates for California was provided by Data Resources Inc., using its model of the California economy. The estimates vary from just under 20 percent for instruments (SICs 381 and 382) to as much as 90 percent for the missiles and space sector. For aircraft and parts, all estimates are slightly over 40 percent. Weighted by employment, the average defense dependency for all of aerospace in California is also approximately 40 percent. In comparison, defense demand is estimated at 6 percent of revenue for all manufacturing industries.

<table>
<thead>
<tr>
<th>Industry (SIC)</th>
<th>Congressional Budget Office (United States)</th>
<th>Department of Commerce (United States)</th>
<th>Data Resources Inc. (California)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missiles and space (376)</td>
<td>84%</td>
<td>90%</td>
<td>81%</td>
</tr>
<tr>
<td>Aircraft (372)</td>
<td>40-43%</td>
<td>43-46%</td>
<td>41%</td>
</tr>
<tr>
<td>Communications (366)</td>
<td>42%</td>
<td>36%</td>
<td>34%</td>
</tr>
<tr>
<td>Instruments (381-382)</td>
<td>18%</td>
<td>--</td>
<td>17%</td>
</tr>
</tbody>
</table>

Because of a change in the kinds of business activities allocated in SICs 366, 381, and 382 in the 1987 coding revision, we have combined employment data for these sectors into a single group that we will refer to as "electronics and communications" for much of the following analysis.
3. THE IMPORTANCE OF AEROSPACE TO CALIFORNIA

Nationally, aerospace employment represents nearly two million jobs. In relative terms, this total amounts to about 2 percent of U.S. employment and between 8 and 9 percent of manufacturing employment. About one-quarter of all aerospace employment is in California, representing about 21 percent of the state’s manufacturing employment but only 4 percent of total employment. Aerospace is even more important to Los Angeles, representing over 26 percent of all manufacturing employees who work in that county and 6 percent of total employment (Figure 1). Note that for all California counties exclusive of Los Angeles, aerospace’s relative importance (expressed as a percentage of total employment) is similar to that of the United States as a whole. However, aerospace remains a significant portion of manufacturing employment, even outside Los Angeles County.

![Graph showing aerospace share of employment (Figure 1--Aerospace Share of Employment, 1990)]
Generally, manufacturing jobs create more economic value than other types of employment. Manufacturing activity creates ancillary service industries and attracts highly skilled, well-paid workers who contribute more to the tax base of a local community. One measure of this extra economic value is illustrated by comparisons of gross state product, or total output, per worker for different industrial categories. As shown in Figure 2, in service industries the gross state product per worker is about $30,000. For the manufacturing sector, the average gross state product per employee is much higher, nearly $55,000. Aerospace production is even more valuable, at about $72,000 worth of output per worker. This is 140 percent higher than the typical service job. A related measure is value-added, which is the best measure for comparing the economic importance of different manufacturing industries. Value-added per employee in 1987 was $69,978 for aerospace compared to $61,613 for all manufacturing—a smaller margin but still 14 percent higher for aerospace industries.

Another reason for the purported desirability of aerospace jobs is the assumption that these jobs are among the most highly skilled in the

Figure 2--Gross State Product per Worker, 1989
economy. Clearly, aerospace workers are highly educated. Figure 3 uses data from the Census Bureau to compare the educational attainment of aerospace workers with that of all other manufacturing workers in California (excluding those in aerospace). Note, for example, that nearly 35 percent of all aerospace workers are college graduates--more than twice the percentage of workers in other fields. In addition, many of the workers in the "Some college" category are technicians with two-year degrees rather than those who have not completed a college program; anecdotally, this is much more prevalent than in the rest of manufacturing.

The occupational mix of aerospace workers also favors higher skill levels. Figure 4 provides percentage breakdowns for four broad occupational categories. For example, about 8 percent of non-aerospace manufacturing workers can be classified as professional or technical employees. In relative terms, this category contains four times as many workers in the aerospace sector. That is, over 34 percent of aerospace employees are in professional or technical categories. This implies that over half of the state's manufacturing professional and technical
workers are employed by aerospace firms (that fraction is even higher in Los Angeles, 60 percent). Thus, regardless of whether or not aerospace jobs are truly more valuable in an economic sense, it is clear that certain occupational groups will bear a heavy burden following defense cuts.

Figure 4--Occupational Mix, 1990
4. THE DECLINES IN AEROSPACE EMPLOYMENT

Following rapid increases during the early Reagan years, aerospace prime contract awards peaked, in real terms, in 1985. By 1990, prime awards fell to 1980 levels, a 40 percent decline compared with the 1985 level (Figure 5). The most dramatic increase and decline occurred in the aircraft sector; however, all three time series exhibit the same pattern. The pattern of employment declines is very similar though less dramatic (Figure 6). This partially reflects the inclusion of commercial employment which, if the number of employees per dollar of revenues is the same as in defense work, accounts for about 60 percent of total employment. Also important is the fact that firms do not generally make instantaneous manpower adjustments in response to changes in labor demand. Still, the time series indicate that aerospace employment fell from a peak of 484,000 to about 416,000 workers in 1991—a decline of about 14 percent. Note that peak employment occurred in

![Figure 5--Prime Awards to California, by Industry](image_url)
1987, reflecting the two-year delay between appropriation levels and discernible effects on employment. (Preliminary data for 1992 show a further 14 percent decline for California in 1992 alone; because of the incomplete nature of the 1992 estimates, we use data only through 1991 for the following analysis. The preliminary 1992 declines mirror the ratio from 1987 to 1991--aerospace employment in the United States fell by almost 10 percent and in California it fell by over 14 percent.)

The comparisons between prime awards and employment are further explored in Figure 7. Annual percentage changes in each are compared for years between 1980 and 1990. This exercise confirms what we have already seen--namely, that there exist strong correlations (with a two-year lag) but fluctuations in aerospace employment are not quite as severe as those in prime awards.

**DECLINES ARE MUCH MORE SEVERE IN LOS ANGELES**

As indicated in Figure 8, Los Angeles has fared very poorly in comparison with the rest of the state. During the earlier expansion and subsequent contraction, Los Angeles County aerospace employment has
Figure 7--Change in California Aerospace Awards and Employment

Figure 8--Aerospace Has Done Poorly in Los Angeles
failed to keep pace with other California counties. During the 1984-1987 period, for example, California aerospace employment grew by over 11 percent. For Los Angeles County the rise was smaller, at 7.4 percent; for other counties the growth rate was over twice as large. This discrepancy is magnified by the fact that Los Angeles County contains half the state's aerospace workers. The same relative performance prevailed during the recent contraction of aerospace employment. The California aerospace employment decline was 14 percent following the 1987 peak. The decline in Los Angeles was significantly higher, at 20.3 percent. Not only is aerospace more important to Los Angeles, but the employment losses were much more dramatic. To put this difference into perspective, recall that aerospace employment, when expressed as a percentage of manufacturing, is three times as important to Los Angeles as to the United States as a whole. Taken along with an aerospace employment decline that was, in percentage terms, twice as large, one concludes that the relative effect of the Los Angeles aerospace declines was six times as great as that in the rest of the country.

DIFFERENTIAL EFFECTS OF FIRM SIZE AND OCCUPATION

Figure 9 decomposes the aggregate employment declines by firm size, comparing the share of declines to the share of total employment for the two-digit SIC industry groups that contain the aerospace industries. (Data on the specific aerospace industries are not available; however, analysis using information from individual large contractors and from Dun and Bradstreet demonstrate similar trends.) The evidence clearly indicates that larger firms have experienced the bulk of the employment declines. For the 1987-90 period analyzed, firms having 1,000 or more workers represented about 50 percent of total aerospace employment. However, employment declines for these firms were 120 percent of the industry's total losses. Employment actually increased for firms having between 250 and 1,000 workers.

These relative differences probably partially reflect broader economic trends that favor smaller enterprises. These include increases in business liability, increased international competitiveness and a
need for flexibility, and rises in the costs of providing standard benefits packages, such as health care. Survey data also indicate that small firms are on average less defense-dependent than larger firms. In addition, smaller firms may have been more capable of converting high-tech assets, particularly human resources, to alternative private sector applications. The largest defense contractors, primarily engaged in the administration and integration of large-scale government programs subject to a wide range of regulatory (as opposed to market) constraints, do not appear to have converted or diversified as readily.

Using data from the Current Population Survey, we have also decomposed employment changes since 1983 by age and occupational category (see Table 2). During the 1983-87 expansion, significant hiring in all categories occurred, especially in the under-30 age category. Especially noteworthy is a 58 percent increase in executive or administrative occupations. During the subsequent contraction, much of the employment decline (about 75 percent) occurred in the under-30 group; the proportion of aerospace workers under 30 years old fell from 29 percent in 1980 to 19 percent in 1991. This decline primarily
Table 2
Changes in Aerospace Employment, by Occupation

<table>
<thead>
<tr>
<th></th>
<th>1983-87</th>
<th>1987-91</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Executives</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All ages</td>
<td>58%</td>
<td>-9%</td>
</tr>
<tr>
<td>Under 30</td>
<td>73%</td>
<td>-61%</td>
</tr>
<tr>
<td><strong>Professional and technical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All ages</td>
<td>23%</td>
<td>-23%</td>
</tr>
<tr>
<td>Under 30</td>
<td>75%</td>
<td>-65%</td>
</tr>
<tr>
<td><strong>Production and craft</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All ages</td>
<td>31%</td>
<td>-13%</td>
</tr>
<tr>
<td>Under 30</td>
<td>29%</td>
<td>-17%</td>
</tr>
</tbody>
</table>

reflects a cessation in hiring activity along with the natural aging of the work force over the four-year period. Although strong conclusions must await more detailed analysis of recent data (from press accounts, it appears that firms may be relying more on layoffs recently), it is clear that the bulk of the job losses thus far are not the result of large-scale layoffs of experienced aerospace workers. On the other hand, the job prospects of younger and more recently educated workers are not promising.

It is also interesting to note that although technical and professional employment fell by 23 percent, the overall employment of executives and administrative workers dropped by only 9 percent. In comparison with the early 1980s, the current composition of the aerospace workforce is more heavily weighted toward administrative overhead rather than the production, professional, and technical employees who directly contribute to a firm's productive activities.
5. EXPLAINING THE CALIFORNIA AEROSPACE DECLINES

There are four likely explanations for the 14 percent decline in California aerospace employment from the 1987 peak to 1991. First, the California decline may simply reflect national employment patterns. Second, to the extent that the composition of aerospace activity is different in California, changes in the national mix of procurement spending could have a differential effect on this state. Third, the California aerospace industry could have differentially suffered because of a deteriorating climate for doing business in the state. Last, changes in procurement policies may have altered the ability of California firms to compete with those in lower-cost states.

Figure 10 compares recent historic trends in national and California aerospace employment. Absolute levels of employment are indexed to be equal to 1.0 in 1983. Although the correlations are not perfect, California's pattern closely resembles national changes.

Figure 10--National Trends Explain Some of the California Changes in Employment
Simple regressions of the annual California employment changes on U.S. growth rates indicate that, on average, about 80 percent of the variation in California can be accounted for by national fluctuations. Note that before 1987, California's aerospace growth outpaced that of the nation; during the decline from 1987 to 1991, California employment fell by 14 percent whereas the national decline was only 10.7 percent. This indicates that the California aerospace growth advantage has diminished over time.

Figure 11 summarizes the U.S./California aerospace growth comparison for four-year intervals since 1978. Note that the growth advantage has been steadily declining and is now negative. California aerospace employment increased by 25.9 percent between 1978 and 1981. At the same time, national growth was 19 percent for a difference of 6.9 percent. This difference fell to 4.5 percent from 1981-84 and to 2.8 percent from 84-87, and by the final period the difference became negative at -3.3 percent.

Figure 11--Change in Aerospace Employment
In looking for the reasons for these differences, we see that the industrial composition of California’s aerospace business differs from the nation’s. In particular, employment in the missiles and space sector represents about 14 percent of California aerospace. This contrasts with the missile and space sector’s 10 percent share prevailing in the country as a whole. At the same time, the aircraft and electronics sectors are slightly less important in California. Until recently, national growth rates have been higher in missiles and space--thus, this sector’s higher share in California has been an advantage to the state. Since 1987, however, missiles and space business has fallen more rapidly than the other aerospace segments, so California’s traditional industrial mix advantage has turned into a disadvantage (Figure 12).

Figure 12--Does California’s Industry Mix Explain the Employment Decline?
We next attempt to decompose the California aerospace employment changes into the portion attributable to the national change, the industrial mix effect, and a residual that can be attributed to a California advantage (or recently, a disadvantage) in attracting aerospace business. For example, during the 1978-81 period, California employment grew by 25.9 percent, about 19 percent of which can be attributed to the national growth in aerospace. In addition, because of the favorable industrial mix (i.e., a greater share for the higher-growth missiles and space sector), California employment in aerospace grew by 1.7 percent more than in the nation. This leaves an unexplained portion of the 1978-81 growth rate of 5.2 percent. This residual can be viewed as California’s aerospace competitive advantage (Table 3). Note that the favorable industrial mix effect steadily declined from period to period, becoming negative by 1987-91. This negative industrial mix effect explains about one-third of the 3.3 percent difference between California’s and the nation’s aerospace employment declines over this period. Thus, we are left with a 2.2 percent California competitive disadvantage.

It is clear that California’s historic competitive advantage in attracting aerospace business has been steadily eroding since the late 1970s. Even when accounting for an increasingly unfavorable industrial mix, California’s ability to maintain its relative edge (vis-a-vis the rest of the country) in aerospace employment growth has now disappeared. We now turn to possible reasons for this competitive decline.

Table 3
Decomposing Trends in California Aerospace

<table>
<thead>
<tr>
<th>Period</th>
<th>California Change</th>
<th>National Change</th>
<th>Industrial Mix Effect</th>
<th>California Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978-81</td>
<td>25.9%</td>
<td>19.0%</td>
<td>1.7%</td>
<td>5.2%</td>
</tr>
<tr>
<td>1981-84</td>
<td>6.0%</td>
<td>1.5%</td>
<td>1.3%</td>
<td>2.9%</td>
</tr>
<tr>
<td>1984-87</td>
<td>11.1%</td>
<td>8.3%</td>
<td>1.2%</td>
<td>1.6%</td>
</tr>
<tr>
<td>1987-91</td>
<td>-14.0%</td>
<td>-10.7%</td>
<td>-1.1%</td>
<td>-2.2%</td>
</tr>
</tbody>
</table>
THE CALIFORNIA BUSINESS CLIMATE

For a variety of reasons, California’s economic environment is viewed as becoming increasingly hostile to business. Observers in the media and business community cite several factors, including the burden of environmental regulation (both the level of standards and the cumbersome regulatory process), increasing costs of worker’s compensation, a more threatening liability system, high-cost but often low-productivity labor, and perceived declines in the overall quality of life. In a series of interviews with executives of several of the top ten defense contractors in the state, a similar set of factors were mentioned as being problematic, although several mentioned that they uncovered no clearly superior alternative. A key distinction that emerged from these discussions was between plant relocations and decisions about where to start new plants. Although all mentioned that California was less attractive for new sites than it once was (for all the reasons mentioned above), the firms viewed relocation costs of $50,000 and up per employee, as well as problems in disposing of existing sites and assets, as major impediments to relocating existing plants.

If such business climate factors have reduced California’s competitive advantage in aerospace, the economic climate for other manufacturing sectors should have deteriorated as well, since they all face at least some of these problems. Examining the evidence to see if this is true, Figure 13 compares annual changes in U.S. and California manufacturing employment (excluding aerospace). As is evident, national business cycles are also reflected in California employment fluctuations. For the most part, California has outperformed the national economy since 1981 (in eight of eleven years), often by a significant margin.

There is no strong correlation between annual changes in California aerospace and non-aerospace manufacturing employment. For example, although the beginnings of the current California recession are reflected in the manufacturing declines during 1990 and 1991, the severity of the aerospace employment reductions since 1987 is not duplicated in the non aerospace manufacturing sectors. The raw
Figure 13--Non-Aerospace Manufacturing Changes

The information contained in the previous figures can be assimilated to make more precise comparisons of California's competitive advantage in aerospace versus non-aerospace manufacturing industries. As in earlier figures, in Figure 14 the California aerospace advantage is defined as the difference in the state and national growth rates minus the industrial mix effect. As indicated above, this advantage has been diminishing steadily and is now negative. Similarly, the California manufacturing advantage is defined as the difference between the state and national growth rate in non-aerospace manufacturing employment minus a manufacturing industrial mix effect. This latter calculation considers differences in the composition of manufacturing industries (at the three-digit SIC level). Until recently, California had a minor (less than 1 percent) industrial mix advantage because of the relative importance of several fast growth industries, including the publishing and metal fabrication sectors. At the same time declining sectors such as primary metals are less prevalent in California.

Interestingly, the pattern in the manufacturing sector is quite similar to that in the aerospace industries. That is, the manufacturing
advantage has steadily declined from 7.2 percent to 1.6 percent. Thus, it appears that the secular declines in California’s aerospace employment advantage may be partly due to general economic phenomena that also affect non-aerospace manufacturing sectors. However, it seems that the relative decline in California’s aerospace employment has escalated recently. This was confirmed by a more rigorous empirical analysis in which California’s aerospace advantage (on an annual basis) was regressed on the manufacturing advantage. Although indicating strong correlations in the series, this simple exercise indicated that the estimated disadvantage in California aerospace during the most recent period (2.2 percent decline) could not be explained by declines in non-aerospace employment (1.6 percent growth). Note however that the manufacturing competitive effect, while shrunken significantly, is still positive relative to the rest of the country—the decline in the business climate is a retreat from higher, earlier levels.
Similar to the more severe declines noted above in the case of aerospace, the bulk of the manufacturing declines are concentrated in Los Angeles County. As illustrated in Figure 15, despite the very modest decline in California non-aerospace manufacturing of -0.4 percent since 1987, such employment fell by over 7 percent in Los Angeles County. Outside Los Angeles, employment in California’s other manufacturing industries rose significantly. The 4.4 percent increase in California (excluding Los Angeles) compares with a national decline of 2.2 percent over this time period. Apparently, California’s economic woes are primarily Los Angeles’ problems.

Although this research made no attempt to isolate the economic factors that were the cause of the manufacturing decline, it is clear that the California-versus-Los-Angeles distinction narrows the set of candidates. That is, factors that are homogeneous across California, such as the regulatory standards, liability standards, the system of higher education, or state statutes, would not cause this differential effect. On the other hand, the declines in the quality of urban life,
housing costs, bureaucratic delays, and problems associated with local public finance are likely to be most relevant for the secular decline in Los Angeles' competitive status.

THE ROLE OF GOVERNMENT CONTRACTING PRACTICES

Thus far, a simple accounting of employment changes suggests that we can account for much of the aerospace employment declines during the post-1987 period. About 80 percent of the 14 percent employment decline in California can be attributed to national aerospace cutbacks. About 1.1 percent of the decline (one-third of the remaining change) is due to an unfavorable aerospace industrial mix (i.e., higher reliance on the missiles and space industry). Although experiencing erosion of large historic advantages, the California manufacturing sector over this period still outperformed the rest of the country. The California advantage in our comparison of non-aerospace manufacturing growth rates (net of industrial mix effects) was 1.6 percent. This implies that California aerospace employment fell by 3.8 percent more than one would have anticipated using our simple decomposition methodology.

A general regression approach that modeled California employment changes as a function of national growth, industrial mix, and the California non-aerospace manufacturing competitive advantage confirmed the underlying assumptions of the simple accounting approach, as well as the statistical significance of the unexplained aerospace decline following the 1987 peak. This suggests that a structural change in the underlying economics has recently occurred. One possible explanation involves an increased prevalence of competition (for example, the 1984 Competition in Contracting Act) in defense contracting and the use of contract types that provide more incentives for cost minimization on the part of defense firms. For example, from 1978 to 1988 the percentage of contracts that were fixed price increased from 52 percent to 62 percent. In addition, the percentage of contract solicitations receiving a single offer fell from 71 percent to 48 percent. Both of

these trends are likely to make high-cost regions and the firms doing business in them less competitive.

To assess the probable effect of these procurement policy changes, we analyzed DoD data describing over 170,000 contract actions involving aerospace firms during 1987 and 1991. Extensive information on buyer, seller, and contract attributes, including the armed service, SIC code, type of procurement (R&D, production, or maintenance), contract type (fixed price vs. cost), and the number of offers received is identified for each contract. We used logistic regressions that assessed correlations between such attributes and the likelihood that a contract would be performed in California. We now summarize key results.

Table 4 presents simulated probabilities that a contract with certain characteristics will be performed in a California location. These simulations are based on parameter estimates from a logistic regression model. For ease of interpretation, all probability estimates should be compared with a base case. The (arbitrary) benchmark 1987 contract was for producing an electronic component (SIC 366) for the Army. The base case award was a cost-plus incentive contract, with multiple offers received. As indicated, 21.6 percent of contracts with such characteristics would be performed in California. This percentage corresponds roughly with California’s share of aerospace awards. By varying some dimensions of the base case contract, we can evaluate the

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NOTE: The base case = a 1987 contract for producing an electronic component (SIC 366) for the Army. Cost-plus incentive, with multiple offers received.
marginal importance of each characteristic. For example, an identical contract awarded two years later would have only a 19.3 percent chance of being performed in California. Since this estimated decline is independent of any fall in the number of awards and is derived from a regression model that automatically controls for other contract characteristics, it should be interpreted as an erosion in California’s ability to attract aerospace business. Note that this decline in 1991 awards is likely to affect aerospace employment at least through 1993.

Other characteristics had significant effects as well. For example, California is more likely to be the site of R&D contracts, especially those awarded by the Air Force. However, contracts involving establishments classified as primarily manufacturing aircraft engines (SIC 3724) have a predicted probability of only 10.3 percent. In contrast, awards for the production of space propulsion units (SIC 3764) have nearly three times the probability, 27.7 percent. Fixed-price contracts, even when controlling for the aforementioned characteristics, are much less likely to be performed in California. To the extent that profits on such contracts are much more sensitive to contractor costs, one would expect establishments located in lower-cost communities to have an advantage, all things equal. This result implies that the cost of doing business in California exceeds that cost in the rest of the country, on average. Contracts awarded to the only firm making an offer are more likely to end up in California. Controlling for other contract characteristics, such awards can be viewed as being less competitive than those having multiple bidders for the business. As in the case of fixed-price contracts, competitive contracts are likely to be awarded to establishments in low-cost areas.

One can take these estimated effects of contract characteristics and simulate the likely effects of changing procurement policies. For example, we noted above that the percentage of fixed-price contracts has increased and the frequency of awards being made in situations where there is only a single bidder has decreased. Judging by the changes occurring during the procurement cycles from 1980 to 1990 (recall that employment effects lag awards by about two years), we estimate that California’s aerospace business would have declined, in relative terms,
by about 6 percent. Thus, it is quite plausible that procurement policy changes could account for much of California's unexplained relative decline. Thus, it appears that doing business in California has both advantages and disadvantages. In a cost-plus, sole-source, uncompetitive environment, some of those disadvantages, primarily high cost, are not very relevant to the location of business. However, changes in procurement policies have placed increased emphasis on such cost factors. As a result, regions such as California are losing aerospace employment at a greater pace than low-cost areas.
6. SUMMARY AND CONCLUSIONS

In summary, we saw that aerospace is quite important to the California economy. At its peak in 1987, the aerospace sectors employed nearly 500,000 workers, representing over 20 percent of California’s manufacturing jobs. Aerospace is even more important to Los Angeles County, accounting for 26 percent of manufacturing employment. Aerospace’s importance is understated by merely looking at aggregate employment numbers. The aerospace business generates more gross state product per worker than other sectors (30 percent more than other manufacturing and twice the per capita total of services). In addition, aerospace has a much higher concentration of highly educated, well-trained employees—for example, over half of California’s technical and professional workers are employed in the aerospace industry.

In California, employment in the aerospace sector has declined rapidly since the 1987 peak. California has lost 14 percent of all manufacturing jobs. In Los Angeles the decline is more dramatic, exceeding 20 percent by 1991. Economic effects appear to be borne disproportionately by large firms and by certain occupations and age groups. For example, despite increasing rapidly in the pre-1987 expansion, only a small percentage of executives and administrative personnel lost jobs during the downturn. Job losses were much higher in the ranks of technical and scientific workers. In addition, most of the job losses (about 75 percent) were concentrated in the under-30 age group. Much of this decline represents reductions in hiring and the natural aging of the work force.

Figure 16 summarizes our decomposition explaining the 1987-91 decline in California aerospace employment. About four-fifths of the 14 percent decline can be attributed to national defense cuts. About one-third of the remaining 3.3 percent decline is due to an unfavorable industrial mix. That is, California has a higher concentration of missiles and space sector employment, a sector that has been declining rapidly at the national level. In addition, the especially rapid decline in California aerospace since 1987 could well be largely due to
Figure 16--Decomposition of California Aerospace Decline

the adoption of procurement strategies that emphasize the costs of doing business. Our analysis of indicators such as the more prevalent use of fixed-price contracts and frequency of multiple competitors could account for a significant portion of the aerospace business decline in California.

Declines in the regional business climate cannot account for the steeper aerospace declines between 1987 and 1991. However, an examination of secular trends in California manufacturing as well as aerospace employment strongly indicates that the state's relative advantage has been eroding steadily at least since the late 1970s. Indeed, if California had been able to maintain the aerospace advantage that prevailed in the late 1970s, the employment decline would have been only 8 percent (recall that the advantage fell from 7.6 to 1.6 percent during this period, a decline of 6.0 percent). It is noteworthy that the evidence seems to link this erosion largely to Southern California,
primarily Los Angeles. The rest of the state appears to be faring quite well, at least on average.

To a large extent, the aerospace declines in California reflect changing national priorities that have altered the volume and mix of defense spending. In addition, budgetary pressures have prompted the more frequent use of fixed-price contracts and competition for award dollars, indicating the increased relevance of cost factors in defense procurement. The evidence suggests that California has been harmed by these changes, probably because the costs of doing business in this state, particularly Los Angeles, are higher than in other regions. Indeed, there has been a steady, long-term erosion of the state's economic advantage in attracting manufacturing business. Clearly, any long-term solution to the aerospace dilemma should be comprehensive and farsighted and should address the root causes of the overall economic decline.

In the short run, several issues are also raised with respect to the health of the defense industrial base. First, the high concentration of business in California and, in particular, Los Angeles highlights the potential vulnerability of the defense industrial base to regional economic phenomena. And given the secular decline in the state's economic base, this concentration makes one pessimistic about the viability of these firms' attempts to compete in private sector markets. In addition, the larger burden placed on technical and professional employees, particularly those under 30 years of age, does not bode well for the future pool of mid-level, experienced, and highly trained workers.

Finally, it is clear that the aerospace cuts will affect certain occupations, firms, and localities disproportionately. Of course, the high concentration suggests that targeted programs are likely to be effective. Although the design of such programs is beyond the scope of

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1For example, even though aerospace declines represent only one-half of one percent of national employment, the percentage decline for technical and professional manufacturing workers in Los Angeles is 5 percent.
this study, we are skeptical that direct subsidizations (for example, preferentially awarding large-scale public projects such as light rail, environmental clean up, etc., to defense contractors) will be effective solutions. Instead, we believe that programs that encourage new ventures (such as R&D tax credits) and asset mobility (e.g., promoting worker mobility by providing channels for information flows, opportunities for skill retraining, and incentives to hire affected workers) are the most promising. Such programs can induce desired changes in business behavior while retaining the efficacy of the competition in the private marketplace.