U.S. Construction Labor Productivity Trends, 1970–1998[a]

Discussion by Paul Teicholz[5]

The authors are to be commended on their efforts to assess the difficult issue of labor productivity in the construction industry over the past three decades. They have used typical tasks from the building construction process and analyzed the labor costs and output productivity trends using root-square-means data. These tasks represent a diverse collection of work with different degrees of labor and equipment intensity and various labor trends. Their results indicate that decreasing real labor costs and more productive equipment account for decreasing labor costs on all of these tasks over the time period studied and that output productivity was influenced more by new equipment than better labor practices. These results are what one might expect, given the various problems of introducing new methods and equipment in an industry dominated by many small and fragmented firms.

The discusser's studies of labor productivity have led to an opposite conclusion, i.e., that labor productivity has continued to slowly decline (with a few exceptions) over the past 25–30 years. This conclusion is based on the data collected annually by the U.S. Bureau of Labor Statistics (total man-hours of field labor) and the U.S. Census Bureau (total dollars of new and remodeling construction contracts, both in current and 1992 dollars). It is impossible to obtain finer breakdowns of these two time series, because they are collected for different segments of construction activity. The productivity data are available from 1964 to the present for the total construction industry, which is about 6–8% of total GDP, and thus represents a very large and diverse set of activities. These data exclude the equipment that is installed in factories and buildings after the construction has been completed. The current dollar values for construction are deflated to 1992 dollars using price indexes developed by the Census Bureau that reflect the mix of materials, labor, and equipment costs used in various areas of construction. This time series is available on the Census Bureau Web site (http://www.census.gov/ftp/pub/const/www/c30index.html).

The labor productivity index developed from these data is equal to the ratio of constant 1992 dollars of contract volume divided by field labor man-hours. This ratio reflects the direct labor input per dollar of construction output. A plot of this index using 1964 as 100 for the base year is shown in Fig. 15. For comparison, this figure also shows the analogous index for all non-farm industries (which includes construction).

The index for the construction industry shows a steady decline at a compound rate of -0.48% per year, while the index for all non-farm industries shows an increasing labor productivity of 1.71% per year over the 1964–1999 time period. This is a very significant difference and reflects structural problems in the construction industry that retard its adoption of labor-saving equipment and better management practices that would reduce the need for field labor. Possible causes of declining labor productivity include: (1) inadequate training for workers and managers; (2) fewer younger workers entering the work-

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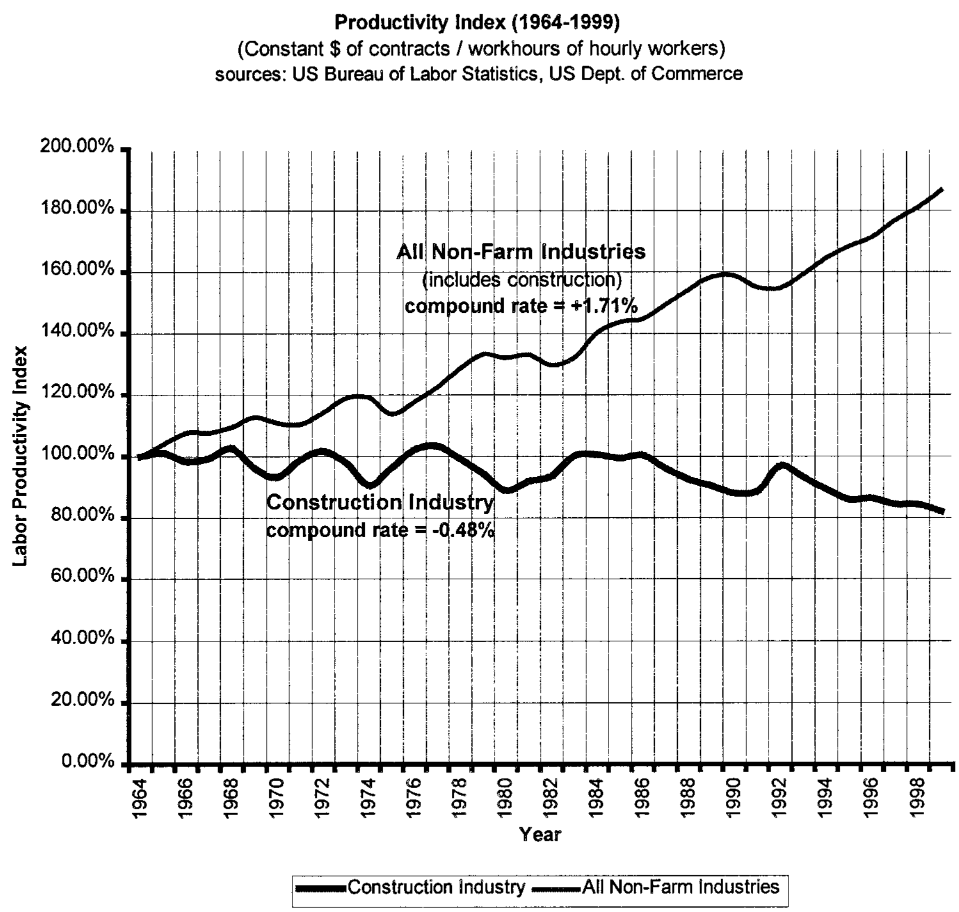

FIG. 15. Graph of Productivity Index for Construction Industry and All Non-Farm Manufacturing Industry (Including Construction Industry) for Years 1964–1999

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force; (3) more safety procedures; (4) increased complexity of projects; (5) greater time pressure on project completion; and (6) greater fragmentation of the work process.

It is difficult to resolve the above results with those reported in this journal paper. On one hand, the index includes all construction costs, while the journal paper is based on a selected sample of work operations from the building industry. On the other hand, the impacts of declining real labor rates, introduction of new construction equipment, output productivity, and management practices should be reflected in both approaches. Thus, there is a clear need for further research that will help resolve the questions of both the definition of and trends in construction productivity. The discusser thinks there is a compelling case for this additional analysis, given the importance of construction to the U.S. economy and the clear implication that the construction industry is lagging other, indeed, almost all other, industries in labor productivity.

Closure by Paul M. Goodrum[6] and Carl T. Haas[7]

The discusser makes a sound argument that labor productivity appears to be decreasing based on analysis of total manhour data from the U.S. Bureau of Labor Statistics and the value of new construction from the U.S. Census Bureau. The discusser is not alone in this assessment. Prior research suggested that construction real output (value added) per hour fell at an annual rate of 2.4% between 1968 and 1974 (Allen 1985), which mirrors similar trends in the discussion's data. This position was supported among owners when the Business Roundtable's Construction Industry Cost Effectiveness Project (1983) assumed a similar decline, but noted the lack of data to quantify it. However, as will be summarized in this closure, there are some inherent problems of using aggregate productivity measures in construction.

Developing a reliable inflation index for construction has been the primary difficulty in accurately measuring construction productivity. As Rosefielde and Mills (1979) found, many of the construction productivity measurements are biased downward, because input cost indices are used in converting dollar values to real output instead of output price indices. Input cost indices estimate the change of the price of construction to the contractor, whereby output price indices estimate the price that an owner pays to buy a constructed facility. Output price indices are typically used in productivity indices for other industries such as manufacturing; however, it is extremely difficult to develop an accurate output price index for construction because of heterogeneous outputs in construction. Therefore, cost indices have typically been used in place of price indices for many sectors of construction. Dacy (1965) and Gordon (1968) found strong evidence that cost indices in construction have overestimated construction inflation, thereby underestimating real output and understating labor productivity. Even Allen (1985) acknowledged that half of the productivity decline in his study was attributed to the inaccuracies of adjusting for construction inflation. Many have found that construction real outputs adjusted using input cost indices do not reflect changes in quality resulting from innovation and design improvements in construction (Dacy 1965; Gordon 1968; Rosefielde and Mills 1979; Pieper 1990). Although the issue of comparing the value of the final product over time is a challenge to other industries, it is a greater challenge in construction, because the value of particular construction projects is much less comparable than the value of other consumer goods. Construction projects are rarely similar, and identical undertakings are virtually nonexistent. Ground conditions, weather, and code requirements, to name a few factors, create a significant hurdle in comparing one project's productivity to another. Also, from 1968 to 1999, the final product in construction became significantly more sophisticated. For example, changes in structural design, fire protection, HVAC systems, and more recently information technology systems dramatically changed the characteristics of construction and significantly raised the level of effort required to create the final construction product. Rosefielde and Mills (1979) argued any measure of construction productivity that does not account for the changes in design and quality will lead to low, if not negative, measures of construction productivity.

The discusser uses the Census' Value of Construction Put in Place deflated to 1992 dollars as a measure of construction output. The Census' Value of Construction is not to be undervalued as an indicator of construction costs; however, there are some inherent problems in using it as a measure of construction output. The Census' Value of Construction includes all the costs of construction installed or erected at the jobsite, including material costs, labor costs, contractor's profit, cost of architectural and engineering work, overhead, and miscellaneous interest and taxes. The Census uses a variety of input cost and output price indices specific to different categories of construction to convert the value of construction to real output. A detailed description of individual indices can be found at the website for the Census Value of Construction Put in Place (http://www.census.gov/prod/www/abs/c30.html). Unfortunately, the use of various cost and price indices provide a biased measure of construction real output. Besides the use of cost indices providing an overestimation of construction inflation, the Census uses a number of proxy indices, which are indices used on a different sector of construction than the one they are designed to deflate. An example is the U.S. Census Bureau Single-Family Houses Under Construction Index, designed for the residential sector, used also to deflate nonresidential construction and military facilities. By relying on the U.S. Census Bureau Single-Family Houses Under Construction Index to deflate cost in these different sectors, it is used to deflate over half of the Census Value of Construction Put in Place.

Despite being a preferred price index, the Census Single-Family Houses Under Construction Index has the potential problem of ignoring changes in the quality of construction. It is calculated using a ''hedonic'' or regression methodology. The Census surveys information on the sales price, lot value, and ten house characteristics on approximately 9,000 speculatively built single-family homes. The sales price less the estimated lot value is regressed against ten house characteristics, including square feet of floor area, lot size, number of stories, number of bathrooms, presence or absence of a basement, garage, fireplace, central air conditioning, metropolitan location, and geographic location, which were based on a 1960 model home and revised in 1974 with the addition of fireplace and central air conditioning variables. With the exception of fireplaces and central air conditioning, all of the independent variables are size and location related. Size, however, is only one facet of construction quality. The census index does not include variables such as quality of materials or other design amenities such as bathroom and kitchen fixtures, closet space, energy efficiency improvements, and patios. The Census index will therefore be biased upward if the quality features not included have risen relative to the included variables. As found by others (Pieper 1990), this appears to be the case. In 1973,

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52% of all new houses used electricity as the type of heating fuel, which is relatively more expensive as compared with other types such as gas and oil. That number had dropped to 26% by 1998 (Department of Commerce). Regarding household appliances, 65% of all new home sales in 1973 included a dishwater. By 1990, the last year for which the statistic was available from the U.S. Census, the percent of new homes including a dishwater had risen to 92% (Department of Commerce). The absence of other quality variables means the Census regression coefficients measure the price of the independent variable plus the value of any omitted quality characteristics correlated with it (Pieper 1990). The end result is the potential of the Census index to overestimate construction inflation, thereby underestimating both construction real output and labor productivity. This bias in the Census index has a widespread effect, since, as previously mentioned, it covers over half of the Census Value of Construction Put in Place.

There are other problems with using the Census Value of Construction Put in Place as a measure of construction output. The Value of Construction's labor component is heavily influenced by wage variations. As reported and described in the original journal article and other sources (Oppedahl 2000), real wages in construction fell from the early 1970s to 1998 by approximately 20–25%. Considering the substantial proportion of a typical project's total cost attributed to labor, the drop in real wages decreases the Census' Value of Construction figures, leading to an underestimation of construction real output and thus an underestimation in the discusser's measure of labor productivity. The decline in real wages and other fluctuations in input cost may actually lead to different trends in labor productivity versus factor productivity. In addition, hours reported by the Bureau of Labor Statistics records need to be reconciled with the dollar amounts reported by the Department of Commerce, since the two agencies use different methodologies and analyses in creating their data series.

It could be argued that these problems of output measurement have always existed and do not necessarily explain all of the productivity slowdown observed by the discusser and others. Rees (1980) argued that, to successfully explain any apparent slowdown in construction productivity growth in terms of errors in output measurement, one must show that the errors grew worse from the 1970s, through the 1980s, and up to the 1990s. This is outside the scope of this closure but worthy of further research efforts. Regardless, it is because of this difficulty in adjusting construction costs to accurately reflect real output that the Bureau of Labor Statistics maintains productivity indices for all sectors of the U.S. economy except for construction (Rosenblum, personal communication, 2000).

While problematic in some ways, examining productivity at the activity level, as done in the original journal article, helps to sidestep many of the problems described in determining construction real output. By examining labor productivity by the direct physical output per man-hour, there is no reliance on cost deflators. Inputs and outputs are much more comparable over time at the activity level, whether the activity involves the installation of aluminum strip siding or moving a cubic yard of earth. Although further studies by the writers have yet to be subject to a peer-review process, they do provide much stronger statistical proof that activity measures of labor productivity as well as partial factor productivity, defined as physical output per labor unit cost and equipment unit cost, show an improvement between 1976 and 1998. These further analyses used three separate data sources: Means Building Construction Cost Data, Dodge Unit Cost Books, and Richardson Process Plant Estimating Standards. Although examining productivity changes at the activity level helps resolve the output issues, this methodology is not perfect. There are inherent concerns regarding the estimation manual's sampling methodology and annual tracking of output data. Furthermore, contractors who submit the hypothetical data in the estimation manuals know they will not be required to construct the project based on their estimations (Pieper 1989). In a larger sense, such analysis also ignores systematic improvements due to completely new methods such as trenchless technologies and new tools like computers and data networks. In addition, there is also a difficulty in measuring enough activities before a wide industry trend can be recognized. Regional deviations also introduce difficulties.

The writers are in full agreement with the discusser that there is a clear need for further research on the trends in productivity as well as the factors that are impacting those trends, from both the discusser's perspective and the one presented here. There is also a clear need for the development of a nationally recognized productivity index for construction, which would provide a clearer understanding of the productivity trends in our industry. In addition, productivity trends in different sectors of construction need to be better understood. It is quite possible that one sector of construction, say, heavy construction, may be experiencing sustained growth in productivity while another sector, such as residential construction, could be experiencing the opposite. There is a need to understand how the growing trend of offsite productivity is impacting construction productivity. Many firms who construct prefabricated units are classified as manufacturing firms. Therefore, there is an issue of how their man-hours and output should be included in an aggregate measure of construction productivity. Public initiatives designed to improve construction productivity are most effective if there is a clear understanding of whether productivity is increasing or declining and where. Industries that engage in more research regarding productivity are by and large the same industries that experience larger improvements in productivity (Mansfield 1980). Additional research and action by industry leaders, governmental officials, and academia in this area will help ensure future productivity growth in construction.

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