The Productivity Slowdown: A Labor Problem?

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Introduction

This paper addresses two related questions. First, what effect have demographic shifts and cyclical fluctuations had on the productivity slowdown?[1] Second, what labor market policies ameliorate the productivity problem? The answers to both questions are shown to depend critically on how one measures productivity. We conclude that most labor market policies are unlikely to increase the best productivity growth rate measures without creating other major problems.[2]

In the first section of the paper, several approaches to measuring productivity are described. The standard approach is to use the average product of labor as measured by the Bureau of Labor Statistics (BLS). An obvious adjustment is to weight the manhours of different demographic groups differently so as to compensate for the changing composition of the labor force. A second approach is to use an estimated production function to calculate marginal products instead of relying on average products. It is also possible to break labor into submeasures corresponding to skilled and unskilled labor so as to obtain two or more average (or marginal) product of labor measures. Other measures discussed include cyclically adjusted labor productivity series, total productivity series, and the trends in Hicks neutral technological progress.

In Section II, measures of the productivity of the labor aggregate are examined. Although all the labor productivity measures show a slowdown has occurred over the past 15 years, the magnitude and the timing of the slowdown vary across the measures.

In Section III, separate measures for youths and adults are examined. The pattern of decline differs dramatically between older and younger

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The authors added the appendix after the conference.

1 For evidence of the existence of a productivity slowdown, see, for example, Denison (1979). For a discussion of productivity in earlier periods, see Kendrick (1969).

2 Because other papers at this conference deal with issues of regulation, energy, and capital, we have restricted this paper to those issues and policies which are primarily related to the labor market. One relevant, overlapping issue is the compositional effect on productivity, as discussed by Nordhaus (1972) and Okun (1973), which we do not discuss in this paper. This issue is briefly discussed in Perloff and Wachter (1980).

workers. Moreover, the total factor productivity measure of the overall productivity growth rate of the economy shows a much less pronounced slowdown between 1965 and 1979 than do the labor productivity measures.

Two general policy issues are raised with respect to the productivity slowdown in Section IV. The first is how the slowdown can be stopped or reversed. The answer to this question depends upon which productivity measure is used as a target by policymakers. The second issue concerns the need to set the productivity debate in the broader context of unemployment, inflation and income distribution.

I. Alternative Measures of Productivity

In studies of the productivity decline of the past decade the average productivity of labor is the most widely used measure.[3] It is calculated by dividing output or GNP by the total manhours (or employment multiplied by average hours of work). This variable has numerous serious, if not quite fatal conceptual flaws. Its appeal is that it can be calculated, without making any statistical adjustment, using government published data. The flaws in this measure can be organized into five categories.

First, average productivity is misleading during periods when the composition of the labor force is rapidly changing. Since this measure treats all manhours equally regardless of skill level, in a period when young workers or workers with little specific training or skills are an increasing percent of the labor force, measured productivity falls. Even if the productivity of each skill level or type of worker remained constant over time, the entry of the baby boom cohort into the labor force during the 1960s and 1970s would have lead to a decline in average productivity due to the increased percentage of youths in the labor market. Similarly, any labor market policy which succeeded in increasing the employment of the poor or the unemployed would lower average productivity. If average productivity were treated as a target by policymakers, successful manpower policies would incorrectly signal a productivity problem according to this measure.

It is important to create an index which would not be confused by compositional shifts. Weighting each demographic or skill group by its wage rate yields a productivity measure with manhours (approximately) measured in efficiency units.[4] Such an index would not be sensitive to purely composi-

[3] Some authors, however, have used other measures of productivity. See for example Berndt and Khaled (1979), Clark (1978), Gollop and Jorgenson (1980), and Norsworthy, Harper and Kunze (1979).

[4] If each worker is paid a wage equal to the value of his marginal product, then the wage ratio of two types of workers equals the ratio of their marginal products. Thus, our weighting scheme gives high productivity (high wage) workers greater weight. Specifically, our new employment index is

$$L = \sum_i W_i L_i$$

where L_i is the total nonagricultural, nongovernmental employment of the i-th demographic group and W_i is the corresponding weight formed by taking the ratio of full-time, year-round, total money income of males age 25–64. The demographic groups are: males 16–19, males 20–24, males 25–64, males 65+, females 16–19, females 20–24, females 25–64, and females 65+. The adjusted labor series L is divided into output to obtain the adjusted average product.

tional shifts in the labor force. Hereafter, such an index is referred to as a demographically adjusted measure of productivity.

A second problem with average product is that it is an imperfect proxy for the marginal product of labor. Presumably policymakers are concerned about the productivity growth rate because it is correlated with a fall in real wages. In a competitive world, the real wage is equal to the value of the marginal product and not to the average product. To obtain a measure of marginal productivity, however, requires the estimation of a production function. The measures of marginal product reported below are derived from two cyclically sensitive translog production functions estimated for the overall economy for the period 1955–78.[5] In one, the inputs are demographically adjusted labor, capital, and energy; while in the other, labor is disaggregated into youth and adult measures.[6]

The marginal product is more sensitive to substitution effects than is the average product. Since the average product is the ratio of output to labor, a relative increase in the use of other factors will increase this measure since output will grow relative to labor. If the economy is Cobb-Douglas, the marginal product is a constant multiple of the average product and hence is equally sensitive to substitution effects. If the economy can be approximated by a (non-Cobb-Douglas) translog production function, the marginal product is not a constant multiple of the average product. Instead, the marginal product equals the average product multiplied by a term which depends on relative factor proportions.[7] Thus the marginal product is more sensitive to input fluctuations than is the average product. As a result, the large supply increases in the 1970s, the energy reduction after 1974, and the dramatic capital accumulation slowdown in the 1970s had a greater effect on marginal products than average products.

Typically when a factor has an exogenous increase in supply, such as that induced by the entrance of the baby boom into the labor market, the average product will decline by more than the marginal product. The impact of rapidly increasing labor force and employment on labor productivity is tempered by the ability of the production process to shift to more labor intensive techniques (or products).

A third problem in using the average product (or the marginal product) to discuss the productivity slowdown is its sensitivity to cyclical fluctuations. Due to labor hoarding and other factors, average (or marginal) productivity tends to decline during recessions and increase during expansions. One

[5] See Perloff and Wachter (1979a) for a description of the estimation technique used.

[6] The single labor measure is the demographically adjusted one described in footnote 4. When two labor series are used, a similar adjustment process is used within a group, where males age 20–24 are taken as the base group for the youths' labor measure, and males age 45–64 are the base group for the adults.

[7] The marginal product of the i-th factor is

$$MP_i = \frac{Q}{i}\left(\alpha_i + \Sigma_j \gamma_{ij} \ln j\right)$$

where Q is output and α_{ij} and γ_{ij} are parameters of the translog production function (see Perloff and Wachter (1979a). If $\gamma_{ij} = 0$ for all i and j, then the production functions is Cobb-Douglas and the marginal product is a constant (α_i) multiple of the average product (Q/i).

method to control for cyclical factors is to use potential productivity measures which are constructed by assuming that the economy is at its equilibrium unemployment rate (U*).[8] The potential marginal and average product reported below were calculated by adjusting both output and labor to levels consistent with an economy in equilibrium (at U*). The potential output (Q*) is calculated using a cyclically sensitive translog production function.[9] Thus, the potential average and marginal productivity growth rates are the trend rates of growth with the cyclical fluctuation smoothed.

The fourth problem with the average product (and other adjusted and unadjusted productivity measures discussed above) is that it cannot be used to discuss distributional effects among different labor groups. For example, the baby boom could be expected to affect youth and adult labor groups' productivity and wages differently, unless these two types of labor are perfect substitutes. If the two groups are perfect substitutes, the demographic adjustment described above will fully control for compositional shifts.[10]

According to the cohort overcrowding model youths and adults are imperfect substitutes and may even be complements.[11] As a result the baby boom should have a differential impact on these two different age groups: reducing the productivity (and wage) growth rate of younger workers relative to adult workers.

The disaggregated labor inputs can be used to examine the effects of the post-1973 energy price increases. If energy is a substitute for young workers and a complement for adult workers, the post-1973 energy shortage should have slowed the productivity growth rate of adults relative to young workers.[12]

A fifth problem with the average product or (marginal product) of labor measure is that is does not reflect overall income and welfare. For example, if the United States were a closed economy, the nonlabor inputs would be completely owned by individuals in the United States. Nonwage income, which does total approximately one-third of national income, depends upon the wages (marginal products) of the other inputs. Gains in labor productivity which are offset by declines in the productivity of other inputs would have very different welfare implications from increases in the productivity of all inputs. The income effects of exogenous shifts in factor supplies may be determined by measuring the productivity growth rates of all factors or the growth rate of total factor productivity.

Thus, a number of measures are useful for examining problems related to the productivity slowdown. Average product measures have the advantage of being easy to calculate, but also have several disadvantages. A demo-

[8] See Wachter (1976a) and Perloff and Wachter (1979a) for a discussion of U* measures.

[9] This technique is explained in Perloff and Wachter (1979a,b). For an alternative view, see Perry (1977) and Rasche and Tatom (1979).

[10] The adjustment method described in footnote 4 implicitly assumes that different types of labor are perfect substitutes in the sense that they vary only in a "labor-augmenting" way.

[11] See, for example, Easterlin (1968) and Wachter (1972, 1976b).

[12] Actually, in a many-factor production function, this assertion should be phrased in terms of net substitutes and complements. See Berndt and Wood (1979).

graphic adjustment of the average product based on relative wages reliably corrects for distortions induced by compositional shifts if different labor groups are perfect substitutes. A better compositional adjustment may be made by separating the labor input into several groups (e.g., youths and adults).[13] With an estimated production function, it is also possible to obtain marginal product estimates instead of average products. Further, estimation techniques can be used to control for cyclical fluctuations. Finally, total productivity measures can be used to examine overall national income effects.

II. The Productivity Slowdown Using a Single Labor Input Model

From 1948 to 1965, average productivity of labor, as measured by the Bureau of Labor Statistics, rose by 2.7 percent per year. For the 1968 to 1978 period, the rate of increase fell to 2.0 percent. During 1973 and 1974, there was an absolute decline in productivity of almost 5 percent, and for the next five years (1973 to 1978), productivity growth has averaged about 1 percent per year.

A. The Changing Composition of the Labor Force

A number of major economic developments have occurred over the past 15 years and these have affected the rate of productivity increase. The most significant labor market "exogenous shock" was the entrance of the huge baby boom cohort into the labor market.[14] This demographic shift, the increase in the ratio of youth to prime age workers, is one of the most dramatic in magnitude in U.S. history. Since the young are relatively unskilled and inexperienced, output per worker has declined as their relative employment increased.

The recent demographic swings, however, suggest that the cohort of new workers in the 1965 to 1979 period had a different impact from the cohort that entered the labor market between 1950 and 1965. Even if both groups were of equal skill and education, the more recent cohort would have had a lower marginal product simply because the baby boom cohort was so large. With imperfect substitution between old and new workers, cohort overcrowding, which occurred between 1965 and 1978, contributed to the decline in the productivity of new workers.

We can partially correct the distortion created by the shift in the com-

[13] Hammermesh and Grant (1979) have noted (p. 518): ". . . future research should concentrate on substitution among various workers disaggregated by age, education, or sex rather than by the blue-collar—white-collar distinction used in most work that has little use in policy analysis."

[14] The following table shows the impact of the baby boom. The numbers are the percent average annual rates of growth by age group:

	16–24	25+	16+	(16–24)/16+
1957–1965	3.56	0.71	1.19	2.34
1965–1972	0.48	2.21	1.90	−1.39
1972–1978	7.53	0.81	2.15	5.27

position of the labor force by measuring labor in "efficiency" units where workers are weighted by their relative wage, which is a proxy for a worker's relative productivity.[15] Using this measure a new average product can be calculated which controls for compositional effects. Similarly, using this measure with capital and energy we can estimate a cyclically sensitive translog production function, with quarterly data for 1955 to 1978.[16] The production function estimates can be used to calculate a marginal product of labor which controls for compositional effects. The changes in these adjusted average and marginal products series, ΔAPL and ΔMPL, are shown in Table 1.

Table 2 shows the average change in these series and the unadjusted BLS average product for the three subperiods 1960–1964, 1965–1973, and 1974–1978. While the unadjusted BLS series shows a slowdown of 0.39 percent from 2.51 percent in 1965–1973 to 2.12 percent in 1956–1964, the adjusted APL series shows only a 0.16 percent reduction. Even more striking, the adjusted MPL shows a 0.12 percent increase. The compositional adjustments do not affect the rate of growth of the APL in 1974–1978, but the adjusted MPL series shows an even greater slowdown in this recent period (2.38 percent) than the unadjusted APL series (1.28 percent).

This type of subperiod analysis, however, can be misleading. The data in Tables 1 and 2 indicate the importance of the choice of years in dividing the period. For example, the years 1965 and 1966 have two of the three largest productivity gains over the past 25 years. Hence, changing the dating of the middle period from 1965–1973 to 1967–1973 makes a significant difference. The overall marginal productivity growth rate for 1967–1973 is only 2.13 percent, down from 3 percent for 1956–1966: the unexpected productivity speedup becomes a more traditional slowdown.

It is, however, reasonable to start this period in 1965. Besides corresponding to a point in the business cycle where U is approximately equal to U* (which is also true of 1956 and 1973), the year 1965 corresponds to a point in the demographic cycle when the baby boom cohort first entered the labor force in large numbers. (The oldest members of the baby boom cohort began to enter the labor market around 1960.)

Although a demographic adjustment for age and sex can explain the decline in productivity between 1965 and the early 1970s, this adjustment does not explain the major slowdown that began during the early 1970s. Indeed, the success of the demographic explanation in the early period compared with its lack of significance in the latest period implies an even more pronounced slowdown after the early 1970s than is shown by an unadjusted productivity series.

[15] This method is described in footnote 4.

[16] The estimates are reported in Perloff and Wachter (1979a). By cyclically sensitive we mean that the parameters are allowed to vary with the cyclical measure. For example

$$\alpha_i = \alpha_i^0 + \alpha_i \text{UGAP},$$

where α_i is a production function parameter in the standard translog, and UGAP is a measure of the deviation of the unemployment level from U*.

Table 1
Percentage Changes of Demographically Adjusted Average and Marginal Products

Year	Average Product (ΔAPL)	Marginal Product (ΔMPL)
1956	1.29	0.80
1957	2.51	2.37
1958	1.17	1.82
1959	4.23	3.88
1960	1.45	1.17
1961	2.27	1.93
1962	5.25	4.88
1963	3.45	3.09
1964	3.71	3.67
1965	4.53	4.78
1966	4.40	5.27
1967	2.02	2.28
1968	3.51	4.48
1969	1.46	2.17
1970	-0.12	-3.48
1971	2.59	0.82
1972	3.34	4.25
1973	2.60	4.41
1974	-2.52	-3.94
1975	1.17	-3.45
1976	2.90	3.87
1977	1.90	2.89
1978	0.73	2.61

Sources: The average product figures are based on a labor series which is adjusted for demographic composition: see Wachter (1976a). The marginal product series are presented in Perloff and Wachter (1979b), based on the production function estimated in Perloff and Wachter (1979a).

Table 2
Productivity Growth Rates

	Rate of Change of		
Years	Unadjusted BLS APL	demographically adjusted APL	demographically adjusted MPL
1956-1978	2.04	2.34	2.19
1956-1964	2.51	2.81	2.62
1965-1973	2.12	2.70	2.78
1974-1978	0.84	0.84	0.40

Sources: See the references in Table 1.

An important result is that adjusting the labor input series for age and sex compositional shifts alters the timing but not the size of the productivity slowdown. The onset of any significant slowdown appears to be delayed until the early 1970s. A gradual slowdown in the productivity growth rate is transformed into a dramatic collapse. As seen in Table 2, the ΔMPL series increases at a 2.62 rate from 1955 to 1964, and at a 2.78 rate from 1965 to 1973, but it grows at only a 0.40 rate from 1974 to 1978.

B. The Cyclical Adjustment

A second major economic development of the past decade has been the increasing length and depth of the cyclical swings relative to the prior two decades. Since we are primarily interested in the secular trends in productivity, we calculated potential average and marginal product series using our cyclically sensitive, three-factor translog production function, which used labor measured in efficiency units.[17] Since our potential output series represents the level of output which could have been produced if the unemployment rate had been at its equilibrium rate, the *potential* average and marginal product series, denoted APL* and MPL* respectively, are *cyclically corrected* productivity series. The percentage changes in these series, ΔAPL* and ΔMPL*, are presented in Table 3. The labor inputs in both the ΔAPL* and ΔMPL* series are adjusted for demographic as well as cyclical factors.

A comparison of the ΔMPL and ΔMPL* series in Tables 1 and 3 yields several striking results. First, if only a demographic correction is made (ΔMPL) productivity growth actually increases between the 1956–1964 and 1965–1973 periods. However, if both demographic and cyclical adjustments (ΔMPL*) are made, productivity appears to decrease slightly. As indicated in Table 4, the MPL* series grew by 2.81 percent during the 1955–1964 period and then slowed to 2.47 percent in 1965–1973.

Second, the cyclical adjustment correction, in comparison to the unadjusted series, yields a productivity growth rate which is three times higher in the most recent period. While MPL grew at 0.40 percent per year, MPL* grew at 1.17 percent between 1974 and 1978. Moreover, the MPL* series growth rate is also higher than the unadjusted BLS average product series. Although the cyclical correction yields a significant upward revision of the productivity growth rate, it is still the case that a productivity growth rate of 1.17 percent is very low by historical standards.

Third, the ΔMPL* series is useful for analyzing turning points in the productivity growth rate. The timing of the productivity slowdown has been a focal point of the current debate. The recent years have been broken into

[17] Potential series were calculated by using our cyclically sensitive translog production function. The cyclically sensitive parameters were set at the equilibrium levels and the labor series was adjusted to the level consistent with the equilibrium level of unemployment (L*). The resulting output (Q*) and L* are then used to calculate potential average product (Q*/L*) and potential marginal product. Since average unemployment over the 1955–1978 period roughly equaled our measure of U*, our actual and potential average productivity growth rates are approximately equal to each other over these years. During expansions, potential average productivity growth rates are lower than the actual rates and the reverse is true during contractions.

Table 3
Percentage Changes of Potential Average & Marginal Products

Year	Potential Average Product (ΔAPL*)	Potential Marginal Product (ΔMPL*)
1956	3.51	3.39
1957	3.33	3.15
1958	2.73	2.56
1959	2.85	2.87
1960	2.80	2.71
1961	2.71	2.57
1962	2.73	2.65
1963	2.79	2.66
1964	2.78	2.71
1965	3.05	2.95
1966	3.43	3.23
1967	3.24	3.01
1968	2.85	2.73
1969	2.77	2.65
1970	2.50	2.30
1971	1.63	1.54
1972	1.98	1.98
1973	1.87	1.86
1974	1.45	1.36
1975	1.08	0.89
1976	1.41	1.45
1977	1.40	1.43
1978	0.63	0.74

Source: See Table 1

Table 4
Growth Rates of Potential Average and Marginal Products

	ΔAPL*	ΔMPL*
1956–1978	2.41	2.32
1956–1964	2.91	2.81
1965–1973	2.59	2.47
1974–1978	1.19	1.17

Source: See the references in Table 1.

numerous subdivisions in an attempt to isolate the onset of the recent slowdown. For example, the view that the increase in energy prices has been the major causal factor requires that the significant decrease in productivity growth developed after 1973. While the post-1973 ΔAPL* and ΔMPL* figures are very low, both series declined below the historical average rate (approximately 2.3 to 2.4 percent) as early as 1970, as shown in Table 3.

Hence it appears that the demographically and cyclically corrected productivity measures show that the slowdown started around 1970 and then accelerated after the energy crisis in late 1973. Indeed a case could be made that the major drop started in 1970 or 1971. Misallocations created by the Nixon price controls program and the expansion of government regulatory efforts (e.g., EPR and OSHA) may have been important causes of this early slowdown.

III. The Two Types of Labor Input Model

A. The Compositional Adjustment Once Again

The approach used in Section II to control for compositional effects by weighting demographic groups' labor by their relative wages is fully appropriate if such units of measure are perfect substitutes for each other. An important assumption of the Easterlin and Wachter cohort-overcrowding model is that younger and older workers are imperfect substitutes for each other. If these groups were perfect substitutes, an increase in the rate of growth of younger workers would not have led to a reduction in their wages or their marginal products relative to those of older workers. In this section, two labor series, workers 16 to 24 (Y for youths) and those over 25 years old (A for adults) are used. Tests for aggregation reject the single input approach.

With both younger and older workers entered as separate inputs, we have a four factor translog production function.[18] The growth rates of the average products and the marginal products (which are based on this four factor production function) are shown in Table 5. The growth rate of the average product of younger workers is actually negative for the overall period

Table 5
Average Productivity Growth Rates

	Youths	Adults	Capital	Energy
1955–1978	-.34	2.74	.04	.66
1955–1964	-.15	3.18	.22	1.42
1965–1973	-1.07	3.07	-.52	.02
1974–1978	.29	1.31	.67	.31

Marginal Productivity Growth Rates

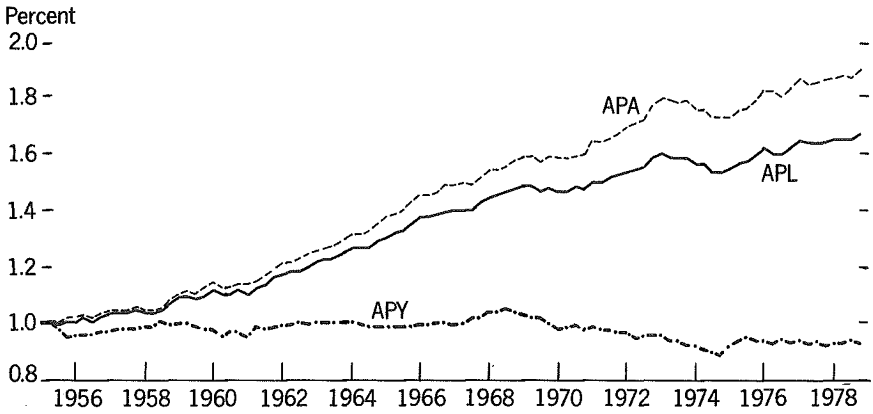
	Youths	Adults	Capital	Energy
1955–1978	1.62	2.30	.38	1.68
1955–1964	2.04	2.67	.69	3.05
1965–1973	2.19	2.75	-.54	-1.60
1974–1978	-.21	.77	1.44	5.09

[18] The four-factor cyclically sensitive translog production function is calculated using demographically adjusted youth and adult labor measures (as described in footnote 6). See the Appendix for details.

1955–1978; that is, the level of APY (average product of young workers) is lower in 1978 than it was in 1955. Only for the latest subperiod, 1974–1978, does APY increase, which is a reflection of the aging of the baby boom cohort. Since the birth rate peaked in 1958 and then remained on a high plateau through 1962, this large cohort's age ranged from 18 to 22 in 1980. As Figure 1 shows, APY has in general grown more slowly than APA (the average product of adults) and, as a result, it has also increased more slowly than the BLS average product of labor measure, APL.

Table 5 shows that marginal products capture input substitution better than average products. A comparison of average and marginal products

Figure 1 **Average Products**



APA is an index (equal to one in 1955:3) of the average product of adults.
APY is the comparable index for youths.
APL is the comparable index for all labor.

shows that the economy shifts techniques to accommodate suddenly plentiful resources. Although the average productivity growth rate is negative for youths, the marginal productivity growth rate for younger workers is above 2 percent per year for the 1955 to 1973 period. On the other hand, although youth marginal productivity increases over most of the period, the marginal productivity growth of adult workers is always higher. The economy can adjust to the oversupply of a given resource to some extent, but that input will have consistently lower marginal productivity growth.

Table 5 also substantiates the results of the previous section that the productivity slowdown does not begin until the early 1970s. Indeed, for both youths and adults, the average and marginal productivity growth rates are slightly higher in the 1965 to 1973 period than in the 1955 to 1964 period. The 1970 productivity slowdown is strongly felt by both younger and older workers. In terms of average products, older workers suffer a larger decline in the 1974–78 period than do younger workers. This relative slowdown effect results from the slower growth of youth employment in recent years (compared to the years of very rapid growth associated with the baby boom cohort). In this recent period, both age groups' marginal products declined by roughly 2 percentage points.

B. The Capital and Energy Inputs

We have also presented in Table 5 the average and marginal product growth rates for both energy and capital. They suggest that the rapid growth in both labor groups' marginal products in the 1965 to 1973 period was associated with a surfeit of capital and energy inputs. The average products for capital and energy, which reflect resource employment, indicate a large growth in K and E inputs relative to total output. Indeed, the marginal product growth rates for both K and E are negative between 1965 and 1973.

After the early 1970s, the input cycle was reversed. The capital investment boom of the 1960s was followed by a relative reduction in capital investment in the 1970s. With the OPEC embargo, oil production cutbacks and energy price increases after 1973, the energy input also grew slowly. The result was an unprecedented growth rate in the marginal productivity of energy and, to a somewhat lesser extent, capital. These data are consistent with the widely held view that the labor productivity slowdown in the early 1970s was due to a reduction in the supply of capital and energy.

Table 5 dramatizes the degree to which trends in labor productivity *do not match* productivity growth rates for other inputs. Labor does well when capital and energy are in abundance and the manhours growth rate is low. That is, the current productivity problem is a labor productivity problem and one solution would involve an increase in the supply of capital and energy. A continuing shortfall in energy will lead to a slow growth rate for the other factors. A partial solution is to encourage changes in techniques which economize on energy usage. Presumably one such method is to allow the price mechanism to work.

C. Potential Productivity Measures

The potential productivity series reflect the pure trend rates of growth since the cyclical components have been removed. The cyclical correction of adults' marginal product makes little difference except in the most recent period where it measures the growth rate from 0.77 percent to 1.26 percent, as can be seen by comparing Tables 5 and 6. Similarly, the cyclical correction only increases youths' marginal product growth rate in the most recent period (from -0.21 to 0.43 percent).

Since the potential marginal rates are corrected for cyclical and demographic effects and allow for substitution effects among inputs, they are perhaps our most reliable indication of secular productivity trends for the different inputs. They illustrate that the declining growth rate of labor productivity during the last five years was associated with increasing growth rates for the potential marginal products of capital and energy.

Table 5 and 6 are also consistent with the widely held view that energy is a substitute for capital and skilled workers, but a complement for unskilled workers. That is, increases in the price of energy cause firms to substitute toward unskilled workers and away from capital and skilled workers. Such a substitution effect results in higher potential marginal rates for energy and young workers and lower rates for capital and adult workers than the corresponding potential average products. On the other hand, the energy substitution effect is not strong enough to reverse the impact generated by each factor's individual supply: the potential marginal growth rate increases for capital and declines for young workers between 1965–73 and 1974–78. The capital shortfall overcomes the substitution impact on productivity growth of the higher energy prices. Similarly, both young and adult workers' potential marginal products decline between these periods.

Table 6
Potential Average Productivity Growth Rates

	Youths	Adults	Capital	Energy
1955–1978	-.29	2.77	-.03	.60
1955–1964	.05	3.06	-.07	1.16
1965–1973	-.26	3.15	-.66	-.13
1974–1978	-.10	1.51	1.21	.83

Potential Marginal Productivity Growth Rates

	Youths	Adults	Capital	Energy
1955–1978	1.68	2.40	1.98	1.02
1955–1964	2.14	2.69	.24	1.52
1965–1973	1.87	2.71	-.33	.11
1974–1978	.43	1.26	1.06	1.69

To evaluate these substitution arguments directly, we calculated the elasticities of substitution using the cyclically sensitive translog production function. They indicate that young and adult workers are complements. In addition young workers are substitutes for energy, while older workers are complements with energy.[19] Further, tests of separability of the labor inputs rejects the aggregation of the labor inputs at the 0.05 level.

The complementarity in production between young and adult workers has important distributional implications. During the 1960s and early 1970s the older cohort benefited from the entry of the large baby boom cohort of the 16 to 24 years olds. The youth group, in turn, was penalized by its own relative size. In the 1980s and 1990s, this large cohort will be in our adult worker category. Hence the baby bust cohort, which will be entering the 16 to 24 age group, will benefit from its own scarcity of members as well as the abundance of older workers. To the extent that the energy shortage continues — in the sense that growth rate of energy usage continues below its earlier trend rate — the labor demand and the marginal productivity of the baby bust cohort of young workers will increase further relative to that of the baby boom cohort of older workers.

D. Total Productivity

While the growth of the actual and potential marginal products is interesting because of what it tells us about relative factor wages, it is of limited value for understanding the pure productivity effects. Two factors contribute to the observed growth rates of the marginal products. First, biased or unbiased technological change can increase the marginal products. Second, increases in an input's supply will tend to lower its own marginal product and raise or lower those of others depending upon whether they are complements or substitutes.

Two alternative approaches shed light on the productivity issue while down-playing the substitution effects. Table 7 shows actual and potential total product and Hicks neutral technological progress.[20] Actual total product is calculated by taking the ratio of output to the estimated translog input index. Potential total product represents the ratio of potential output to the potential input index. The Hicks neutral technological change measure represents the values of the time trend terms multiplied by their coefficients from the production function equation where time, time squared, and time cubed are included in the equation.[21]

These series show less of a change over time than the series discussed above. However, all show a slowdown. The potential total product series indi-

[19] Griffin and Gregory (1976) and Berndt and Wood (1979) present estimates of energy-labor elasticities of substitution. Berndt and Wood point out the dangers in estimating these elasticities using production functions which are assumed separable in energy. White and Berndt (1979) present substitution elasticities based on a five-factor production function: production and nonproduction workers, capital, energy, and materials.

[20] See Solow (1957) for an excellent discussion of technological progress. For more recent discussions see Brinner (1978) and Berndt and Khaled (1979).

[21] The higher order time trends allow for a slowdown.

cates that the slowdown was less severe from the early (1955:1–1964:4) to the middle period (1965:1–1973:4) than the actual series (0.45 percent compared to 0.77 percent), but more severe later (1974:1–1978:4) than the actual series (0.54 percent compared to 0.16 percent). The Hicks neutral progress series is quite close to the potential total product series, but shows slightly faster growth in the early and late periods, which indicates that factor supplies limited growth in these periods.

E. Productivity, Wages and Income

As was argued in Section II, the marginal product of labor is more closely related to wages than is the average product. Both are more highly correlated with wages than with incomes.

Table 8 shows the growth rates of real wages. By comparing these figures to the marginal product figures in Table 5, it can be shown that they follow similar growth patterns (and both wages and marginal products growth rates deviate substantially from those of the average product). As Table 8 shows, however, income of full-time workers moves somewhat independently of wages (and marginal products), since income is more sensitive to supply fluctuations and nonlabor earnings. For example, where youths' real wages fell, on average, by 0.05 percent per year during the last five years, their real income rose by almost 0.1 percent per year. Similarly adults' wages rose by 1.4 percent while their incomes fell by almost 0.5 percent per year during the same period.

Table 7
Growth Rates

	Actual Total Product	Potential Total Product	Hicks Neutral Progress
1955–1978	1.73	1.78	1.85
1955–1964	2.22	2.16	2.34
1965–1973	1.45	1.71	1.64
1974–1978	1.29	1.17	1.27

Table 8
Growth Rates

	Real Wages*		Real Income*	
	Youths	Adults	Youths	Adults
1955–1978	1.59	2.68	1.01	1.812
1955–1964	1.96	3.00	1.06	2.304
1965–1973	2.35	3.04	1.50	2.60
1974–1978	-0.05	1.39	0.07	-0.47

* Real series created by using the implicit GNP deflator.

IV. Policy Issues

Two general types of policy issues are frequently raised in the policy debate on the productivity slowdown. The first is how productivity growth rates can be increased. As we have indicated, the answer to this question in part depends upon the measure of productivity which is used.

The second is whether policies which can increase productivity growth are more socially desirable than other policies which are competing for scarce government resources. Policies which increase the growth rate of productivity will also have positive or negative effects on a broad set of macroeconomic variables such as unemployment, gross national product, and the distribution of income. Policies which increase labor productivity at the expense of increased unemployment or decreased employment are unlikely to be viewed as socially beneficial.

A. Policies to Increase the Rate of Growth of Productivity

Whether we believe a given policy increases productivity growth depends critically upon which productivity measure we use. For example, policies aimed at reducing the equilibrium unemployment rate are bound to lower the rate of productivity growth as traditionally measured. The reason is that workers in the unemployment pool are predominately at the bottom of the skill range; hence an increase in their employment induces a negative compositional effect on the aggregate labor productivity index. To illustrate this dilemma, suppose that welfare payments and the minimum wage were lowered relative to market wages so that some lower skilled workers became employed for the first time. Since the average product of labor reflects that ratio of output to *employed* labor, such a policy could result in a decrease in this measure of productivity growth while decreasing unemployment and generating what many people would consider to be a positive effect on work incentives. The two methods that we have adopted to avoid this problem are either to weight the demographic groups using wage rates and/or to analyze productivity changes separately for adults and youths.

If the criterion for successful policy is to increase total productivity growth then only those policies which stimulate technical progress — for example, research and development — are likely to be effective.[22] On the other hand, if either the average or marginal productivity of labor is used, then policies which induce substitution away from labor and towards other inputs will augment productivity growth. Examples are policies that increase the supply of capital and energy. Further, if separate labor productivity measures are used for different demographic or occupational groups, such as youths and adults, then policies may increase productivity growth for one group while decreasing it for the other.

[22] Policies which increase Hicks neutral, technological progress will increase all the measures of technological progress discussed in this paper.

Obviously, the desirability of policies which increase technological growth, induce substitution away from labor as a whole or some subgroup of labor, or increase capital formation, differ. If ultimately we are concerned with the size of output and how it is distributed, labor productivity measures may be relatively poor indicators of these criteria. While total productivity or technological change tells us about the size of income, they tell us little about how income is distributed. Average and marginal productivity of labor tell us about labor's wage, but little about the total output or how other factors fare.

The nonlabor market policies to increase the rate of growth of labor productivity work through substitution effects. Almost all policies which increase the availability of the other major inputs into the production process, for example, capital and energy, are likely to stimulate labor productivity growth. The usual policy options for increasing the capital stock, including investment tax credits, accelerated depreciation, and indexing the tax schedule for inflation effects are well known. What is not known are the "bang-for-the-buck" or the impact multipliers of these policy alternatives. The success of such policies depends heavily on the degree to which new capital embodies technological change. The "technological change" or "knowledge" variable tends to be the major factor in productivity growth, but there is little information on the mechanisms which affect its growth rate. Since these issues are discussed in the other papers being presented at this conference, we will ignore these policies and concentrate on those which relate specifically to the labor market.

B. Labor Market Policies

Labor market policies are not generally a desirable way to increase productivity growth. Except for policies which increase the quality of the work force or offset existing inefficiencies, labor market productivity policies work by reducing the ratio of labor to other inputs. That is, such policies require a decrease in the employment of some or all labor groups, given a fixed technology and the supply of factors. As a result, such problems are inconsistent with other macroeconomic objectives including those concerning unemployment and income distribution.

This negative view is in conflict with the frequently expressed discontent with the workings of the labor market. It is often argued that labor productivity growth rates would increase if the numbers of hours of work were reduced, if labor unions imposed fewer work rules that restricted innovation and if the work ethic could be restored. The problem with these arguments is that they are unsupported by data. Indeed, it is unclear that policies designed to achieve these three objectives would increase productivity growth.

First, repeated attempts have been made in recent years to introduce legislation which would reduce the average workweek by about five hours. Attempts to spread the work by reducing the numbers of hours for straight-time wages under the Fair Labor Standards Act could prove counterproductive; that is, they could decrease rather than increase productivity growth rates.[23] If firms were to reduce the regular workweek, many workers would start to moonlight. Moonlighters' second jobs tend to require fewer skills, a result which is consistent with economic theory. Thus, one impact of "spreading the work" amendments to the Fair Labor Standards Act would be to lower efficiency and productivity as individuals switched some of their hours to secondary jobs.

If workers could not find secondary jobs, or were prevented from doing so by legislation, the effect of a reduced hours law would be a reduction in total labor and hence an increase in labor's marginal product. In an earlier paper,[24] we used our cyclically sensitive, three factor translog production function to calculate the effect of a reduction in hours. We found that a 10 percent drop in the labor aggregate would increase labor's marginal product by 10.5 percent in the short run (i.e., before adjustments in the capital stock take place). Since total hours would fall less than the wage increased, the total wage bill would rise by approximately 10 percent.

In this respect it is also useful to make similar calculations using Berndt and Christensen's (1974) aggregate U.S. manufacturing production function with capital, production (blue collar) workers, and nonproduction (white collar) workers as inputs. While we prefer the youth-adult division of the labor input, such a study sheds some light on the income redistribution effects of a policy to regulate hours.

A reduction in hours for one or both types of labor will have differing effects for two reasons. First, there are virtually twice as many blue collar as white collar workers.[25] Thus, a 10 percent cut in white collar workers' hours is only about half as large a reduction in absolute terms as a comparable reduction in blue collar workers' hours. Second, and more importantly, white collar (highly skilled) workers are more complementary with capital than are blue collar employees.[26] While additional capital increases white collar workers' productivity (since these two factors are complements), it reduces the need for blue collar workers (since capital and blue collar workers are substitutes). Thus decreasing the labor-capital ratio will raise the wage of white collar workers by more than that of blue collar workers.

For example, suppose that the average hours per week were reduced sufficiently so that total hours worked by blue and white collar workers fell by 10 percent. Blue collar labor's marginal product would rise by 9.4 percent while that of white collar workers would rise by 11.5 percent, reflecting the greater complementarity between capital and white collar labor. The wage

[23] The Fair Labor Standards Amendment of 1978, sponsored by John Conyers of Michigan, would have raised the premium rate of pay from time-and-a-half to double time, eliminated compulsory overtime, and gradually reduced the standard workweek from 40 to 35 hours over a four-year period.

[24] Perloff and Wachter (1978).

[25] Berndt and Christensen estimate the cost shares of capital, blue collar and white collar workers as 0.181, 0.534 and 0.786 in 1968.

[26] Berndt and Christensen estimate the Hicks partial elasticities of substitution between white collar labor and capital as 3.72 while the elasticity between blue collar workers and capital is −3.77. The elasticity between the two types of labor is 7.88.

bill of the two groups would be affected differently: the white collar workers' wage bill would rise, while that of the blue collar workers would fall.[27]

If only the total hours of blue collar labor fell by 10 percent while white collar employees continued to work the same hours, the marginal product of blue collar labor would go up by 6.7 percent while that of white collar labor would increase by just 5.1 percent. If, on the other hand, only white collar hours fell by 10 percent (which is a smaller drop in labor due to white collar workers' smaller share), then their marginal product would increase by 6.4 percent, while that of blue collar workers would rise by only 2.8 percent. Of couse all these calculations represent once-and-for-all adjustments.

In our earlier paper, we also used our three factor production function to calculate the effect of such policies on potential output, assuming that capital and energy continued to grow as before. Assuming a once-and-for-all drop of 10 percent in total labor hours, the rate of growth of potential output would be cut in half in the first year.[28] If capital were also reduced by 10 percent in response, the growth rate of potential output could be reduced by over 2 percent. Thus, these policies would have substantial output effects as well as productivity effects.

Second, it is difficult to intelligently discuss whether the work ethic has recently become impaired, since it is an undefined term. A recent review of the literature suggests that the demise of the work ethic has been claimed as far back as the Industrial Revolution.[29] The "shiftless and lazy generation" seems to be one of the constants of the labor market. In any case, we are aware of no serious policy which could offset such a decline even if it has occurred.

Third, it is common to blame unions for low productivity because of featherbedding or other restrictive work rules. While there may be some merit in attributing inefficiencies to unions, there seems to be little evidence that unions have increasingly reduced efficiency. Indeed, some recent studies have even suggested that internal labor markets of firms represent an efficient response to the externalities imposed by specific training, bounded rationality, and other factors.[30] It is not obvious how one could test whether unions are responsible for the development of internal labor markets. A study by Brown and Medoff (1976), for example, suggested that these internal labor market effects offset the inefficiencies created by higher wages: that is, unionization was found to have a substantial positive effect on output per worker. Unfortunately, this study rests on two crucial assumptions which cannot be directly tested. Further, it is difficult to adequately control for ability differences between union and nonunion workers.

While there is some anecdotal evidence that restrictive work rules have become less common, very little is known with certainty. Nonetheless, it may

[27] We are assuming that wages equal the value of the marginal products.

[28] Potential output growth rate would fall from 3.33 percent to 1.66 percent in the first year. By the second year, the growth rate would be almost the same in both cases.

[29] See Bernstein (1980).

[30] See, for example, Wachter and Williamson (1978).

be possible to obtain a once-and-for-all increase in productivity by barring certain union practices. Table 9 shows the percent of workers covered by specific contract clauses of all workers under union contracts which cover 1000 or more workers in 1972 and 1976 and 5000 or more workers in 1970. As the data suggest, relatively few union contracts place restrictions on moonlighting, crew size and weight; but almost seven out of ten contracts restrict work by nonbargaining unit personnel. Further it could be argued that the crew size and weight restrictions are often for safety reasons and may not be inefficient. As the table shows, only restrictions on crew sizes have become more prevalent during the 1970s. However, inefficient restrictions are common in a few industries. For example, many construction workers are covered by contracts which limit the use of prefabricated materials (11.7 percent of all construction workers and 70.1 percent of plumbers), require that union-made materials be used (11.5 percent of all construction workers), or

Table 9
Percent of Workers Covered by Contract Clauses

	All Industries			Manufacturing			Nonmanufacturing		
	1970[1]	1972[2]	1976[3]	1970	1972	1976	1970	1972	1976
Restrictions on Moonlighting	9.23	8.19	9.65	.96	.85	7.36	20.45	17.53	11.97
Crew Size (total)	7.94	12.09	20.75	1.92	4.60	8.57	16.10	21.64	33.14
Crew Size (Safety)	NA	NA	10.88	NA	NA	3.70	NA	NA	18.17
Weight	2.87	2.38	2.04	1.92	1.22	.82	4.16	3.84	3.28
Work by Nonbargaining Unit Personnel:	62.82	67.69	67.74	77.83	79.34	82.31	42.47	53.08	52.93
Labor-Management Committees on Productivity:[4]	NA	NA	19.71	NA	NA	26.56	NA	NA	12.74
Testing Provisions	23.48	28.14	30.22	33.74	29.31	35.90	9.56	26.64	24.44
Advance Notice of Technological Change Required	8.99	18.66	18.16	8.22	23.94	23.07	10.03	11.94	13.17
Wage-Employment Guarantee	12.67	13.21	19.37	10.83	4.12	13.36	15.18	24.80	25.48
Production Standards:[5]	29.97	35.31	29.02	51.77	61.84	56.63	.38	1.53	.96
Measures Applicable in Slack Work Periods:									
Division of Work	8.89	10.31	8.39	15.44	16.46	14.08	0.0	2.48	2.61
Reduction in Hours	34.80	32.57	28.70	45.80	41.70	40.37	19.89	20.95	16.84
Regulation of Overtime	23.70	8.10	6.58	39.56	13.40	11.59	2.19	1.36	1.48

[1] Union contracts covering 5,000 or more workers. BLS Bulletin 1686, 1970.
[2] Union contracts covering 1,000 or more workers. BLS Bulletin 1784, 1972.
[3] Union contracts covering 1,000 or more workers. BLS Bulletin 2013, 1979.
[4] "A labor-management committee on productivity is a joint committee which meets periodically to discuss in-plant production problems and to work out methods of improving the quantity and quality of production."
[5] "Production standards refer to the expected output of a worker or group of workers, consistent with quality of workmanship, efficiency of operations, and the reasonable working capacities of normal operators."

restrict tools and equipment (11.7 percent of all construction workers and 83.2 percent of painters).[31]

The case studies of make-work practices which are discussed by Slichter, Sumner, and Healy (1960, pp.317–41), suggest such restrictive practices usually occur in markets which are local or whose products are perishable. Thus, preventing such restrictions is more likely to increase productivity in railroads, construction, entertainment, local transportation, and a few other industries which make up a relatively small sector of the economy.

Collective bargaining contracts requirements such as labor-management committees on productivity and on production standards could easily work in favor of or against efficiency. Other provisions such as those covering testing of workers (30.2 percent of all contracts) and advance notice of technological changes (18.2 percent of all contracts) are also ambiguous in their effects on efficiency.[32] Production standards which occur in roughly three out of ten contracts (and almost six out of ten manufacturing contracts) could set targets rather than merely placing lower-bounds on production and hence create inefficiency.

Various union rules which apply during slack work periods affect both productivity and unemployment. Since division of work (8.4 percent), reduction in hours (28.7 percent) and regulation of overtime (6.6 percent) are fairly uncommon, layoffs remain the most common adjustment mechanism.[33] By laying off workers, a firm adds to measured unemployment but prevents a drop in productivity which would occur if it kept all its employees during a downturn.

Only about 11 percent of the contracts which refer to scheduled weekly hours have a shorter than 40-hour workweek (and only 0.3 percent have a shorter than 35-hour week). As a result, union restrictions on workweeks are unlikely to be binding constraints. On the other hand, guaranteed overtime at one-and-one-half or double rates may lead to inefficiency in production.

Finally wage-employment guarantees may actually lead to efficiency as Leontief (1946) argued. By appropriately setting both hours and wages, a union can act as though it were a perfectly discriminating monopolist (i.e., the contract is Pareto efficient and on the contract curve at the edge of the core of the economy). While such clauses are rare (16.7 percent of all industries), they are important in transportation where they affect 86.9 percent of unionized workers (ignoring railroad and airline employees) and services (39.9 percent).

Other work rules may affect both unionized and nonunionized firms' measured productivity. The recent trend towards increased paid vacations has caused hours worked to deviate from hours paid. An inattention to this fact may cause certain measures of labor productivity to fall.

[31] See "Characteristics of Construction Agreements, 1972–73," BLS Bulletin 1819, 1974.

[32] It should be noted, however, that advance notice of technological change has become more common since 1970 (or appears more frequently in contracts covering 1000–5000 workers than in those covering over 5000 workers).

[33] Reduction in hours and regulation of overtime are now relied on less frequently than in the beginning of the decade.

To date, little is known about the effects of taxes and subsidies which affect the labor market. Social Security may induce older workers to retire at an earlier age. Such a policy reduces total output, but may increase or decrease measured productivity of various labor inputs. To the degree that unemployment insurance induces workers to remain unemployed, it may exacerbate the unemployment problem, at the same time that it increases productivity.

C. The Broader Macroeconomic Issues

The second policy issue involves the need to examine the productivity slowdown simultaneously with unemployment, income distribution, and inflation. Since policies may be viewed as competing for scarce government resources, there is often a tradeoff between stimulating productivity growth and the other objectives.

Most labor market policies are aimed at lowering unemployment rates or altering the distribution of income. Few are specifically geared to the secular decline in labor productivity growth rates. Most policies, however, are likely to have an indirect impact on one or more of the labor productivity measures by inducing a substitution effect among the various labor and nonlabor inputs. These policies include a complex set of subsidies and taxes on labor such as welfare programs, employment tax credits, unemployment insurance, and social security. Further, government employment policies such as training programs and jobs programs are likely to have a direct impact on productivity. Finally, the growth of government employment may have had dramatic effects. Unfortunately, little evidence currently exists about the productivity effects of government programs.

Recently, employment tax credits have been offered to stimulate employment. The New Jobs Tax Credit (NJTC) may have had an effect in 1977 and 1978; however, the more recent Targeted Jobs Tax Credit (TJTC) is an extremely small program. Our calculations suggest that in 1977 the NJTC may have induced those firms which knew about it to increase employment by over 3 percent compared to firms which did not know about the credit, while holding sales constant.[34] Since the credit gave a greater proportional subsidy to low-wage (unskilled) workers, it may have had a more adverse productivity effect on youths than adults. It is relatively difficult to calculate the productivity effects, however, since the NJTC was not universally used.[35] Thus, some of the new hires by firms claiming the credit may have been drawn from firms which ignored the credit (possibly because they were unaware of its existence). As a result, the credit may have lowered labor productivity in some sectors while raising it in others.

Most government training and employment programs appear to have been so small as to be largely irrelevant as explanations for trends in produc-

[34] See Perloff and Wachter (1979c).

[35] Approximately 14 percent of all firms claimed the NJTC in the first year, and 28 percent in the second year.

tivity. On the other hand, the expansion of government employment may have been quite important, at least in terms of measured productivity. In most studies, government productivity is set at zero (presumably because government output cannot be measured in the same way as that of other sectors). Thus, if the government draws workers and other factors from other sectors, the productivity levels in those sectors will change. We are unaware of a systematic study which has attempted to measure the effects of such movements.

Although most labor market policies are not designed to increase the growth of productivity, there is some confusion on this point. First, the recent identification of stagflation as a single unified problem, has served to confuse long-run secular trends in productivity and unemployment. As we have argued elsewhere the slowdown in productivity and the increase in unemployment rates are largely distinct.[36] The recent high rates of unemployment in the United States, even when the economy is experiencing high capacity utilization rates, are largely a function of increases in the equilibrium level of unemployment. Demographic changes and government labor market programs alone can explain at least a 1.5 percent increase (from a 4 percent base) in the equilibrium rate since 1955. Estimating the equilibrium unemployment rate by inverting a Phillips curve yields an equilibrium rate of at least 6.3 percent in 1978.[37] Our results, however, indicate that much of the increase in the equilibrium rate occurred prior to the productivity slowdown.

One aspect of the picture is quite favorable, however. As the baby boom cohort ages and the baby bust cohort enters the labor market, the equilibrium unemployment rate should decline while the conventionally measured productivity growth rate should increase.

Our calculations indicate that the equilibrium unemployment rate will decline by approximately 1 percent over the next decade due to demographic factors. Government policy and external events can operate to either offset or further this projected decline in the equilibrium unemployment rate. Slow growth and high inflation can remain as problems even as the demographic factors operate to lower the unemployment rate.

Second, the public debate on "supply-side" economics has occasionally confused the adverse effects on welfare programs and high marginal tax rates effects on potential output with those on productivity. Since most labor market policies affect output and labor in offsetting directions, they have only a small effect on productivity. However, if the policy concern is potential output or the rate of growth of output rather than of the average product of labor, the impact of labor market policies can be quite large. Any policy that affects the number of manhours supplied will also affect potential output. Ending mandatory retirement rules, easing the marginal tax rate on wage income, and increasing the flow of immigrants are a few of the vast number of government actions that could lead to an increase in the number of

[36] See Perloff and Wachter (1980).

[37] See, for example, Perloff and Wachter (1979a).

manhours supplied. It is important to stress, however, that these policies would alter potential output, but would not necessarily have any impact on the rate of growth of labor productivity. On the other hand, increases in output due to increases in manhours will still mean increases in income per capita and to many, this may be as important as income per manhour.

VI. Conclusions

While labor market factors cannot fully explain the productivity slowdown, it is important to control for the composition of the labor market in order to accurately measure productivity and determine the timing of the slowdown. In this paper, we examined several approaches to developing better measures of labor and productivity.

The usual productivity measure of labor, the average product, was shown to be unreasonably sensitive to shifts in the composition of the work force. The now fairly standard adjustment which creates demographically corrected labor and productivity measures is also biased if labor groups are not perfect substitutes.

In this study, we disaggregated labor into youth (unskilled) and adult (skilled) labor groups, instead of the more usual production — nonproduction worker dichotomy. Using estimated aggregate production functions, we were able to reject the hypothesis that the different types of workers are perfect substitutes.[38]

We therefore stress the use of disaggregated labor productivity measures. In particular, we rely on marginal productivity measures which are sensitive to substitution and technological progress effects. The demographically adjusted youth and adult marginal product figures (Table 5) show that youth productivity has lagged behind adults'. Indeed, while youths' average productivity increased relative to earlier periods in the last five years (Table 5), their marginal productivity follows the opposite pattern.

By asking the counter factual question, how would productivity have grown in the absence of cyclical fluctuations, we can examine the effects of those fluctuations on income and productivity. Comparing the potential marginal product figures in Table 6 to the estimated actual numbers in Table 5, one sees that the major cyclical impact on marginal products occurred during the last five years. Indeed, had the economy been at full employment during this period, both youths' and adults' marginal productivity would have averaged over 0.5 percentage point greater annual growth.

It is also worth noting that fixating on labor productivity leads one to form an over-grim picture of the economy. During the last five years, capital and energy's marginal products have grown at historically high rates. As a result, total productivity measures show a much lower productivity slowdown than do labor productivity measures.

[38] Comparable results were obtained by Berndt and Christensen (1974) using production and nonproduction workers.

Finally, while it is difficult to evaluate government *labor market policies* quantitatively, there is little evidence to suggest that they can be used to stop or reverse the slowdown. For given growth rates of technology and supplies of nonlabor inputs, most labor market policies to raise productivity growth rates would require a slowdown in the rate of growth of employment. This approach, however, would be inconsistent with other desirable public policy goals. Indeed, since most labor market policies are oriented toward increasing employment, decreasing unemployment, or redistributing income, they will generally decrease the employment of skilled workers and other inputs relative to unskilled workers, thus exacerbating the productivity slowdown. It must be stressed, however, that there is little quantitative evidence to suggest that these policies generate large negative productivity effects. Labor market policies, to the extent that they have a large impact, probably operate indirectly; on the margin these programs involve the allocation of government budgetary resources that could be used for programs with a direct and positive impact on productivity growth. Of particular importance are programs that would increase the supply of other inputs — especially capital and energy.

Appendix

The three-factor cyclically sensitive translog production function and the associated data are described in Perloff and Wachter (1979a). The four-factor cyclically sensitive translog production function will be described in more detail in a forthcoming paper.

The capital, demographically adjusted labor, and energy series are the same as in Perloff and Wachter (1979a). The new youth and adult labor series were constructed in the following manner. Annual Current Population Survey (CPS) hours data for the 14 standard BLS demographic groups were interpolated to quarterly numbers using the average weekly hours series for males 16+ which is available quarterly. Hours were multiplied by quarterly nonagricultural employment data from *Employment and Earnings* after civilian government employees were removed (using data from the May CPS and unpublished sources). Then the data were aggregated into two groups (workers age 16–24 and 25+), using the annual relative income of year-round, full-time workers (March CPS) as weights within each group.

The income data were used to estimate wage bills for the two groups subject to the constraint that the two wage bills had to sum to the total labor wage bill. The total wage bill is the compensation of employees in the private nonfarm sector from the *Survey of Current Business*.

The cyclically sensitive translog production function is:

$$\ln Q = \beta_0 + \beta_1 + \beta_2 t^2 + \beta_3 t^3 + \beta_4 I_0 + \beta_5 I_1$$

$$I_0 = \sum_i \alpha_i^0 \ln i + \tfrac{1}{2}\sum\sum \gamma_{ij}^0 \ln i \ln j,$$

$$I_1 = \text{UGAP}\left(\sum_i \alpha_i^1 \ln i + \tfrac{1}{2}\sum_i\sum_j \gamma_{ij}^1 \ln i \ln j\right), \quad i,j, = Y,A,K,E,$$

where t is a time trend.

See Perloff and Wachter (1979a) for details as to how coefficients are estimated using share equations. The maintained hypothesis is that the production function is homogenous (but not necessarily of degree one).

The estimated coefficients are:

α^0_Y	.013 (0.101)	α^1_Y	0.672 (0.414)
α^0_A	0.706 (0.057)	α^1_A	−0.504 (0.279)
α^0_E	0.395 (0.162)	α^1_K	−1.027 (0.729)
α^0_E	−0.115 (0.169)	α^1_E	0.858 (0.757)
γ^0_{YY}	−0.056 (0.030)	γ^1_{YY}	0.379 (0.115)
γ^0_{YA}	−0.032 (0.009)	γ^1_{YK}	−0.122 (0.042)
γ^0_{YK}	0.032 (0.026)	γ^1_{YK}	−0.127 (0.106)
γ^0_{YE}	0.057 (0.031)	γ^1_{YE}	−0.130 (0.127)
γ^0_{AA}	0.268 (0.036)	γ^1_{AA}	−0.732 (0.165)
γ^0_{AK}	−0.131 (0.026)	γ^1_{AK}	0.467 (0.123)
γ^0_{AE}	−0.105 (0.020)	γ^1_{AE}	0.387 (0.095)
γ^0_{KK}	0.009 (0.044)	γ^1_{KK}	0.070 (0.195)
γ^0_{KE}	0.091 (0.043)	γ^1_{KE}	−0.410 (0.191)
γ^1_{EE}	−0.043 (0.057)	γ^1_{EE}	0.153 (0.245)

R^2 for the system = 0.9216
Weighted mean square error for the system = 1.1303
with 270 Degrees of Freedom.
(Standard Errors are in the parentheses).

This production function is globally convex (evaluated at the data means). It is convex for each quarter (evaluated at the equilibrium values). The following production function was estimated using a first-order autocorrelation correction:

$$\ln Q = \underset{(0.4071)}{4.2029} + \underset{(0.0055)}{0.0284t} + \underset{(0.0005)}{0.0003t^2} - \underset{(0.00001)}{0.00001t^3} + \underset{(0.0855)}{0.3866\ I_0} - \underset{(0.0234)}{0.2178\ I_1}$$

$R^2 = 0.9786$
Degrees of Freedom = 90
$\rho = \underset{(0.0524)}{-0.8584}$

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Discussion

J.R. Norsworthy*

This paper on demographic shifts and cylical fluctuations in the productivity slowdown is an excellent one in several respects. I will note these points quickly, and, as is customary, turn my attention to matters that could be improved.

The authors begin by pointing out that average labor productivity is inferior to marginal labor productivity for analyzing the productivity slowdown — a point well taken but perhaps belabored. Their general approach is then to estimate a model of the production process that is sensitive to cyclical fluctuations and changes in energy prices separating the "lumpenproletariat" into two "lumpen" — young and adult workers. The authors then use the results of this estimation to analyze productivity growth, real wages and income, and labor market policies. In my opinion, their general method is entirely appropriate, and only this kind of approach could make the conclusions believable.

It seems to me, however that a number of points warrant discussion in that alternative or additional procedures would make the conclusions easier to evaluate and perhaps ultimately to believe.

The results of the production function estimation are not reported nor are the data on which it is based in sufficient detail. Since the entire paper depends upon the estimation, the authors might have devoted one page (in a total of 50) to reporting the estimation technique, parameter estimates and equation properties. The substitution elasticities, or other indications that the demand surfaces for young and adult workers indeed slope downward, are really essential to establish the credibility of the rest of the results. My earlier plaudits really should be conditional on satisfactory estimation results and convexity for the productivity function.

The authors claim to have adjusted for cyclical movement in the economy by incorporating a single variable in the production function — the gap between the current and equilibrium employment rates, UGAP. There are three difficulties with this. First, UGAP is itself subject to changes due to other than business cycle influences. . . . how about demographic change? The "youthful bulge" in the labor market? The rising participation rate of females? Second, a closely related point is that UGAP is codetermined with

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the demand for labor in the aggregate sector for which the authors estimate the production function, and should be estimated jointly with the share equations describing the production function. Third, a single variable describing the disequilibrium in production associated with varying levels of output seems inadequate and indeed the cyclically adjusted data retain some procyclical movements. In particular, the quantity of capital cannot be instantaneously adjusted, and this leads to compensating under- or over-adjustment in other input factors.[1] The disequilibrium adjustment process for a four-factor model such as the authors estimate would be described by nine parameters rather than only three — or perhaps nine *more* parameters. Because the theory and practice in dynamic modeling of the production process are in a state of rapid and multidirectional evolution, it may be better to modify the claims for the present approach rather than to attempt to live up to them. An appropriate claim would be "that first-order effects of labor market disequilibrium in the demand for the input factors have been adjusted for, ignoring the codetermination of labor market disequilibrium and labor demand."

Now it is somewhat inappropriate to refer to "the production function" in the first place, because in fact no translog-based production function has the share equations that the authors estimate. This should not be taken as too harsh a criticism, because the same is true of many of the dynamic multifactor studies including some of mine.[2] Again, the key to the "no such production function" problem is the codetermination of unemployment and the demand for labor in the author's model. Accordingly, even if the authors had reported elasticities of substitution for the estimated model, some question would have remained about their interpretation.[3]

The authors make much of the point that youth and adult labor are not perfect substitutes, based on tests for aggregation. These tests should be described at least generically. (Are they separability tests following the Berndt-Christensen reference?) Further, it is at least arguable that if the youth and adult age groups had been adjusted for other characteristics — education, occupation, industry and (possibly) class of worker (i.e., employed or self-employed) — the aggregation tests would have passed. More precisely, it cannot be concluded that the two groups cannot be aggregated into a single input due to the influence of a particular characteristic, age — presumably operating primarily as a proxy for experience — unless the effects of age alone can be isolated. If the effective quantities of labor input from the two groups are measured without regard to age, and the aggregation test fails, it is at least a

[1] See M.I. Nadiri and S. Rosen, "Interrelated Factor Demand Functions," *American Economic Review*, Sept. 1969, pp. 457–71.

[2] However, substantial improvements are being made now; the work of E.R. Berndt and others provide an outstanding example of theoretically complete approaches. See the sections by Berndt and Morrison, and Denny, Fuss and Waverman in E.R. Berndt and B.C. Field, eds., *Measuring and Modeling Natural Resource and Energy Substitution*, MIT, forthcoming.

[3] For a discussion of this problem see J.R. Norsworthy and Michael J. Harper, "Dynamic Models of Energy Substitution in U.S. Manufacturing," in Berndt and Field, *Measuring and Modeling.*

reasonable presumption that age is the critical factor. However, there is pretty good evidence that the rapid employment growth since the mid-1960s was characterized by more education; that employment grew more rapidly in the nongoods producing industries; and that particular occupations expanded more rapidly.[4] Thus these other characteristics may be responsible wholly or in part for the authors' results.

The discussions of the comparative trends of average and marginal labor productivity, and total (factor) productivity would be clearer if based on effective labor inputs — adjusted for other elements of composition change as noted above. Likewise effective capital and energy inputs should be used in estimating the production function. (They may have been — this information would be helpful in interpreting the results.) In particular, the discussion of the dating of the productivity slowdown would be improved — and probably more convincing — if effective rather than largely undifferentiated factor inputs were its basis. In any event, I think that the slowdown is best thought of as occurring in two phases — as I have argued elsewhere[5] — an early phase which was unevenly distributed among major industry groups, and a post-1973 phase which was far more general. (Clearly the latter phase must also be examined for energy-related effects.) The dating of the earlier phase may well depend on whether one's primary concern is the average product of labor, the marginal product of labor, or total factor productivity. Inflection points in the subject series should be determining, with due regard for the business cycle.

I think the discussion of policies to promote productivity growth is somewhat off the mark in spots. It should be stated clearly for productivity policy that promoting only total factor productivity growth is the only reasonable goal. Any single-factor productivity policy may raise that factor's productivity at the expense of total factor productivity growth and thus total cost, and therefore exacerbate inflation. At any event, much of the recent productivity policy discussion has centered on incentives to increase capital formation, rather than labor market policies.

The historical focus on labor productivity was not really that wide of the mark, however. Labor was after all the scarcest factor, as judged by the relative rates of price increase, a major cost factor (especially in national income statistics!), and the only factor whose welfare was a widespread national concern. Indeed, in the private business sector the average product of labor, real hourly compensation (adjusted by the CPI rather than the implicit price deflator), were strongly and positively correlated during the postwar period. Of course, nothing much was changing in the relative price movement of major input factors. Multifactor productivity (capital and labor only) also moved parallel with labor productivity, its growth slowing by about 1 per-

[4] Peter Chinloy, "Sources of Quality Change in Labor Input," *American Economic Review*, March, 1980.

[5] J.R. Norsworthy, Michael J. Harper and Kent Kunze, "The Slowdown in Productivity Growth: Analysis of Some Contributing Factors," *Brookings Papers on Economic Activity*, 2: 1979, pp 389–421.

cent in 1965–73. But from 1973 to 1978, whereas labor productivity growth (unadjusted) slowed a further 1 percent, but K–L productivity growth slowed only about 0.15 percent per year.[6] So it is indeed time to examine other measures of the efficiency of resource use, and the authors' suggestions in this vein are quite appropriate.

The discussion of labor market policies is encouraging in that appropriate quantitative techniques are brought to bear on the issues. Again, the author's conclusions would be easier to evaluate if the estimated model and its properties were at hand. As regards future work that might be undertaken in the authors' framework, it would be interesting to see what the distributional implications of the model are, as between laborers, rentiers, and sheiks, over the next 10 years for a range of energy prices and output demand.

In summary, the generally quite plausible results are achieved by what seems to me to be an entirely appropriate analytic method. The major problem in execution is the failure to adjust the youth and adult labor segments for other characteristics that may have biased the results. The freedom-of-information spirit of the times suggests also that the estimation results and other model characteristics be reported, perhaps in an obscure appendix

[6] Ibid.