The Productivity Collapse in Schools

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About the Author

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Introduction

A minor controversy has developed over the pattern of productivity in public schools. A *prima facie* case for a productivity collapse can be found in the rapidly rising spending on schools over the past quarter century with no apparent improvement in student achievement (Hanushek et al. 1994). There are, of course, a number of factors that could contribute to these aggregate trends and therefore could provide an alternative explanation other than a productivity collapse. One explanation receiving considerable publicity concentrates not on fundamental changes in students or schools but on pure measurement issues (Rothstein and Miles 1995; Mishel and Rothstein 1996). The central issue in their discussion is how to allow for the effects of inflation in measuring school spending. While not their interpretation, the position taken here is that their analysis provides perhaps the most persuasive case for a productivity collapse that is currently available.

The basic argument of Rothstein and Miles is that increases in spending should not be judged relative to price increases for general goods and services in the economy. Instead they should be judged relative to price increases in service industries, because one might expect schools to look more like the service sector in terms of productivity and price increases. They highlight the fact that prices in the service sector have risen more rapidly than the general price level. In doing so, they also demonstrate that schools have had much larger spending increases than those for the service sector. When combined with information about performance of schools, this implies that productivity in schools has declined sharply when compared to the service sector—a sector expected to have very low measured improvements in productivity. In other words, schools are doing noticeably worse in terms of productivity growth than the part of the economy we expect to do badly for a variety of reasons.

The measurement of productivity change in the service sector is notoriously difficult, largely because the measurement of output is very difficult. In this regard, measurement in the education sector is easier, because there are regular external measures of quality that do not rely on observed expenditure. The analysis here makes heavy use of measures of student performance in order to obtain more precise measures of productivity change than are typically possible for the service sector.

This paper begins with some basic data on school resources and performance over time. It then discusses a series of conceptual issues in the measurement of price and productivity change. Finally, it returns to the Rothstein and Miles evidence on productivity collapse in public schools.

Basic Data on Schools

The starting point for consideration of productivity changes is simply the changes in spending and performance of schools. In 1965, current spending per pupil was $538. By 1990, it was $5,258. These basic data are open to a variety of interpretations. School spending in simplest terms represents the quantities of inputs purchased by schools (teachers, books, transportation, etc.) times the price of each input. Thus, the spending growth could reflect growth in the prices of inputs to schools, an expansion in the inputs that are used, or a combination of the two.

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Significant increases in traditional school inputs have occurred. As table 1 shows, there have been dramatic and steady reductions in pupil-teacher ratios and increases in the percentage of teachers with a master's degree. While heavily influenced by demographic cycles, the experience levels of teachers have also increased over the three decades. Experience and degrees directly influence teacher salaries, and pupil-teacher ratios indicate how salaries are translated into spending per pupil. Combined these input changes will lead to substantial changes in real spending per pupil. A detailed picture of the full pattern of spending changes over the twentieth century can be found in Hanushek and Rivkin (1997), but for the purposes here the simple summary is sufficient. Regardless of what has happened to input prices, it is clear that the quantities of a number of the real resources that are traditionally the basis of aggregate school policy have increased. Nonetheless, some adjustment for price changes is needed in order to assess how large the increase in resources has been. This is addressed below.

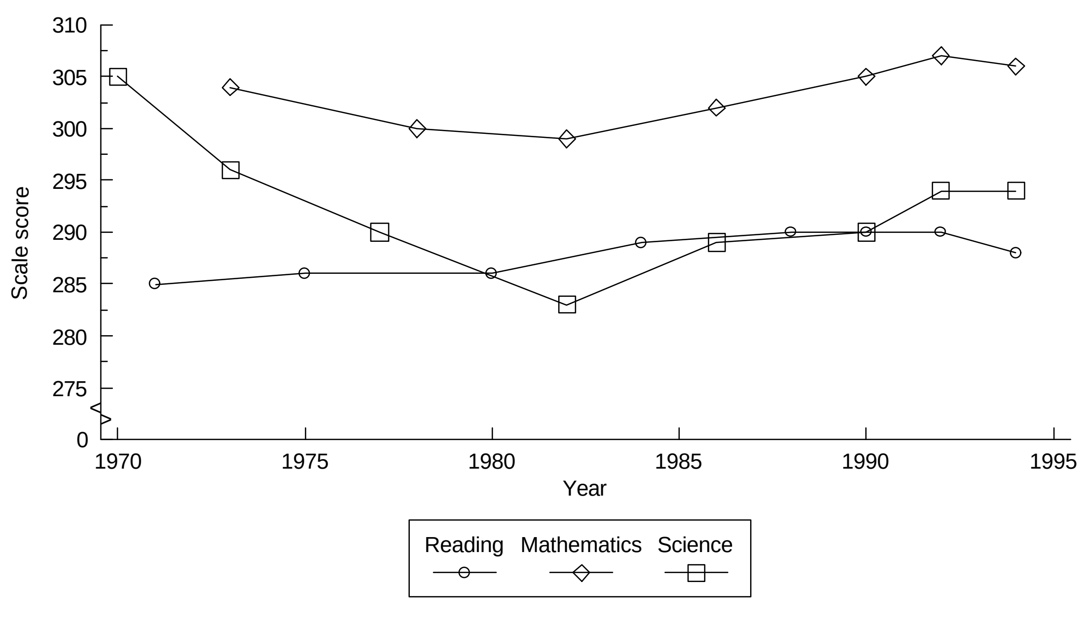
Of course, changes in spending and resources by themselves are not overly interesting. If these spending increases were accompanied by enhanced student achievement, then the discussion would be very different than if these spending increases were to occur with no change in student achievement. The path of achievement is not easily described, because data collection has been sketchy and the data are subject to varying interpretations. Nonetheless, the best available information suggests that the overall trend in student performance has been flat or falling. Figure 1 displays changes in scores of 17-year-olds on the National Assessment of Educational Progress (NAEP) for the tests in mathematics, science, and reading. These scores are available from the early 1970s through 1994. Comparing the end points of these trends, one sees that mathematics performance is up slightly, reading is essentially flat, and science is down slightly. Moreover, the trends in the Scholastic Assessment Test (SAT) [not shown] indicate that there was a precipitous fall from the mid-1960s through the early 1970s. The trend of the SAT is of course subject to potential problems from the well-known selection effects that come from changes in the population taking the test. It is, however, useful to

Table 1.—Public school resources in the United States: 1961–91

Resource	1960–61	1965–66	1970–71	1975–76	1980–81	1985–86	1990–91
Pupil-teacher ratio	25.6	24.1	22.3	20.2	18.8	17.7	17.3
Percent of teachers with master's degree	23.1	23.2	27.1	37.1	49.3	50.7	52.6
Median years teacher experience	11	8	8	8	12	15	15

SOURCE: U.S. Department of Education. 1994. *The Condition of Education,1994*. Washington, DC: National Center for Education Statistics.

Figure 1.—Performance on NAEP: Reading, science, and mathematics: 1970–94



SOURCE: U.S. Department of Education. 1994. *The Condition of Education, 1994*. Washington, DC: National Center for Education Statistics.

provide some evidence for the 1960s, since the Rothstein and Miles analysis begins in 1967.

These data on spending, resources, and student performance provide the basic building blocks for assessing productivity trends in schools. Before doing so, though, some discussion of costs and productivity is needed.

Prices and Productivity

Everybody recognizes that general inflation will tend to push up nominal spending on goods and services, even if exactly the same things are being purchased over time. To deal with this, the federal government statistical agencies routinely produce a variety of price indices designed to indicate exactly how much prices are rising over time. There are complex issues involved in calculating such indices, and the choices are sometimes quite controversial.[1] The underlying ideas are, nonetheless, quite straightforward.

In the case of education, however, much of the discussion about productivity and costs has become thoroughly confused. Therefore, it is useful to begin with a very general discussion of concepts and then to apply them to schools.

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Basic Concepts

Consider the production of widgets (or any other good purchased in the economy). If widgets require only labor to produce and if there are many suppliers of widgets so that there is competition among firms, an increase in the general price level of the economy will tend to involve an increase in the salaries paid to widget makers. If firms producing widgets continue to produce them in the traditional way with, say, exactly the same workers as before, the increase in salaries to workers will be translated directly into an increase in the price of widgets. The price index for inputs would reflect how much more it costs in current dollars to employ a given worker when compared to some point in the past. The price index for the output of widgets will reflect how much more it costs over time to buy widgets. In the simplest case these indices will tend to move together.

Now consider what happens if widget producers devise a better way of producing widgets so that each worker can produce a few more each day, say by substituting machinery for workers. This increased productivity of workers implies that the prices of widgets will tend to increase less rapidly than the salaries paid to widget makers. For example, if worker salaries increase by 10 percent over the year but each worker can produce 3 percent more widgets each day, one might expect in the simplest case for the price of widgets to rise only by 7 percent. This lower increase in widget prices reflects the productivity improvements in the widget industry, as each worker can now produce more and the cost of widgets in terms of worker hours has fallen. If this happens across the economy, then one can also see that productivity improvements will be the basis for real wage increases (i.e., wage increases above any price increases).

These simple ideas can be translated into the estimation of productivity indices. One could calculate an input price index (reflecting the increase in worker salaries) and an output price index (reflecting the increase in the cost of widgets). The difference would be the improvement in productivity in the widget industry. Key to these calculations, however, is an assumption that the quality of both input and output

[1] Recent controversy over the calculation of the Consumer Price Index (CPI) represents a combination of disagreement about the best way to deal with certain technical problems and concern about the ramifications of change because of the effect of the CPI on social security and other governmental programs.

remain constant. (In actual application, quality issues will be central to any measurement.

At the aggregate level, the activities of different industries are combined. Thus, for example, to calculate an index of prices facing consumers it is natural to take a weighted average of the prices for widgets and for other goods and services purchased by consumers. The Bureau of Labor Statistics (BLS) will sample the prices paid across the country for a market basket of consumer goods and then weight these prices by an estimate of how important each item is in the total purchases of a typical consumer. Similar calculations can be performed for inputs into production, instead of the outputs that are purchased by consumers. The difference in the rates of increase of the input and output prices is the rate of productivity improvement in the economy.

A variety of complications arise in the application of these ideas to the actual calculation of price indices. Two complications are particularly relevant to the considerations here. First, if the relative price of some consumer goods and services change (e.g., computers become cheap relative to automobiles), consumers will tend to react by switching their purchases to things that are now cheaper (i.e., buying more computers and fewer cars). Firms would be expected to do the same sort of switching in how they produce things if the relative prices of inputs changes (e.g., computers become cheap relative to workers). These changes in behavior imply that the appropriate weighting for individual input or output prices will change, leading to complications in the actual construction of price indices.

The concept of a price index presumes that prices relate to the same item, but quality changes frequently occur and must be accounted for in any calculations.

Second, over time the range of products (and inputs) changes, particularly in terms of the quality of products. For example, a personal computer today can literally do calculations 100 times quicker than a personal computer of just a few years ago. The concept of a price index presumes that prices relate to the same item, but quality changes frequently occur and must be accounted for in any calculations. For example, if today's top-end personal computer and the top-end available five years ago each cost $5,000, then we would not say that the price of computers has been constant. Indeed the price of computers (or, more precisely, of the services of computers) has fallen dramatically. If we think of quality improvements as getting more of the product, then we can simply reduce the observed rate of increase of the price of an item by the rate of increase in its quality.[2]

In many cases, measurement is difficult to do with precision, even if the approach is conceptually very straightforward. For example, many services, prices, and quantities are not independently observed; instead only total expenditure is sampled. The total expenditure represents a given amount of a service of a given quality at a given price, and each of these items might be changing. Calculation of price indices requires separating the different components of expenditure, either by observation or by assumption. While it is often assumed that measurement is easier for goods in the economy as opposed to services, this is not entirely clear. The availability of direct measures of quality in some service sectors (including education) provides significant advantages for the measurement of price and productivity change.

[2] The appropriate correction of the CPI for quality changes is one of the current sources of controversy. Similarly, some dispute about the pattern of overall change in the productivity of U.S. manufacturing relates to the measurement of computer and information systems inputs into production. Over a longer period of time, it is not just quality changes but also the introduction of new products that leads to problems.

Baumol's Disease

While not precisely related to the calculation of price indices, a series of economic arguments emphasize the cost implications of differential technological change and productivity growth (Scitovsky and Scitovsky 1959; Baumol and Bowen 1965; Baumol 1967). The focus of this work is the cost disadvantage of a sector that experiences little apparent technological change while other sectors undergo regular productivity improvements. Because the rise in real wages—increases above general inflation—are roughly proportional to the average growth rate of labor productivity in all sectors, the technologically stagnant sector faces increased real labor costs. In other words, industries with rapid improvements in their ability to produce outputs can afford to pay more for workers and will bid up the wages of workers. It is often assumed that the nature of production prevents the stagnant sector from hiring fewer of the increasingly costly labor inputs, thus leading to increases in the price of output. The lack of substitutability of machines for workers can arise either because of some necessity (e.g., the need for four musicians in a horn quartet) or because the quantity of labor input is directly related to perceived quality (e.g., class sizes and the demand for teachers in schools).[3] These simple predictions of increasing costs in low productivity growth sectors, often termed simply "Baumol's disease," dominate explanation for cost growth in government services, the arts, many nonprofit activities, and other industries in which labor services are the most significant input factor.

These arguments, which we will return to later, provide predictions about the rate of cost increases in certain industries—those with low productivity growth. They do not, however, necessarily imply that any modifications in the measurement of cost changes or productivity growth are required.

Costs and Productivity in Schools

It is fairly straightforward to apply these ideas to the calculation of cost and productivity in education. In other areas, such as those for automobiles or toasters, estimation of price indices begins with simply buying a sample of items and looking at the prices paid. We cannot readily do that in the case of schools because there is no market for public school services. On the other hand, we do observe total expenditure on schools. Expenditure is simply price times quantity. If we calculate expenditure per student per year, quantity changes would be accounted for, and our major concern would be whether or not the school quality had changed. Figure 1 showed that quality, at least as measured by cognitive skills, has been roughly constant, implying that the growth in expenditure per student is simply the growth in the price for schooling. (If quality has actually fallen, then this calculated growth in price will be understated). This calculation is a simplification. For example, changes in the mix of primary versus secondary school children could lead to different spending, because these groups cost different amounts to the school. Those changes are not overly important (see Hanushek and Rivkin 1997), but, as discussed below, other changes in students and activities may be more important.

If school output is constant, the obvious question is how has the price of schooling grown relative to other prices in the economy.

If school output is constant, the obvious question is how has the price of schooling grown relative to other prices in the economy. To do this comparison, we can simply subtract off the growth in the CPI

[3] Again, measurement issues abound. For example, while musical groups may be constrained to a relatively fixed mix of musicians, some believe the advent of recordings, radio, television, and now the Internet have led to a very large expansion of output for the same number of musicians. If defined solely in terms of concert performances, there may be little substitutability, but this does not hold if defined in terms of total music output.

or the deflator for the Gross Domestic Product (GDP).[4] By doing this, we can immediately see if we are giving up more or less of other goods and services, in order to purchase schooling.

Table 2 provides a general comparison. This table shows price increases for two overlapping periods: 1982–91 and 1967–91. If we concentrate on the most recent period, we see that expenditure per student increased by 7.6 percent annually. The general price level over the same period increased by either 3.7 percent (GDP deflator) or 3.9 percent (CPI) over the same period, implying that the price of schooling relative to all other goods in the economy rose by close to 4 percent per year. Said another way, if school quality has not changed, any productivity improvements in schools lagged behind those in the typical other sector by 4 percent per year. If quality in fact declined, then these calculations understate the increases in education prices that have occurred. Only if there has been some increase in outcomes (unmeasured by the external achievement data presented) would these calculations give measures that were higher than the true price increases in schools. If the current CPI and GDP deflators actually overstate price increases, schools are doing even worse than estimated by these calculations. The overstatement of inflation and the consequent understatement of general productivity growth has received considerable recent attention (see Norris 1996). These estimates presume that the general price indices are accurate measures of inflation.

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As mentioned, part of this price increase in schools might simply reflect Baumol's disease. Schools rely heavily on college-trained workers, and the relative pay of college workers has risen dramatically since the mid-1970s (Murphy and Welch 1989; Hanushek et al. 1994). Therefore, we could calculate an input index for the prices that schools must pay for workers and for other inputs. Input price indices, particularly for labor, face large problems with potential quality adjustments. These quality problems will be particularly large with specialized labor, such as teachers. For the analysis here, I simply use changes in the average wages for college-educated workers age 25–35. This approach assumes that position in the distribution of wages for college-educated workers is the relevant measure of quality for school teachers. I calculate this input index by giving equal weights to the relative price of college-educated workers aged 25–35 and to the CPI.[5] Table 2 shows this separately for all young college workers and for young female college workers. These calculations suggest that input prices have risen roughly 4.5 to 5 percent per year over this period. While the increase in school output prices was compared to the average price of college educated workers to calculate an input price index, schools actually purchased workers from ever-lower points in the distribution of all young college workers (Hanushek and Rivkin 1997). In other words, the average salary of teachers was allowed to slip relative to pay for college workers elsewhere in the economy. This implies that the cost of inputs actually employed by schools did not increase as fast as the general input prices in table 2. For the productivity calculations, however, this is not a central issue. Schools presumably spent less on teachers, got lower quality teachers than they could have, but used the money saved to

[4] The CPI by definition measures prices for items directly purchased by consumers. The GDP deflator measures price increases for both consumer and producer goods. Over time these tend to move together.

[5] The combination of the CPI and the salaries of college graduates is meant to reflect the various inputs purchased by schools. Changing the weights within reasonable ranges will have relatively minor effects on the indices.

Table 2.—Alternative views of price increases in public schools (annual compound percentage increases)

	1982–91	1967–91
Current school expenditure per pupil (nominal dollars)	7.6	9.5
General ouput price indices		
GDP deflator	3.7	5.6
CPI	3.9	6.0
School input price indices		
.5 college wage + .5 CPI	4.4	5.9
.5 female college wage + .5 CPI	5.1	6.5
Output price indices for low productivity sectors		
CPI—services	3.9	7.0
Net services index (NSI)	4.1	N/A

SOURCE: Council of Economic Advisors. 1997. *Economic Report of the President, 1997*. Washington, DC: U.S. Goverment Printing Office; author's calculations.

purchase other inputs. Since the rise in output price is in this case simply the rise in input prices less the increase in productivity gains per year, these calculations suggest that *productivity in schools has fallen by 2.5 to 3 percent per year*.

The final part of table 2 provides comparisons suggested by Rothstein and Miles (1995). They suggest that performance of schools should be compared to output price indices for low productivity sectors of the economy, like the service industries. An alternative justification, although not one that they make, is that the output index for services can be used to measure the prices of inputs to schools. If this were the case, the input costs would be estimated to grow more slowly than the input indices used. The BLS provides a CPI for services. Rothstein and Miles calculate an alternative, which they call the Net Services Index (NSI). This adjusts the CPI services for shelter and medical costs. Either of these indices indicate that educational productivity is *falling at 3.5 percent per year relative to low productivity sectors of the economy*. In other words, education has been doing significantly worse than the typical low productivity industry as identified by Rothstein and Miles. Further, this relative fall has been even larger than the absolute productivity decline calculated previously because service sectors have been able to make modest productivity improvements over the recent period. As discussed, productivity improvements in the general service sector may actually be larger than the common measures indicate, chiefly because of problems in appropriately including quality improvements. The modest improvement calculated in table 2 (found by comparing service price increases to the input price indices) presumes that services have had the same input mix as identified for schools. The productivity improvement may be larger if other service sectors rely less heavily on college-educated labor, implying that input prices have gone up less than estimated in table 2.

The picture from looking at the longer period of 1967–91 has changed very little.[6] If anything the productivity decline is larger when looked at from the longer perspective.

Explanations

The productivity collapse that Rothstein and Miles (1995) identified is a complex phenomenon, and understanding its sources will be important to improving the nation's schools. Here I can just sketch some of the components.

First, while the general Baumol arguments imply that external forces drive cost increases, table 1 shows that schools systematically hired more of the increasingly expensive inputs (teachers) over this period. While one might believe that schools cannot do with less of the expensive labor input, nothing in the general Baumol story would necessitate moving toward the more expensive input. This is akin to hiring a fifth musician for the horn quartet when the price of skilled workers rise. The productivity problems from this are also underscored by evidence about the general ineffectiveness of reduced class sizes.[7]

Second, as is well known, there have been changes in schools brought about by increased proportions of students receiving special education services (Rothstein and Miles 1995; Hanushek and Rivkin 1997). This change could ameliorate some of the productivity collapse to the extent that quality has improved for special education students (by amounts greater than any quality drop for regular education students). Nonetheless, it does not seem possible that any of these effects could be sufficient to yield large changes in the data of table 2.

Third, the students coming to schools could be increasingly more expensive to educate. For example, over this time period the proportions of students from single parent families and living in poverty have increased. Again, while it is difficult to sort out the full effects, these effects would be balanced by improvements through better educated parents and smaller families. Grissmer et al. (1994) suggests that students may actually have improved over this period—thus making the productivity picture worse than that presented—but it is difficult to do such calculations with precision.

My explanation is actually simpler and more straightforward (Hanushek et al. 1994). The structure of schools does not provide incentives to improve student performance or to conserve on costs. Therefore, it is not particularly surprising that these do not happen.

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6 We could not calculate the NSI index prior to 1981 because of missing data on the shelter component.

7 The documentation of this can be found in Hanushek (1997). While subject to some continuing controversy, little evidence supports the general reductions in class size (see Hedges, Laine, and Greenwald 1994; Hanushek 1996).

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