# Judging Investment Strength: Taking Account of High Tech

By Jon Faust

Was investment growth strong or weak in the 1980s? This question is important because strong investment has historically promoted higher living standards for U.S. citizens. Surprisingly, however, there is no consensus on the strength of investment in recent years. Some analysts argue the last decade witnessed an investment boom; others insist investment growth was anemic in the 1980s.

Why the controversy? Judging investment strength has always been difficult, but one issue in particular clouds the current debate: the rise of high tech investment. Over the last 15 years, much investment has shifted from heavy equipment toward high tech equipment, such as computers and other information-processing equipment. The unprecedented change in the makeup of investment has confused the interpretation of standard investment measures. Simply put, it is hard to compare the value of today's high tech investment with that of yesterday's investment in tractors and lathes.

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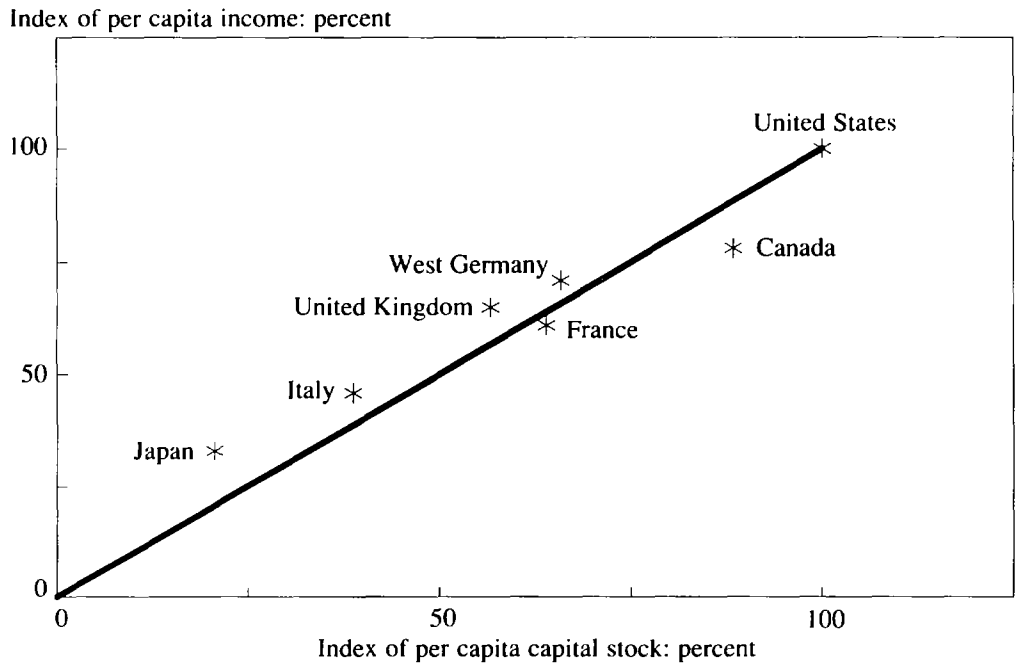
This article evaluates the strength of investment in the 1980s in light of the shift toward high tech investment. The article shows how the rise of high tech investment has distorted traditional investment indicators, and advocates the use of some new, less distorted indicators. The article concludes that, after accounting for the rise of high tech investment, there was no investment boom in the 1980s—nor was there a great bust.

Section I explores the investment controversy. Since the mid-1970s, a rising depreciation rate of the nation's capital stock has caused formerly consistent indicators of investment strength to give conflicting signals. Behind rising depreciation has been a shift toward high tech investment. Section II shows how the shift toward high tech investment has made traditional measures of investment fundamentally unreliable. Section III presents alternative, more reliable measures, which show that investment growth since 1975 has been neither exceptionally strong nor exceptionally weak.

## I. The Investment Controversy

Beginning in the mid-1970s, traditional measures of investment strength began to send

Chart 1
## Per Capita Income and Per Capita Capital Stock, 1960




Source: Lipsey and Kravis 1987.

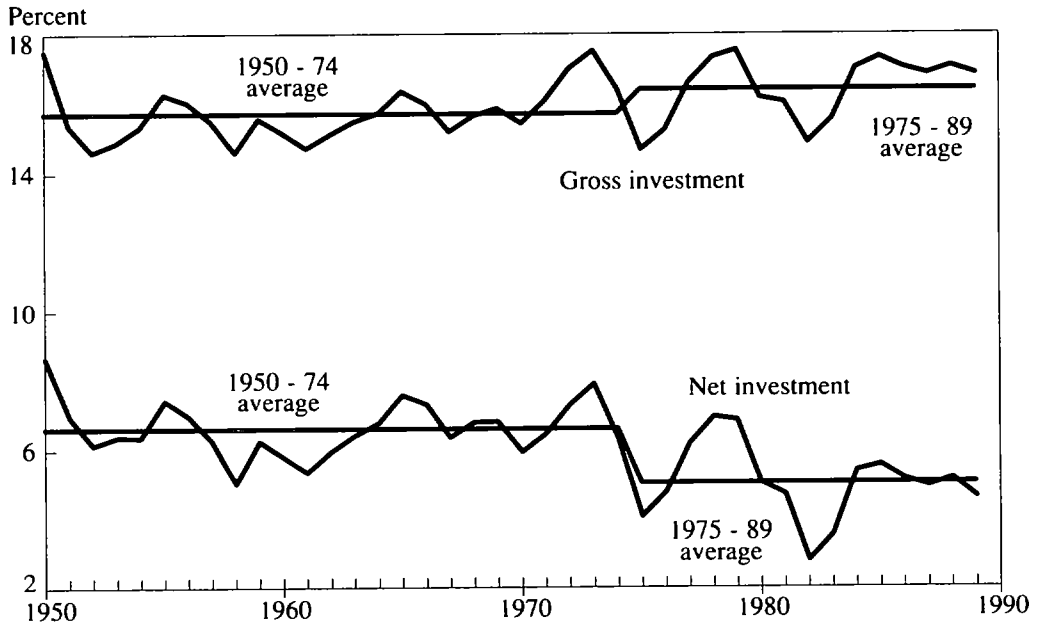
conflicting signals about the strength of investment. Without reliable signals, it has been difficult to gauge the effects of policy initiatives. For example, analysts have been unable to resolve whether the tax reforms and large government budget deficits of the 1980s increased or decreased investment growth.[1] Some analysts contend "the changes in the tax law and regulatory climate inaugurated with Reagan in 1981, and the dramatic decline in the inflation rate thereafter, greatly increased investment demand" (Darby 1989). Other analysts charge that "Reagan's new fiscal policy delivered not more capital formation but less" (B. Friedman 1988).[2] This section shows why such varying views have arisen and how rapidly rising depreciation lies at the heart of the debate.

### Diverging investment measures

Analysts monitor investment because it is a key element promoting economic growth. By giving workers more capital to work with, investment allows the average worker to produce more goods than before. For example, using tractors and other modern equipment, a single farmer today can produce about seven times more food than a farmer could produce in 1950.[3] Similar examples of the importance of investment abound throughout the economy.

More generally, data for major industrial countries show a strong relation between investment and economic growth. For example, in 1960 countries with a higher capital stock per capita also enjoyed a higher per capita income (Chart 1).[4] These data for 1960 are typical of the

Chart 2
## Gross and Net Investment as a Share of GNP




Source: Department of Commerce, Bureau of Economic Analysis, July issues.

relation between capital and income for these countries since World War II (Lipsey and Kravis 1987).

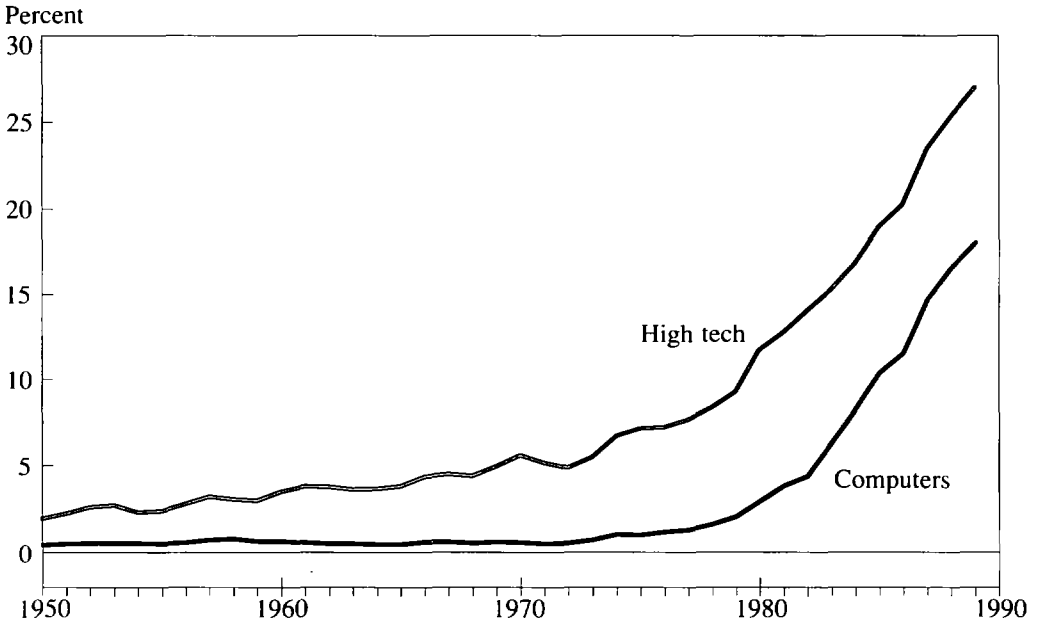
Because investment is such an important determinant of growth, it is imperative that it be measured accurately. Traditionally, analysts have focused on two measures of investment: *gross investment* as a share of GNP and *net investment* as a share of GNP.[5] While both measures represent the share of GNP set aside to build the nation's capital stock, the measures differ in the way they view investment. Gross investment counts all investment spending, while net investment counts only that portion of investment spending that actually increases the capital stock, leaving out investment going to replace worn-out capital. In other words, net investment equals gross investment minus depreciation. For years analysts have debated the relative merits of the two measures (see box). Until recently, however, the two measures always tended to move together.

The investment controversy has arisen because the gross and net investment indicators have recently been sending conflicting signals. From the late 1940s to the mid-1970s, the two indicators rose and fell together, telling the same story about the health of investment. Since the mid-1970s, however, interpreting the indicators has become much more complicated. The gross investment share has signaled an investment boom, while the net investment share has signaled an investment bust.

The divergence in the behavior of the two investment measures is quite striking (Chart 2). From 1950 to 1974, the shares of national

Chart 3

## High Tech and Computer Investment as a Share of Gross Investment




Source: Department of Commerce, Bureau of Economic Analysis, July issues.

income going to gross and net investment remained very close to their average levels of 15.7 and 6.6 percent, respectively. While the investment shares fluctuated, the two series moved up and down in lockstep. Since 1975, however, the two indicators have suggested opposite conclusions about investment strength. The average share of income going to gross investment has risen to 16.4 percent, while the average share of income going to net investment has fallen to 5.0 percent. In particular, this divergent behavior of net and gross investment has continued during the extended economic expansion that began in 1983. From 1983 to 1989, the gross investment share averaged 16.8 percent, while the net share averaged 4.9 percent.

### Rising depreciation and high tech investment

It is clear the divergence of the gross and net investment measures is due to rising depreciation. By definition, depreciation is the only difference between the two measures of investment. Indeed, as a share of national income, depreciation rose by two percentage points from 1974 to 1988. And that increase, in turn, is due largely to a shift toward high tech investment.

High tech investment has grown rapidly since the mid-1970s. While there is no high tech category in official investment statistics, the category "information processing and related equipment" is a good measure of high tech investment. This category includes data on three

types of equipment: office computing and accounting; communications; and instruments, photocopiers, and related equipment. These types of equipment encompass many high tech items.[6]

Gross investment in high tech categories jumped to 27 percent of overall gross investment in 1989, up from 7 percent in 1975 (Chart 3).[7] As might be expected, much of this jump was due to increased computer investment. The computer category of high tech investment rose from 1 percent in 1975 to 18 percent in 1989.

Not since World War II has the composition of investment changed so quickly and dramatically. For example, the share of gross investment going to high tech items jumped 18 percentage points during the 14 years ending in 1988. Previously, the largest jump in a single category over a 14-year period was only seven percentage points, which occurred during the commercial building boom following World War II.[8]

The shift toward high tech equipment is the major source of the rise in depreciation. Increased high tech investment has raised the depreciation rate because high tech equipment generally wears out faster than other sorts of

## Do Measurement Difficulties Argue for Gross Measures of Investment?

Why cannot analysts simply decide whether gross or net is the more appropriate indicator of investment? If there were good reasons to ignore one measure in favor of the other, the conflicting signals given by the two indicators would not be a problem—analysts would simply use the best indicator. Discussed here are some arguments put forward in favor of gross or net indicators. It is concluded that none of these arguments resolve the conflict, implying that the answer to the investment controversy must be found elsewhere.

Analysts have made both "in principle" and "pragmatic" arguments in favor of one measure or the other. For example, some analysts contend that net investment is, in principle, the more appropriate indicator of investment's contribution to growth. Since investment used to replace worn out capital does not contribute to net growth of the capital stock, the argument goes, net investment should be the better indicator of future growth. On the other hand, other analysts argue that the amount of depreciation is mainly determined by the amount of capital put in place in the past (the more capital put in place in the past, the more capital there is to wear out today). Thus, depreciation is a backward-looking measure. Subtracting depreciation from gross investment, they claim, gives an indicator more of past investment than of future growth (deLeeuw 1990).

Both of these groups have valid points, and analysts have not agreed which measure is better in principle. Ultimately, however, these in principle arguments may not be too important. What analysts are seeking is a reliable simple indicator of investment's contribution to growth. The exact nature of this contribution is complex, and there will be objections to any simple indicator. The important question is, what simple indicator is likely to be most reliable in practice?

On this more pragmatic note, analysts have put forward two arguments about why net investment should be ignored in favor of gross investment. Both arguments stem from the pragmatic issues about how accurately net investment is measured (Scott 1989; and Tatom 1990). Neither argument is convincing.

The first argument is that depreciation is very hard to measure, making net investment measures unreliable. While it is true that

capital. For example, the Bureau of Economic Analysis estimates that the average service life of computers is eight years, nearly the shortest of any type of capital. Metal-working equipment, for example, lasts 16 years, railroad equipment 28 years, and warehouses 40 years (Department of Commerce 1987).

As high tech investment has grown, the expected average service life of new investment in equipment has fallen from 22 years in the first half of the 1970s to 18 years in 1988. For equipment and structures together, the average service life has fallen from 39 years to about 34 years.[9]

The shift to short-lived, high tech investment goods can explain a large portion of the rise in depreciation as a share of GNP. From 1974 to 1988, depreciation on high tech items as a share of GNP increased 1.7 percentage points. In contrast, depreciation on low tech items as a share of GNP increased only 0.3 percentage points. These figures somewhat exaggerate the role of high tech, because investment and hence depreciation in low tech would have been higher if the shift to high tech had not occurred. Nonetheless, the shift to high tech accounts for a substantial portion of the rise in depreciation as a share of GNP.[10]

depreciation is hard to measure, this is not alone an argument in favor of gross investment indicators. If depreciation is important, net investment measures based on shaky depreciation data may well be better than gross investment measures that ignore depreciation entirely.

The second argument in favor of gross investment provides a reason why measured gross investment might be the best indicator of *true* net investment. The argument begins with the fact that investment funds seldom go simply to replace worn out capital. Instead, old machines are usually replaced with better, more efficient, or more useful machines. If this improvement in capital is not accurately measured, then investment going to improve the capital stock might be counted as simply replacing worn out capital. This argument is important because most analysts agree than quality change in capital is very difficult to measure.

For two reasons, however, problems measuring quality change should not lead analysts to ignore depreciation. First, the Department of Commerce has implemented special techniques for dealing with computer investment that are meant to measure the rapid quality change in computers. Thus, the quality issue may not argue for ignoring the rising depreciation on computers.

Second, the appeal of using gross measures due to quality improvement relies on the rough assumption that the mismeasured quality improvement and depreciation nearly cancel out. While this cancellation assumption might be plausible during stable times, it is not plausible when the depreciation rate on capital is changing, as it has recently. For example, when the depreciation rate rises, the cancellation assumption will be valid only in the unlikely event that the pace of mismeasured quality improvement rises with the depreciation rate. If the rate of mismeasured quality improvement does not change in this fortuitous way, the growth of measured net investment will be the best indicator of the true growth in net investment. This is true even in the face of substantial mismeasured quality change. (This conclusion does not imply that net investment is a better measure, only that quality change does not provide a reason to ignore net investment in favor of gross investment.)

Overall, these in principle and pragmatic arguments do not provide a reason to rely exclusively on either gross or net measures.

## II. High Tech Distorts the Standard Investment Indicators

The rise in high tech helps explain why the two standard investment measures have diverged. Yet resolving the puzzle over which measure, if either, has been sending an accurate signal requires digging more deeply into the effects of the shift to high tech. This section shows that both measures of investment have been badly distorted by the rise of high tech. The distortions arise from three sources.

*Shorter service life implies higher productivity.* High tech equipment wears out faster than other capital. In order for it to make good business sense to buy a short-lived piece of equipment, the return on that equipment must be high enough to pay the investment off in a short time. Longer lived equipment can have a lower payoff that stretches over many years. For example, a firm might erect a building that will have a small annual return, knowing that the total payoff over 40 years will justify the initial investment. In contrast, a computer will earn a return for only about eight years and must pay off much more quickly. Thus, to justify an initial investment of $100 in high tech equipment, businesses must expect a return of about $20 per year. In contrast, the building only needs to earn about $8 per year to pay off the same $100 investment.[11]

The higher productivity of high tech investment causes both gross and net investment to paint pictures that tend to be too pessimistic. Both measures ignore the fact that since the mid-1970s investment dollars have shifted into more productive investment than before. Thus, both measures will tend to underestimate investment's contribution to growth.[12]

*Short life implies smaller long-run capital stock.* While shorter lived capital may be more productive, it contributes for a shorter time. Thus, money spent on short-lived capital will make a smaller long-run contribution to the capital stock than long-lived capital. The long-run increase in the capital stock associated with a given amount of investment in computers, for example, will fall far short of that associated with an equal amount of investment in buildings.

Because the gross investment share takes no account of the more rapid depreciation of high tech items, gross investment measures will currently tend to be too optimistic regarding the long-run investment picture. Depreciation is removed from net investment, on the other hand, implying that it will not be affected by this factor.[13]

*Falling high tech prices imply falling high tech productivity.* Although high tech investment is more productive than low tech, high tech's relative advantage has undoubtedly fallen throughout the 1980s. This fall in high tech productivity is related to the fall in the price of high tech investment goods.

A typical piece of high tech equipment that cost $100 in 1975 would have cost only $51 in 1989.[14] The price decline has been even more extreme in the computer category of high tech. Computer equipment that cost $100 in 1975 would have cost only $15 in 1989. The decline in high tech prices is even more significant given that the price of other investment goods has risen significantly over this period. For example, a typical piece of low tech capital that cost $100 in 1975 cost $152 in 1989. Thus, while the price of high tech goods fell by almost 50 percent, the price of other capital goods grew by 33 percent.

Falling prices of high tech equipment imply falling productivity of new high tech investment. Productivity declines because businesses apply expensive capital goods only to highly productive tasks, while cheaper capital goods are applied to much less productive tasks. For example, when computer prices were very high, computers were purchased only for extremely productive uses. The biggest firms purchased computers for large jobs that would have been prohibitively expensive without computers.

Today's cheap computers are applied to more mundane tasks, such as keeping electronic address books.

This third effect will tend to make both standard investment measures too optimistic. The standard investment indicators basically assume that a dollar invested in computers today has the same productivity a dollar had in 1982. Why? Because the inflation-adjusted data state values in 1982 dollars, as if 1982 prices still prevailed. But since new computers purchased today are actually applied to less productive tasks than those in 1982, both standard investment measures will tend to give too optimistic a picture of investment.[15]

Thus, the rise of high tech has brought three complications to standard investment indicators. First, high tech equipment is more productive in each year of service than low tech equipment. Second, the equipment is short-lived, and will not contribute to the economy for as long as low tech equipment. Third, new high tech equipment is being applied to less and less productive uses. These complications make one conclusion clear: both gross and net investment measures are currently sending unreliable signals. What is the true picture of investment after adjusting for these distortions?

## III. Adjusting for High Tech Distortions: No Investment Boom or Bust

Knowing that the rise of high tech has made both gross and net investment measures unreliable, analysts need some other indicator to judge investment strength. This section discusses the evidence from a relatively new form of investment indicator called *capital input indexes.* These indexes are constructed to be less distorted by rapid changes in the composition of investment. Capital input indexes suggest that the contribution of investment to growth in the 1980s was similar to the contribution in prior decades. Thus, investment measures that account for the shift to high tech support the conclusion there was no investment boom or bust in the 1980s.[16]

### Constructing capital input indexes

Capital input indexes are intended to measure the growth in the contribution of capital to economic output. The indexes measure each type of capital separately. Initially, the indexes compute the growth rate of the net stock of each type of capital. The indexes then weight and combine the growth rates into an overall index of capital input growth, using weights that reflect the productivity of each capital type. The weights used in combining the capital growth rates are allowed to change each year to reflect changing productivity of the various types of capital.

Because of the way they are constructed, capital input indexes should not be greatly distorted by the three factors that distort standard investment indicators. The first distortion—the higher productivity of high tech capital—is accounted for in the index by applying a larger weight in the index to high tech capital growth than to low tech growth. The second distortion—the smaller contribution of high tech investment to long-run growth in the capital stock—is directly accounted for in computing the growth rates of the individual capital stocks. The capital stock growth rates are computed using net capital data that reflect the service life of each type of capital. Finally, the third distortion—that falling price implies falling productivity—is accounted for by computing new weights for each year, based on the prices that exist in that year. Thus, while the standard measures use 1982 prices as a base for weighing each year's data, capital input indexes use weights for each year that reflect prices in that year.

If these indexes are so good, why do analysts

rely on the traditional investment measures? The simplicity of traditional measures is, of course, an important virtue. The traditional measures are based directly on data from the national income accounts and have a direct interpretation in terms of the share of income spent on investment. In contrast, creating the weights for the capital input indexes requires complex calculations. While the resulting indexes are indicators of investment strength, they lack the simple, direct interpretation of traditional measures.

Until the mid-1970s, there was no need to abandon the simplicity of the traditional measures. As demonstrated above, however, the recent unprecedented change in the composition of investment has badly distorted traditional measures. In times like these, capital input indexes may be a valuable supplement to simpler measures.

Capital input indexes do not solve all the problems of measuring investment. Important questions remain. For example, should investment include education and military spending?[17] Such questions also plague traditional investment measures. While the capital input indexes do not solve all problems regarding the measurement of investment, they do help solve the problems brought on by rapid change in investment's composition.

## What do capital input indexes say about investment?

The impact of the rapid rise in high tech investment can be captured by constructing a simple capital input index that assumes three types of high tech capital—computers, communications, and instruments and photocopiers—and one, generic type of low tech capital. This index, constructed by the author and explained in the appendix, will henceforth be called the HT index. By ignoring changes in the composition of low tech investment, the HT index highlights the shift from low tech to high tech investment. The weights for each capital type in the HT index are assigned in a simple way to reflect the service life and price of the capital.

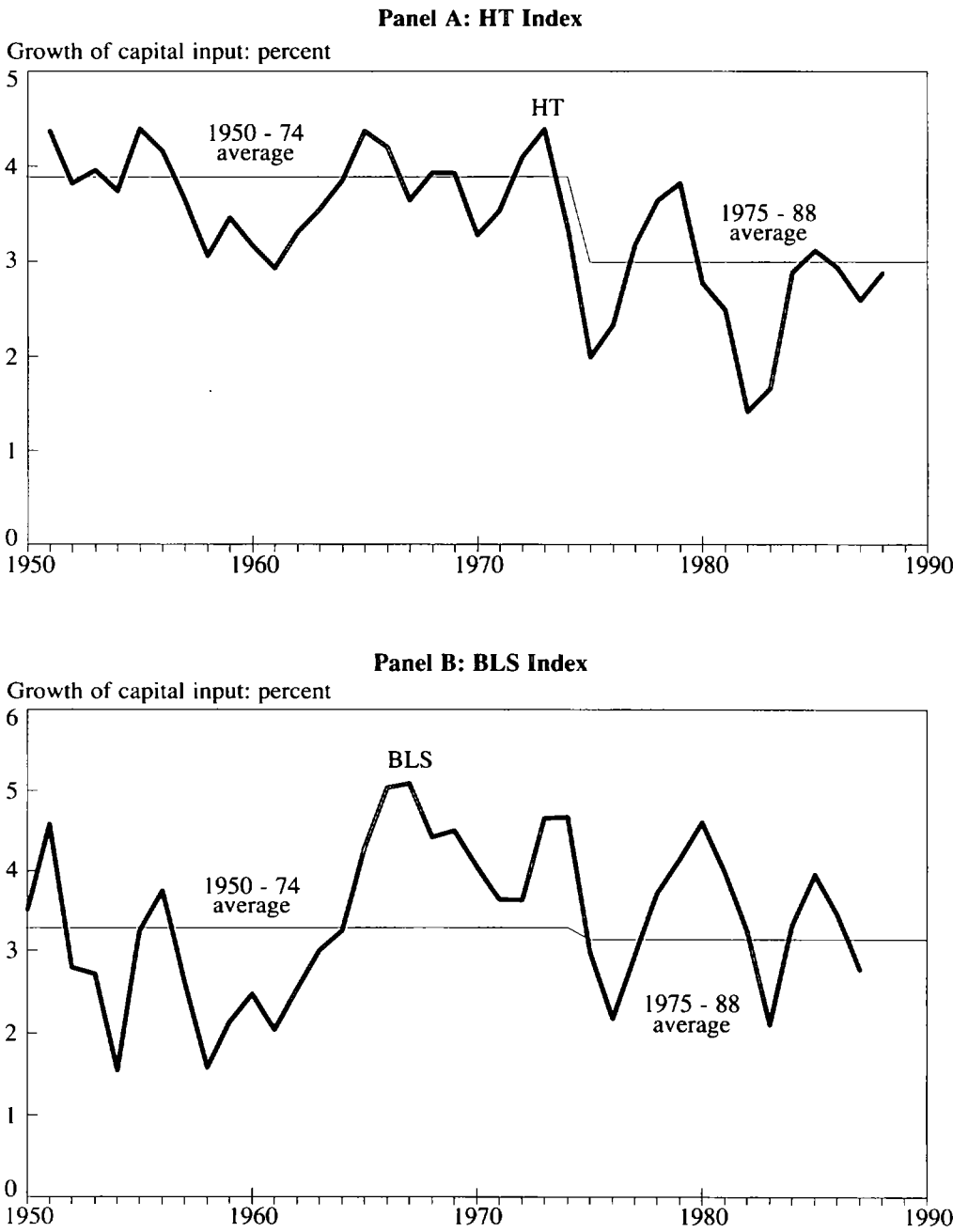
The HT index shows that capital input growth has declined somewhat since the mid-1970s (Chart 4, Panel A). Capital input growth fell from an average 3.9 percent during 1950-74 to an average 3.0 percent during 1975-88.

While the HT index emphasizes the shift to high tech, a more comprehensive capital input index, constructed by the Bureau of Labor Statistics, captures all changes in the composition of investment (Chart 4, Panel B). That is, the BLS index takes into account a much broader range of issues than does the HT index.[18] Chart 4 shows that the two capital input indexes have tended to move together closely, except during the 1950s and early 1960s. This agreement since the mid-1960s suggests that the simple HT index, which adjusts only for the shift to high tech, seems to have captured most of the important changes in capital input growth since the mid-1960s. The HT index does not, however, capture some of the adjustments in the capital stock following World War II that are reflected in the BLS index.

By the BLS index, capital input growth averaged 3.4 percent from 1950 to 1974 and only slightly less, 3.3 percent, thereafter. Thus, by this index, which reflects the shift to high tech as well as the earlier adjustments of investment following World War II, capital input growth has shown little change with the rise of high tech.

Overall, then, the capital input indexes provide evidence of neither exceptionally strong nor exceptionally weak investment growth since the mid-1970s.[19] This evidence underscores the unreliability of traditional investment indicators. The changes in the composition of investment have made the gross investment share send too optimistic a signal regarding investment,

Chart 4
## Two Capital Input Indexes




Sources: Bureau of Labor Statistics for BLS index; see appendix for HT index.

while the net investment share is sending too weak a signal.

## IV. Summary

Was investment growth strong or weak in the 1980s? The unprecedented change in the composition of investment since the mid-1970s has made this seemingly simple question difficult to answer. With the rise of high tech investment, indicators that were traditionally relied upon to answer such questions have become unreliable. Gross investment indicators now send signals that are too optimistic, while net investment indicators send overly pessimistic signals.

During times when investment is shifting, analysts can look to capital input indexes that are less distorted by shifts in the composition of investment. While these capital input indexes do not solve all the problems of measuring investment, they are useful in judging investment strength in a changing investment environment. The picture they paint should lead neither to great optimism nor great pessimism: There was no investment boom in the 1980s—nor was there a great bust.

## Appendix

## Capital Input Indexes

The capital input indexes discussed in this article measure capital input growth as a weighted average of the growth rates of the net stocks of individual capital types. The weights used are based on the budget share (in rental terms) of each capital type. The weight used in each period is the average of the current and previous periods' budget share.

The precise formulation of the HT index is as follows. Define $K_i$ as the net stock of capital of type $i$. If the price of purchasing capital of type $i$ is $p_i$, then the cost of using (renting) capital of type $i$ for one period is defined as: $w_i = A_i p_i$, where $A_i = (r + 1/s_i)/(1 + r)$, $s_i$ is the service life of capital of type $i$, and $r$ is the real interest rate. This simple user cost formulation assumes that the only factors affecting the user cost are straight line depreciation, a constant real interest rate, and the price of capital. This ignores, for example, taxes.

Using the notation from above, the formulas for the HT index are as follows. The budget share measures are defined by

$$z_{it} = w_{it} K_{it} / \left( \sum_{j-1}^{4} w_{jt} K_{jt} \right); \; Z_{it} = (z_{it} + z_{it-1}) / 2$$

The index is then given by:

$$Capgrowth = \sum_{i-1}^{4} Z_{it} \log (K_{it}/K_{it-1}).$$

In constructing the HT index, the composite low tech service life is assumed to be 40 years. A real interest rate of 4 percent is assumed. Capital prices are based on implicit deflators from the capital stock data for low tech and on fixed weight deflators for the high tech categories. The service lives of the high tech categories, implicit deflators, and capital stock data are from the U.S. Department of Commerce 1987, the fixed weight deflators are from U.S. Department of Commerce, various issues.

Indexes of the form described here are known as Tornqvist indexes and have been widely studied by economists. They exactly reflect growth in the indexed quantity (capital input in this article) under certain restrictive assumptions, and approximately reflect growth under a broad range of assumptions. Accuracy, in practice, relies on the appropriateness of the assumptions as well as on the accuracy of the data used.

Standard investment measures similarly will only be accurate under restrictive assumptions and in the presence of accurate data. A central point of this article is that, when the composition of investment is changing rapidly, the assumptions underlying the Tornqvist indexes are probably more nearly correct than those underlying the standard measures (Diewert 1976).

# Endnotes

[1] Actually, any decrease in the growth of investment may have begun in the mid-1970s, well before the Reagan era. Thus, some analysts argue the proper question is whether the policies of the Reagan era reversed any decline that started in the 1970s.

[2] On the strong investment side, see also Tatom 1989 and deLeeuw 1990. On the weak or flat investment side, see Englander and Steindel 1989.

[3] U.S. Department of Agriculture 1988. Part of this increased productivity is due to increased inputs other than capital, such as fertilizer.

[4] While these data perhaps convey too simple a tie between capital and income, analysts generally accept this relation between capital growth and income growth. Many factors complicate the relation, however. For example, education and social and political stability also play an important role in economic growth. Thus, some countries have grown without large increases in capital, and others have increased capital but not grown (Lipsey and Kravis 1987).

[5] Analysts also consider other simple indicators of investment (Englander and Steindel 1989). The two measures considered here are representative, however, and highlight the source of the investment controversy.

[6] Other high tech items such as industrial robots are not included in this measure.

[7] Net investment in high tech categories has shown a similar increase, as the rise in depreciation has shrunk both the numerator and the denominator of the ratio of net high tech investment to total net investment.

[8] Commercial buildings showed this jump for the 14 years that ended in 1961.

[9] These service lives are weighted averages using real investment shares as weights. The reported changes reflect all changes in investment shares, not simply the rise of high tech investment.

[10] Evaluating what the depreciation share would have been in absence of the shift to high tech is difficult in the general equilibrium setting of the real economy. It is difficult both to make clear what counterfactual experiment is being contemplated (what exogenous shock nullified the high tech shift?) and to carry out that experiment. One accounting approach to this question (manifestly a disequilibrium approach) is to simulate what the depreciation share would have been if gross investment were at its historical level, but the high tech share remained at its average 1970-74 level (the extra investment distributed to other categories of business fixed investment based on their shares). This simple experiment suggests the high tech shift accounts for somewhat less than half of the rise in depreciation as a share of GNP. Other similar experiments show a higher role for the high tech shift.

[11] This assumes a real interest rate of 4 percent; service lives of eight years and 40 years for computers and buildings, respectively; straight line depreciation; and a flat return per unit of capital remaining.

[12] In more precise technical terms, the distortion can be stated this way. In equilibrium, firms allocate investment dollars in terms of the rental cost of the capital (often called the *user cost*), investing so that the marginal product of an additional dollar spent *renting* each type of capital is the same. This implies that the marginal product of the last dollar spent *purchasing* high tech must be higher than for low tech. Why? The rental cost includes the cost of replacing worn out capital. Since high tech wears out faster, the rental cost implied by any given purchase price of capital is higher for high tech than for low tech. Thus, if the marginal products are equal in rental cost terms, the marginal product of the last dollar spent *purchasing* high tech must be higher than the marginal product of the last dollar spent purchasing low tech.

[13] There actually may be short-run effects even on net investment. Net investment will be less prone than gross investment to being optimistic due to this factor, however.

[14] The typical piece of high tech equipment used in this example is a composite of the four categories of high tech investment, with the shares based on 1982 investment data. The price index is a weighted average of the fixed-weight indexes for the four categories using these weights. As the next section emphasizes, use of fixed-weight indexes and fixed shares can lead to distortions.

[15] As noted in note 12, firms allocate investment dollars to equalize the marginal product of an extra dollar (in rental cost terms) spent on each type of capital. If the price of high tech capital falls, the rental cost falls. When this happens, the additional dollar now rents more high tech capital than before, say, two units instead of one. The marginal product of a dollar spent on low tech remains about the same when the price of high tech changes. Thus, to equalize marginal products of each type of capital, the marginal product of these two units of high tech must be about the same as the marginal product one unit formerly produced. Thus, the marginal product of each unit must fall.

[16] For a more detailed analysis of the measurement issues that justify looking at capital input indexes, see Oliver 1989.

[17] The issue of the breadth of investment measures was discussed in Faust 1989. The issues regarding measure-

ment of quality change and depreciation discussed in the box also apply to capital input indexes as well as to traditional measures.

[18] This index is for business capital input. The BLS computes two other indexes. Nonfarm business capital input showed a slight decline from 3.7 percent to 3.6 percent. In contrast, manufacturing capital input showed a decline from 3.9 to 2.7 percent. The construction of this index is described in detail in U.S. Department of Labor 1983; the data are reported in U.S. Department of Labor, various issues.

[18] It is important to emphasize that the conclusions of this article about investment strength regard the equilibrioum growth of investment arising from the interaction between the supply of, and demand for, funds. The conclusion of unchanged investment growth remains silent about what offsetting changes in these supply and demand relations may have occurred.

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