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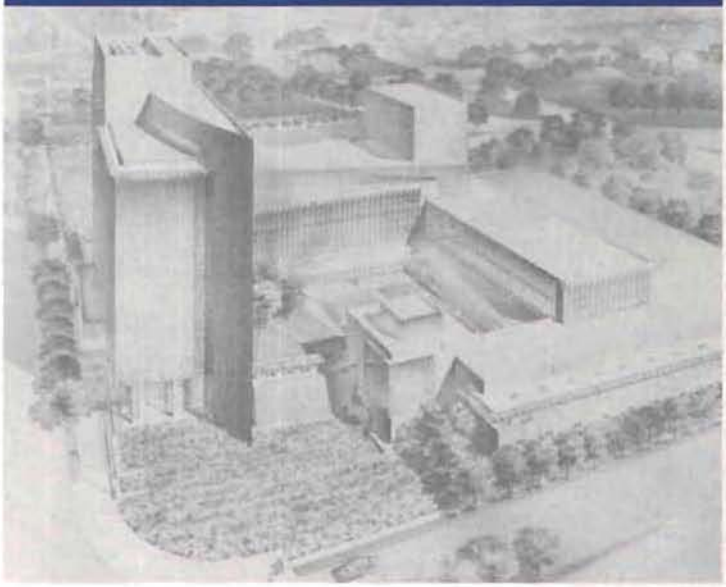

The Consumer Price Index

Mark A. Wynne and Fiona D. Sigalla

The Texas Construction Sector: The Tail That Wagged the Dog

D'Ann M. Petersen, Keith R. Phillips, and Mine K. Yücel

Is NAFTA Economic Integration?

William C. Gruben and John H. Welch

Solving the Mystery of the Disappearing January Blip in State Employment Data

Franklin D. Berger and Keith R. Phillips

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On the cover: an architectural rendering of the Federal Reserve Bank of Dallas.

Contents

Contents

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The Consumer Price Index

> Without the notion of price there would be no economic science. The concept is of absolutely central significance. It is not as easy and trivial a concept as it appears to be at first sight. A satisfactory measurement of price is, as a consequence, a difficult undertaking, and it is not surprising that price statistics, abundant as they are, have to be approached with utmost caution.
>
> —Oskar Morgenstern
> *On the Accuracy of Economic Observations*

The consumer price index (CPI) is one of the most closely watched price statistics published by the federal government. As an indicator of inflationary trends in the U.S. economy, the monthly CPI report undergoes intense scrutiny. For example, an upsurge in the rate of increase in the CPI in early 1993 prompted the Federal Reserve to lean toward raising interest rates in its policy deliberations. When the inflationary surge proved short-lived, the Fed reverted to a neutral stance.[1] Movements in the CPI also have a direct impact on the pocketbooks of many Americans. For instance, the annual increase in the CPI determines the rate at which the nominal payments to Social Security recipients will rise each year. The tax brackets that determine the income tax liability of most workers are indexed to the CPI as well. In this article, we review the construction of the CPI and discuss its potential shortcomings. We also examine how well the CPI measures what it is supposed to measure, namely, changes in the cost of living.

Our primary objective is to review and put into context what is known about the potential biases in the CPI. Inherent in the concept of bias is some notion of the true value of the CPI, which the actual published value only approximates. The true value of the CPI is considered to be the true cost-of-living index, and so we begin with a discussion of the theory of the cost of living index. We progress to the construction of the actual CPI as it is reported every month, following the description of methodology in the Bureau of Labor Statistics' (BLS) *Handbook of Methods*. In the remainder of the article, we consider how well the CPI approximates the true cost-of-living index, paying particular attention to the problems of substitution, quality change, and the introduction of new goods, which are generally considered to cause the CPI to overstate the rate of increase in the cost of living or, alternatively, overstate the rate of inflation.[2] Some analysts have suggested that these measurement errors are so large that

We are grateful to Marshall Reinsdorf and Jack Triplett for detailed comments on this article. We also received helpful comments from Evan Koenig, Marilyn Manser, Steven Braun, Ken Emery, and Zsolt Becsi. This article is based on a longer paper, entitled "A Survey of Measurement Biases in Price Indexes" (Federal Reserve Bank of Dallas Research Paper no. 9340), that was prepared for the Joint Meeting of the System Committees on Business and Financial Analysis at the Board of Governors of the Federal Reserve System in Washington, D.C., September 22–24, 1993. We thank our discussant at that conference, Ana Aizcorbe, for comments on that paper.

[1] *Note that some of this increase has since been revised away as a result of changes in the seasonal adjustment factors used to calculate the seasonally adjusted CPI. We do not review CPI seasonal adjustment procedures in this paper.*

[2] *These problems with the CPI are common to almost all official price indexes and have implications that extend beyond the measurement of inflation to such issues as the measurement of real output growth and productivity.*

CPI inflation in the 3 to 4 percent range constitutes effective price stability. We argue that there is little evidence to support this belief and that, insofar as the CPI does overstate the rate of inflation, it probably does so by no more than 1 percent annually.

The conceptual basis of the CPI

The conceptual basis of the CPI is the theory of the cost-of-living index.[3] The cost of living is a unique concept for each individual and is determined by the individual's preferences for different types of goods and services and the prices at which that person can purchase them. We can think of the preferences of each individual as being characterized by an intertemporal utility function that is defined over all the goods and services consumed today as well as all the goods and services the individual expects to consume in the future. The most general specification of this function includes items that have a price attached to them, such as automobiles, haircuts, and bananas, and items that are typically consumed without a user charge, such as roads, clean air, and leisure. Specifically, we can write

$$(1) \quad U = U^j(q_1^1, q_2^1, \ldots, q_M^1, q_1^2, q_2^2, \ldots, q_M^2, \ldots) \equiv U^j(q),$$

where q_i^t denotes the quantity of the ith good or service consumed at date t.

Calculating a cost-of-living index requires that all items in the utility function be assigned a price. This task is relatively straightforward for commodities and services that have a user charge for consumption (meaning, they are purchased on markets) but is more difficult for items such as leisure and clean air that are typically consumed without a user charge. It is also difficult for durable goods such as houses and cars, which are typically purchased in one period but yield services to the consumer over several periods.

Because it is impossible to ascertain the price of every single good and service that is valued by consumers, the theory of the cost-of-living index as it is applied to the measurement of consumer prices typically focuses on a narrower set of goods and services, specifically, those that are purchased on markets in some time period. Focusing attention on this narrower set of goods and services, which we will denote as $x^t \equiv (q_1^t, q_2^t, \ldots, q_N^t)$, where $N < M$, we can define a cost or expenditure function for the individual as follows:

$$(2) \quad e(p^t, u) = \min_{q_i^t} \sum_{i=1}^{N} p_i^t q_i^t : U(q^t) \geq u,$$

where $p^t = (p_1^t, p_2^t, \ldots, p_N^t)$. The expenditure function gives the minimum cost to the individual of attaining some specified level of utility, u, when faced with a set of prices, p^t, for the goods and services that enter that person's utility function. The true cost-of-living index is then defined on the basis of the expenditure function. Specifically, it is the change in the cost of attaining some base level of utility, u^b, between a reference period, r, and a comparison period, c:

$$(3) \quad \frac{e(p^c, u^b)}{e(p^r, u^b)},$$

where p^c and p^r denote the prices faced by the individual in the comparison and reference periods, respectively. If all prices in the comparison period, p^c, are twice the reference prices, the index is 2; if all prices in the comparison period are one-half the reference period prices, the index is 0.5. If all prices in the comparison period are the same as prices in the reference period, the index is 1. The CPI is an approximation of this true cost-of-living index.

How the CPI is constructed

The purpose of the CPI is to measure the rate of change in the cost of living for urban consumers. It does this by calculating the average change in the prices paid by urban consumers for a fixed market basket of goods and services of constant quality. Since it is obviously impossible to obtain price data for all consumer transactions in the United States, the CPI is estimated from a

[3] *For a general review of the theory of the cost-of-living index, see Pollak (1989). For a discussion of the theory of the cost-of-living index as the conceptual basis for the CPI, see Gillingham (1974).*

series of samples. These samples are designed with the objective of making the CPI representative of the prices paid by consumers in all U.S. urban areas for all goods and services. The use of a sample, of course, introduces a source of error into the index, but this is more than offset by the errors that sampling eliminates.[4] Each year, the BLS selects new item and outlet samples for 20 percent of the primary sampling units on a rotating basis, with the intention of capturing new developments in the market for consumer goods through such rotation.

Individual commodities in the CPI are weighted by the share of expenditure on the item, as estimated in the Consumer Expenditure Survey. The outlets from which price quotes are obtained are determined on the basis of information collected in the Continuing Point-of-Purchase Survey, with an outlet's probability of selection being proportional to its share of consumers' expenditure for the good in question. Currently, the CPI is constructed using expenditure shares obtained from the 1982–84 Consumer Expenditure Surveys and is formally defined as

$$(4) \qquad CPI^t = 100 \times \frac{\sum_i p_i^t x_i^b}{\sum_i p_i^r x_i^b}$$

$$= 100 \times \sum_i \left(\frac{p_i^t}{p_i^r} \right) \frac{p_i^r x_i^b}{\sum_i p_i^r x_i^b}$$

$$= 100 \times \sum_i \left(\frac{p_i^t}{p_i^r} \right) \omega_i^b,$$

where p_i^t, is the price of the ith good in the comparison period, t, p_i^r is the price of the same good in the reference period, r, x_i^b is the quantity of the good consumed in the expenditure base period, b, and $\omega_i^b = \frac{p_i^r x_i^b}{\sum_i p_i^r x_i^b}$ is the share of the ith good in base period expenditures valued at reference period prices. When the expenditure base and the reference periods coincide, the result is the standard Laspeyres price index formula.[5] Note that, in general, there is a difference between the base period for the expenditure weights and the numeric reference base period, although at present both are 1982–84 = 100. Indexes are estimated for wage earners and clerical workers (CPI–W) and all urban consumers (CPI–U). The CPI–W is representative of the buying habits of about 32 percent of the U.S. population, while the CPI–U (which was introduced in 1978) covers about 80 percent of the U.S. population.

The prices used to calculate the CPI are collected from about 21,000 retail and service establishments in eighty-five urban areas across the United States. Data on rents are collected from about 40,000 landlords or tenants, and 20,000 owner-occupants are asked about their housing units. All price information is collected by Bureau of Labor Statistics field agents through visits or telephone calls. The CPI is published monthly, typically about two weeks after the end of the month to which it refers.

The problems that are typically thought to bias the CPI as a measure of inflation or the cost of living are substitution bias, quality adjustment bias, and new goods bias. The sample of goods and services that makes up the CPI is also criticized occasionally for being unrepresentative of the buying habits of all urban consumers. Substitution bias and new goods bias are aspects of this sampling problem, as is outlet substitution bias. The problems that arise from the use of list rather than transactions prices in constructing an index are less frequently discussed in relation to the CPI than they are in relation to the producer price index.[6] We argue that the list–transactions problem is probably an issue in consumer price measurement, although for different reasons than in producer price measurement.

[4] *For estimates of the standard error of the CPI, see Leaver (1992).*

[5] *A Laspeyres price index calculates the price change between two periods by comparing the cost of purchasing in each period the bundle of goods purchased in the initial period. A Paasche price index calculates the price change between two periods by comparing the cost of purchasing in each period the bundle of goods purchased in the final period. For a review of the theory of index numbers, see Diewert (1987).*

[6] *For a review of some of the problems with the producer price index, see Wynne and Sigalla (1993).*

We now illustrate how these various biases can arise in the CPI and review their quantitative importance.

Substitution bias

The CPI is estimated from a series of samples because of the impossibility of tracking the prices paid by every urban consumer for every purchase he or she makes. The first part of the sampling process is to figure out what it is that people buy and how their expenditures are distributed over the different goods and services that make up consumer spending. At present, the weights used to aggregate the prices of the different goods and services are based on expenditure patterns during the period 1982–84. The CPI is a fixed-weight index, meaning that the weights used to aggregate the prices of the different goods and services are held constant for relatively long periods. (For an alternative approach to evaluating the bias due to the use of fixed weights, see the box entitled "Statistical Approaches to Index Number Construction.") However, because the prices of all goods and services do not change at the same rate, and because consumers can substitute less expensive for more expensive goods, over time the weights used to combine the prices become increasingly unrepresentative of consumers' actual expenditure patterns. For example, if the price of beef rises more rapidly than the price of chicken, consumers will typically buy relatively more chicken and relatively less beef. Spending on beef becomes less important in consumers' budgets, while spending on chicken becomes more important. Because the CPI does not allow for these changing expenditure patterns, it tends to overstate the increase in the cost of living over time. The bias in the CPI due to this phenomenon is known as *substitution bias*.

Substitution bias is probably the best known and most frequently studied problem in the CPI. The most authoritative review to date of measurement problems in price indexes concluded that "estimates of substitution bias that have so far been made indicate that it is extremely small, so small that substitution bias cannot be viewed as an important empirical defect of fixed-weight consumption price indexes" (Triplett 1975, 66). The size of the substitution bias in a fixed-weight cost-of-living index depends on two things: the extent to which households substitute between goods in response to relative price changes and the extent to which relative prices change over time. Absent either of these factors, a fixed-weight Laspeyres index will give an unbiased estimate of the true cost-of-living index. Thus, if household preferences are of the fixed-coefficient or Leontief type, no substitution occurs in response to relative price changes and the fixed-weight Laspeyres index is equal to the true cost-of-living index. Likewise, if all prices increase or decrease together, relative prices never change and again the fixed-weight Laspeyres index coincides with the true cost-of-living index. It is unlikely, however, that either of these conditions holds in practice.

At the time of Triplett's 1975 survey, the principal studies of substitution bias in the CPI were Noe and von Furstenburg (1972), Christensen and Manser (1976), and Braithwait (1980) (which circulated as a BLS working paper in 1975). The major conclusions of these studies, which are summarized in Table 1, were that

1. the size of the substitution bias was small, probably no more than 0.1 percent a year,
2. the estimated magnitude of the bias was relatively insensitive to the choice of functional form for household preferences,
3. the estimated magnitude of the bias increases with the level of commodity disaggregation, and
4. the size of the bias was greater during periods of high inflation when relative price fluctuations were greater.

Since Triplett's survey, Manser and McDonald (1988) have revisited the problem of substitution bias in fixed-weight Laspeyres-type indexes. Manser and McDonald used consumption data from the National Income and Product Accounts (NIPA) for 101 commodities over the period 1959–85 to obtain two sets of estimates of the substitution bias. First, using nonparametric methods and maintaining the assumption of homothetic preferences (which they test and are unable to reject) they calculate bounds on the size of the substitution bias in the Laspeyres index for the period 1959–85. They calculate a maximum possible bias of 0.22 percent per year and a minimum possible bias of 0.14 percent per year.

Table 1
Studies of Substitution Bias in the CPI

Study	Sample period	Categories covered	Size of bias
Noe and von Furstenberg (1972)	1964–70	All	.03 to .11
Christensen and Manser (1976)	1947–71	Meat and produce (four categories of each)	.1 to .2
Braithwait (1980)	1958–73	All	.1
Manser and McDonald (1988)	1959–85	All	.14 to .22
Reinsdorf (1993)	1980–89	Food and gasoline	.25 to 2
Aizcorbe and Jackman (1993)	1982–91	All	.2 to .27

NOTE: Bias is expressed in percentage points.

Second, using superlative index numbers to calculate changes in the cost of living, they estimate a substitution bias of about 0.18 percent per year over the same period.[7]

More recently, Aizcorbe and Jackman (1993) examined the issue of substitution bias using even more disaggregated data, specifically, the consumer expenditure data used to construct the CPI. They compare measures of price change over the period 1982–91 and arrive at an estimate of the substitution bias over this period of 2.6 index points (an average of 0.2 percent a year) when a fixed-weight Laspeyres index is compared with a fixed-weight Tornqvist index. The estimated substitution bias is somewhat higher (0.27 percentage points a year) when chain-linked index numbers are compared. Aizcorbe and Jackman argue that these estimates are small and conclude by noting the desirability of having some measure of whether the estimated bias is significant in a statistical sense.

The findings of these studies of substitution bias in the CPI are summarized in Table 1.[8] The bottom line on substitution bias is that this particular form of bias in the CPI is probably relatively unimportant quantitatively, amounting to at most 0.2 percentage points a year. This conclusion is shared by Triplett (1975, 1988) and Gordon (1992), among others. However, recent work by Moulton (1993) shows that the issue is not yet settled. Moulton examined substitution effects within CPI product categories (or *strata*, as they are called by the BLS) and showed that substitution effects within product categories are in some cases larger than those between categories. This is hardly surprising: it is plausible that consumers should be more willing to substitute between different types of fruit than between, say, fruit and meat. Moulton looks only at data for the period from June 1992 to June 1993, and it remains to be seen how his findings generalize to other sample periods.

Insofar as substitution bias is considered a problem in the CPI, it could be handled in one of two ways. One is to update the expenditure weights more frequently: currently the expenditure weights are updated about once a decade, the most recent revision occurring in 1987, when expenditure patterns from the 1982–84 Consumer Expenditure Survey replaced those from the 1972–73 survey. Updating the weights every year (or every quarter) would constitute a shift from a fixed-weight to a chain-linked or multiweighted index.[9] The United Kingdom uses this approach in

[7] *A superlative index number is one that provides a second-order approximation to the true cost-of-living index for a large class of preference specifications. See Diewert (1976).*

[8] *We do not review the results of two recent studies by Kokoski (1987) and Blisard and Blaylock (1991) that examine the relationship between demographic factors and substitution bias.*

[9] *For a discussion of the merits of chain-linked price indexes, see Forsyth and Fowler (1981) and Szulc (1983).*

Statistical Approaches to Index Number Construction

Bryan and Cecchetti (1993) adopt a novel approach to estimating the bias that arises from the use of fixed weights in the CPI. The essence of their approach is to estimate the common (inflation) factor in a number of the subcomponents of the CPI and interpret the difference between the estimated common factor and the CPI as an estimate of what they term the "weighting bias" in the CPI. Estimation of a common inflation factor is essentially the same as constructing a price index where the individual prices are weighted on the basis of the strength of their common inflation signal. The estimates of weighting bias they obtain average 0.60 percentage points a year over their full sample, which ranges from 1967:1 to 1992:12, with a standard error of 0.17 percentage points. They also estimate the bias for two subsamples, finding that the CPI overstated inflation by about 0.88 percentage points annually during 1967–81, whereas the bias was essentially zero (–0.07 percentage points with a standard error of 0.13 percentage points) during the 1982–92 period.[1] Insofar as substitution bias is a special form of weighting bias, their findings confirm the earlier results that substitution bias tends to be higher during periods of high inflation, which typically are also periods of substantial relative price variability.

The Bryan and Cecchetti study is not really comparable to the other studies of substitution bias discussed in our article. As we have already noted, substitution bias is defined as the difference between the CPI as constructed and a true cost-of-living index. Bryan and Cecchetti are interested in the CPI as a measure of inflation rather than as a measure of the rate of increase in the cost of living. In many ways, their paper could be considered to be a contribution to the statistical approach to index number construction that had its origins in work by Jevons and Edgeworth but has since been largely abandoned in favor of the behavioral approach. For further details on the distinction between the statistical and behavioral approaches, see Diewert (1987). Other recent contributions to the statistical approach are Clements and Izan (1987) and Dow (1993).

[1] Bryan and Cecchetti rationalize the possibility of a negative, or downward, weighting bias in the CPI by pointing out that for some time periods and some goods, expenditure shares and price changes might be positively correlated if there is a taste shock that raises demand for the good.

constructing its measure of retail prices. Schmidt (1993) examines the consequences of recalculating the CPI using more recent expenditure patterns and finds that the differences for estimates of annual inflation rates are no more than 0.2 percent. The second alternative is to construct an index using a superlative index number formula, such as the Tornqvist or Fisher index number formulas, instead of the Laspeyres formula currently used. Superlative index numbers have the desirable property of being exact for a class of utility functions that are second-order approximations for any utility function and are thus less susceptible to substitution bias.[10]

Both of these possibilities are now feasible since the Consumer Expenditure Survey has been conducted on an ongoing basis since 1980. Kokoski (1989) describes ongoing BLS research into using superlative and chain indexes to track price movements. However, use of chain indexes entails some sacrifice in terms of the timeliness with which the inflation estimates can be obtained, as it takes

[10] *For further details on Fisher and Tornqvist index numbers, see Diewert (1987).*

more time to collect and process information on consumer expenditure patterns than it does to collect and process information on prices. Furthermore, depending on the behavior of relative prices, chain indexes may be just as prone to substitution bias as fixed-weight indexes and in some cases, more so.[11] Note that the Bureau of Economic Analysis (BEA) recently introduced chain-linked superlative price indexes for gross domestic product (GDP) and its major components.[12]

Outlet substitution bias

Once the BLS has determined how consumers allocate their expenditures across different goods and services, it then has to determine which varieties of the goods will be priced for the CPI. For example, suppose the BLS determines that urban consumers allocate some fraction of their expenditures to buying apples. The BLS then has to decide which varieties of apples it will price for calculating the CPI (in other words, Granny Smith, Golden Delicious, or whatever) and also where it will obtain these prices. The choice of outlet where prices are obtained is potentially very important. In an early study of the postwar growth performance of the U.S. economy, Denison (1962) argued that the price statistics used to deflate consumer spending were biased upward because the BLS typically relied on higher priced stores to obtain price quotes for various items in the CPI, neglecting the postwar shift in consumer spending patterns toward lower cost retailers and away from more traditional higher priced outlets. Persistent price dispersion in the retail market is essential for consumer gains from switching outlets not to be reflected in the CPI. Such persistence may arise due to market disequilibria or information costs. An index that tracks prices at incumbents is biased if quality-adjusted prices at incumbent retailers fail to decline to match those of the new retailer.

The BLS looked into this potential source of bias in the CPI nearly thirty years ago and concluded at that time that it was not a problem, claiming that the sample of outlets used for obtaining price quotes was quite representative of how consumers actually shopped.[13] The concern that there might be an "outlet substitution bias" in the CPI has recently come to the fore once more because of the rapid growth in low-cost, high-volume discount stores such as Wal-Mart, Sam's Club, Price Club, and so on during the 1980s. Further examples of this trend are the growth in home shopping and the increasing market share of factory outlet stores.[14]

Table 1 reports the estimates of the "outlet substitution bias" obtained by Reinsdorf (1993), since bias in the CPI as a result of consumer substitution toward lower price retail outlets is in some sense analogous to the standard substitution bias in a fixed-weight index as a result of commodity substitution. Reinsdorf offers two types of evidence on the size of the outlet substitution bias in the CPI. First, he compares the prices at incoming and outgoing CPI retailer outlet samples, and second, he compares the evolution over time of unlinked sample average prices and their (linked) CPI component counterparts.[15]

Comparing prices at new and old outlets, Reinsdorf obtains an estimate of upward bias in the food-at-home component of the CPI of 0.25 percent a year and a comparable figure for the motor fuel component. Reinsdorf notes that this figure may overstate the true size of the bias if average quality declines along with average prices. Reinsdorf's second test compares the growth of the Average Price series published by

[11] *For details, see Forsyth and Fowler (1981) and Szulc (1983).*

[12] *For details, see Young (1992) and Triplett (1992a).*

[13] *The issue of outlet substitution was also discussed by the Stigler Committee (NBER 1961, 58) and, in more detail, by Backman and Gainsbrugh (1966, 29–31). Backman and Gainsbrugh cite studies by the BLS and Willard Arant that put the magnitude of this bias at no more than a couple of tenths of a percentage point a year.*

[14] *See, for example, Helliker (1991).*

[15] *When new item–outlet combinations are rotated into the CPI, all the difference in price between the old item–outlet combination and the new item–outlet combination is assumed to be due to a difference in quality. This is the way in which the price quotes that go into the CPI are "linked" together. By contrast, for the Average Price program, all of the difference in price between old item–outlet combinations and new item–outlet combinations is assumed to be due to differences in price. Thus, the Average Price series are said to be "unlinked."*

the BLS with that of the corresponding components of the CPI.[16] For food during the 1980s, various components of the CPI rose more rapidly than the corresponding Average Price series, yielding an implicit estimate of outlet substitution bias of almost 2 percent a year. While quality-adjusting the Average Price food indexes might reduce some of the difference with the CPI, it would not eliminate it completely since the willingness of consumers to shift to low-cost retailers presumably indicates that the quality difference must be more than compensated for by the better prices. For gasoline the estimated bias is 0.3 percent per year. Reinsdorf notes that the estimates obtained from a comparison of Average Prices with the CPI should be taken as upper bounds on the amount of substitution bias, since no attempt is made to control for the possibility that the average quality of outlets may have declined.

In view of the importance that some analysts have attached to Reinsdorf's findings (see, for example, Gordon 1992 and *The Economist* 1993), it is important to be explicit about the caveats that accompany his results.[17] One is that outlet substitution and variety substitution typically occur at the same time. To the extent that this allows the substitution in the CPI sample of, say, a (low-cost) store-brand item for a name brand item, some of the difference found by Reinsdorf may be simply due to switching brands. Also, it is important to try to quantify the quality difference between different retail outlets to get a proper handle on the size of the bias. Popkin suggests the use of hedonic type regressions of the sort used to make adjustments in the apparel indexes to determine the appropriate quality adjustments for outlets. Fixler (1993) notes that comparison of Average Price series with corresponding CPI series does not provide direct evidence of outlet substitution bias because outlet switching is not the only source of difference between the two series.

Quality bias

> If a poll were taken of professional economists and statisticians, in all probability they would designate (and by a wide majority) the failure of the price indexes to take full account of quality changes as the most important defect in these indexes. And by almost as large a majority, they would believe that this failure introduces a systematic *upward bias* in the price indexes—that quality changes have on average been quality improvements (NBER 1961, 35) [emphasis added].

There is a general perception among economists that quality bias is probably the most serious shortcoming of the CPI, causing it to overstate the true rate of increase in the cost of living. This perception probably reflects two other beliefs. First, that the average quality of all goods is increasing over time and, second, that the BLS does little or nothing to take quality improvement into account when calculating its price indexes. As we will see, neither of these statements is completely true.

While it is the case that the quality of most products does seem to improve over time, we should not overlook the obvious examples where quality seems to deteriorate—for example, the increased use of graduate students for undergraduate instruction at major universities, the disappearance of full-service gas stations, and the decline in the quality of in-flight service on some airlines.[18] Second, the BLS has a number of methods for dealing with quality change. The question then becomes how adequately do these methods capture changes in the quality of the products sampled for the price indexes. We will see that in some cases the BLS may in fact *overadjust* for quality change in calculating the price indexes, causing them to understate the true rate of inflation.

[16] *Average Prices are estimated from CPI data for a limited number of goods and are calculated as weighted averages of price quotes obtained for a representative variety of the good in question. For further details, see U.S. Department of Labor (1992, 199).*

[17] *See, for example, Popkin (1993).*

[18] *On the latter, see, for example, Hirsch (1993), who notes, "Seeking to stanch their financial hemorrhaging, most airlines are putting fewer attendants on board their aircraft. The result: Passengers wait longer for meals and beverages; meal carts clog the aisles longer; dirty trays stack up; and obtaining the little extras of life aloft—a pillow, a magazine, a drink of water—is often a do-it-yourself experience."*

How the BLS deals with quality change

The quality adjustment problem in constructing a price index may be stated as follows.[19] Suppose some particular variety of a good is selected for inclusion in the CPI. Suppose further that at some later date, the chosen variety disappears and is replaced by a newer model. How do we compare the price of the old variety of the good in the earlier period with the price of the new variety in the later period? As a concrete example of this problem, consider how we would compare the price of an older model VCR without remote control capability with the price of a newer model VCR that has remote control capability. Since higher quality goods are typically more expensive than lower quality goods, a direct comparison of the prices of the two varieties would result in an overestimate of how much prices have increased.[20] The appropriate comparison of prices requires that we compare prices for goods of the same quality. In the VCR example, we need to somehow adjust the price of the model with remote control capability for the improvement in quality that remote control represents.

In practice, the BLS has a number of methods for dealing with quality change. The BLS categorizes the methods it uses to deal with new product varieties or quality change as follows: (1) direct comparison, (2) direct quality adjustment, and (3) imputation.

In direct comparison, if the two varieties are judged to be sufficiently similar in terms of quality in some well-defined sense, all the observed difference in price between the new and old varieties of the product is counted as a price change, and nothing more is done. The risk here, of course, is that some unnoticed quality change is inadvertently being treated as a price change, imparting an upward bias to the CPI.

If, however, the varieties are judged to be different in some meaningful sense, the BLS makes some form of direct quality adjustment using one of a number of different methods.[21] The simplest case is when the two varieties are observed in some common period, in which case it is possible to obtain overlapping price quotes for the two varieties. In this situation, the ratio of the two prices in the period of overlap is taken as the quality adjustment. For example, if a VCR without remote control costs $200 while one with remote control costs $220, the $20 price difference between the two varieties can be considered an estimate of the value of remote control capability to consumers. The problem with this adjustment procedure is that we rarely observe overlapping prices for new and old varieties.

An alternative is to make an adjustment based on the manufacturer's production cost differences for the two varieties. In this case, the manufacturer is asked to estimate the cost difference for the two varieties, which is then scaled up to the retail level and added to the price of the old variety in the initial period to obtain an estimated price for the new variety in the previous period. This form of quality adjustment, in use since around 1960, is used most frequently in valuing quality changes in automobiles.[22]

Another form of quality adjustment, and the one that serves as the basis of most studies of

[19] *This discussion follows Triplett (1988). See also Armknecht and Weyback (1989), Armknecht and Ginsburg (1992), U.S. Department of Labor (1992), Gordon (1992), and Kokoski (1993).*

[20] *Computers seem to be an exception to this rule, and as a result, the problem of quality-adjusting computer prices has attracted a lot of attention. Some of this research is reviewed in Wynne and Sigalla (1993). For more detailed reviews, see Triplett (1989) and also the chapter on computer prices in Gordon (1990).*

[21] *Triplett and McDonald (1977) use a hedonic price function to evaluate the judgment of the BLS commodity specialists as to whether specification changes for refrigerators are "major" or "minor." During their sample period (1960–72), there were seventy-six changes in the specifications of refrigerator-freezers priced for the Wholesale Price Index (WPI). In forty-six of these cases the BLS judged that the changes were minor, and no quality adjustments were made. Triplett and McDonald apply a quality adjustment to twenty of these forty-six cases. Of the remaining thirty cases that were judged by the BLS to be major, Triplett and McDonald apply a quality adjustment to twenty-five.*

[22] *Gordon (1981) notes that a problem with this procedure is that a manufacturer may overstate the cost of a quality improvement to disguise some part of an actual price increase, especially when price controls or guidelines are in force.*

quality bias in the CPI, entails estimating a hedonic regression that relates the prices of different varieties of a good to the characteristics of the different varieties.[23] The estimated parameters from such a regression provide implicit prices for each of the price-determining characteristics of the good. Thus, when a new variety of a product that differs from the existing variety in terms of some or all of the relevant characteristics becomes available, it is straightforward to make a quality adjustment on the basis of the hedonic regression. Despite the initial promise of hedonic techniques, however, these techniques have not proven to be a panacea in dealing with the problem of quality change.[24] Specifically, hedonic techniques are not able to deal with quality changes that are not easily quantified (such as the handling characteristics of a car, the multitasking ability or portability of a personal computer, the quality of care during a hospital stay, or whether an item of clothing is in or out of fashion).

In some situations, the BLS has not yet determined how best to make quality adjustments. New product varieties that can be neither directly compared nor quality adjusted are called *noncomparable*, and in these situations, the BLS estimates the constant-quality price change by imputation.

The most common type of imputation for noncomparable substitutions in the food and services categories consists of setting the rate of price change for the new and old varieties equal to the average price change for similar goods. The implicit assumption that treating noncomparable substitutions in this manner is benign is questionable. For example, it is quite likely that the new product is in the early stage of its product cycle and experiencing substantial price declines, while the products used to impute the price change are probably mature products that are experiencing price increases.

The inherent difficulty of deciding whether new products, or new varieties of existing products, are comparable to old is the essential source of quality error in the CPI. When a new (higher priced) product is deemed comparable with an old product, some quality change may be incorrectly treated as price change, leading to an upward bias in the CPI. When the new product is deemed noncomparable, some price change may be incorrectly treated as quality change, leading to a downward bias in the CPI.[25]

How big is the quality bias in the CPI?

Since the Stigler Committee Report in 1961, numerous studies have attempted to estimate the extent of quality bias in the CPI. It is not a simple matter to use the results of these studies to infer the extent of quality bias in the CPI as it is currently constructed because the methods used by the BLS have evolved over time, partly in response to these studies.

Triplett (1975) concluded his survey of quality bias in the CPI by noting that "...the research results imply that no simple estimate of the overall quality error can be made, and, moreover, even the sign of the error is in doubt" (Triplett 1975, 48). In concluding a more recent review of research on price indexes, Triplett was even more emphatic about the uncertainty surrounding the sign and magnitude of the quality bias in the CPI, noting that "...because a number of large CPI components appear quite clearly downward biased, I suspect that the CPI has, if anything, understated inflation in the last several years" (Triplett 1988, 67).

What components of the CPI are downward biased, and how large are the biases? The first component of the CPI that Triplett suggests contained a downward bias was housing. Before 1988, when estimating the shelter cost component of the CPI, the BLS did not take into account the deterioration in housing stock quality as a result of aging and depreciation. Randolph (1988) shows that failure to allow for depreciation in the housing components of the CPI cause the shelter cost indexes to be downward biased by as much as 0.3 to 0.4 percent annually. However, since 1988

[23] *Hedonic methods are reviewed in Triplett (1987, 1986) and Griliches (1971). Griliches (1961) is the seminal application of hedonic methods to evaluating the quality bias in the CPI.*

[24] *See, for example, Triplett (1988) and Gordon (1990).*

[25] *See Armknecht (1984, 58).*

the BLS has made adjustments to the shelter components of the CPI to allow for aging.[26]

Another source of downward bias in the CPI is in the indexes for apparel and clothing. Here Triplett cites the almost impossible task of separating taste or fashion changes from quality changes and the strong seasonal pattern in clothing styles as sources of error in the CPI treatment of clothing. One piece of evidence of downward bias in the apparel indexes comes from a comparison of the rates of inflation for infants' and toddlers' apparel, which presumably is less subject to fashion cycles, with those for men's and boys' apparel and women's and girls' apparel. In the 1967–87 period, the index for infants' and toddlers' apparel grew at a 6-percent average annual rate, while those for men's and boys' apparel and women's and girls' apparel grew at 3.4 percent and 2.9 percent, respectively, suggesting that the BLS may have overadjusted for quality change in these categories. Armknecht and Weyback (1989) and Liegey (1993) provide further evidence of the likely downward bias in the apparel components of the CPI.

Triplett also argues that auto prices are downward biased because of the manner in which the BLS treats mandatory safety and pollution devices. Specifically, the BLS treats these changes as quality improvements rather than price increases, as the theory of the cost-of-living index indicates they should be treated.[27] Triplett (1992b) presents evidence to suggest that frequently these mandatory changes account for a significant proportion of the estimated quality change in autos.[28] Further insight on the quantitative significance of these mandatory changes can be obtained from Gordon (1990), who disentangles the various components of the quality adjustments applied to the auto component of the CPI (see Gordon 1990, Table 8.10). Gordon shows that over the period 1967–83, quality adjustments reduced the average annual rate of increase in the auto component of the CPI from 7 percent to 4.3 percent. Furthermore, safety and environment related quality adjustments account for 2 percentage points of the 2.7 percent difference between the unadjusted and adjusted CPIs for autos.

The candidates for upward bias Triplett identifies are services, used cars, and "miscellaneous other." The problems with measuring the prices of services accurately, and especially the price of medical care, are well known. We will return to the measurement of service prices in more detail below.

For used cars, the problems stem from the inadequate quality adjustments made to price observations for used cars, although since 1987 the BLS has been making adjustments based on the quality adjustments for new cars. As for the "miscellaneous other" category, Triplett cites the difficulty of dealing with the subtle substitutions between restricted and unrestricted airline fares as a source of possible upward bias in the CPI. Until recently, the BLS priced unrestricted full-fare airline tickets in calculating the CPI, although relatively few people purchased such tickets.

Table 2 summarizes the principal studies of quality bias in the CPI that have appeared in the past five years.

Probably the single most important recent piece of research on the problem of quality change and price measurement is Gordon's (1990) study of durable goods prices. While Gordon's primary objective is to obtain improved estimates of the prices of producer durables for better deflation of the producers durable equipment (PDE) component of investment in the national accounts, he also looks at selected categories of consumer

[26] *These adjustments are described in more detail in Lane, Randolph, and Berenson (1988).*

[27] *This is probably too extreme. Presumably some consumers would be willing to pay for extra safety features even if they were not mandated by the government, and for these consumers the safety improvements do constitute quality improvements. We thank Evan Koenig for this point.*

[28] *See Triplett (1992b) Table 7.1. Most recently (November 1993), the BLS estimated that the retail equivalent value of quality changes for 1994 model passenger cars averaged $363.63, just under two-thirds the average increase in manufacturers' suggested list prices of $612.74. The $363.63 estimated retail value of quality changes could be further broken down into $223.53 associated with changes in accordance with mandated pollution and safety features and $140.10 for other quality improvements, such as powertrain improvements, corrosion protection upgrades, and changes in levels of standard or optional equipment.*

Table 2
Recent Studies of Quality Bias in the CPI

Study	Categories studied	Sample period	Estimated bias
Noe and von Furstenberg (1972)	1964–70	All	.03 to .11
Armknecht and Weyback (1989)	Women's coats and jackets, women's suits	1987–88	–3.4 to 3.5
Randolph (1988)	Housing	1983	–.3 to –.4
Gordon (1990)	Durables	1947–83	1.54
Liegey (1993)	Women's coats and jackets, women's suits	1989	–1.3 to 6

NOTE: A negative bias means that the CPI *understates* the rate of inflation of the item.

durables.[29] Gordon concludes that the CPI overstated the rate of increase in durables prices by an average of 1.54 percentage points a year over the full 1947–83 sample, with the largest errors occurring before 1960. Table 3 summarizes the details of Gordon's findings on the biases in the official estimates of consumer durables prices.

The figures in Table 3 are the average annual rate of drift of the ratio of Gordon's alternative price indexes for the indicated categories to the official price index, where both the alternative and official indexes are constructed using the Tornqvist index number formula. (For a description, see the box entitled "Tornqvist Index Numbers.") The negative drift in all the price ratios over all the sample periods Gordon examines suggests that the CPI significantly overstated the rate of price increase for these categories of goods for the indicated periods. Gordon notes that while the rate of drift, or error, for the appliance and radio–TV categories of durables may appear surprisingly high, the data used to construct these indexes are among the most accurate and comprehensive parts of his study. The difference between Gordon's price series and the official price series is attributable to Gordon's use of alternative sources for his price data in conjunction with a more rigorous application of quality adjustments when such adjustments are called for. Gordon uses hedonic methods to quality-adjust prices when data allow their use, but for most of the data, quality adjustment is carried out using existing BLS techniques.

Again, we need to interpret these results with caution. Triplett (1993) argues that by following the BLS convention on the treatment of government-mandated pollution and safety features on durable goods, Gordon omits a significant source of downward bias in automobile prices. Thus, Gordon overestimates the size of the overall quality bias in durable goods prices, possibly by as much as one-third to one-half.

New goods bias

In some respects, the new goods problem is simply another version of the quality adjustment problem: the distinction between a new variety of an existing product and an entirely new product is not always obvious. For example, a personal computer can be considered a new product, or it can be viewed as an extraordinarily efficient combination calculator and typewriter. Fixler (1993) suggests that a quality change be defined as a change in a product's characteristics and a new good be defined as a rebundling of a product's characteristics or the addition of new characteristics.

[29] *Indeed, it is arguable that, given the data sources Gordon relied upon (the Sears catalog,* Consumer Reports*), his results are more relevant for assessing potential problems in the CPI than the PPI.*

Table 3
Drift of Ratio of Tornqvist Indexes
Gordon's study and Corresponding NIPA Implicit Deflators for Selected Consumer Durables, 1982 base

	Annual growth rates			
	Full sample	**1947–60**	**1960–73**	**1973–83**
Motor vehicles and parts	−1.71	−2.39	−1.69	−.85
Furniture and household equipment	−1.79	−2.52	−1.26	−1.55
Kitchen and other household appliances	−3.22	−4.39	−2.37	−2.83
Radios and TV's	−5.94	−9.07	−3.77	−4.69
Total consumer durables	−1.54	−2.21	−1.24	−1.05

SOURCE: Gordon (1990). Table 1.2.

NOTE: The table shows the drift in the ratio of Gordon's alternative price indexes to the official price indexes for different periods. Thus, negative numbers are interpreted as showing that the official series are *upward* biased; that is, they overstate inflation.

The essence of the problem posed by the arrival of new goods is as follows.[30] Suppose we are trying to track a measure of the price level over time, and we have price and quantity data for N–1 commodities in periods 1 and 2, p_n^t and x_n^t for t = 1,2 and n = 1, ...,N–1. Suppose, in addition, that x_N^2 units of a new good are sold at price p_N^2 in period 2. How are we to calculate the bilateral price index $P(p^1,p^2,x^1,x^2)$ when we do not know p_N^1, the price of the new good in period 1? Stated this way, the similarity between the problem posed by new goods and quality change in existing goods becomes clear.[31]

While there do not appear to be empirical studies of the new goods problem as such, an example from Diewert (1987) is illuminating and gives us some sense of the potential magnitude of the problem. Diewert estimates that, depending on the fraction of expenditures allocated to new products not covered by the price index and the price profile of new products (typically, new products experience rapid price declines following their introduction), the price level would be overstated by between 1 and 5 percent annually when calculated using the Laspeyres formula.

Lebow, Roberts, and Stockton (1992) attempt to put more concrete numbers on the size of the new goods bias by making some simple assumptions. They isolate the CPI categories in which they think rapid product innovation is most likely to be important and find that the relevant categories account for about 2.4 percent of the CPI. Assuming that new products experience price declines at a rate comparable to that of computers—that is, about 20 percent a year on average—they arrive at an estimate of new goods bias in the overall CPI of 0.5 percent a year. Insofar as new goods are important in categories other than appliances, lawn equipment and power tools, and medical care commodities, the 0.5 percent figure is an underestimate of the size of the new goods bias.

[30] *This discussion follows Diewert (1987).*

[31] *A formal solution to this problem was proposed by Hicks (1940). Simply calculate the "shadow" price that would just make the consumer's demand for the good in period 1 equal zero. The calculation of this shadow price requires knowledge of the consumer's preferences, which might be obtained by econometric techniques. In practice, however, it is too costly to resort to such techniques, and official indexes frequently ignore new goods. Cars were not introduced into the CPI until 1940, while the PPI did not include computer prices until 1990.*

Tornqvist Index Numbers

A Tornqvist price index is defined as

$$P_T = \prod_i \left(\frac{p_i^2}{p_i^1} \right)^{si},$$

where

$$s_i \equiv 0.5 \left(\frac{p_i^1 x_i^1}{\sum_i p_i^1 x_i^1} + \frac{p_i^2 x_i^2}{\sum_i p_i^2 x_i^2} \right).$$

The interpretation of an index number of this type is a little clearer if we rewrite it in logarithmic form:

$$\log(P_T) = \sum_i si(\log(p_i^2) - \log(p_i^1)).$$

That is, the (log of the) Tornqvist index is a weighted average of the growth rates of the individual prices, with weights equal to the average of the expenditure shares in the two periods used to compute the growth rates. The choice of the Tornqvist index number formula is motivated by the fact that it belongs to the class of "superlative" index numbers identified by Diewert (1976). Superlative index numbers have the property that they are exact for utility functions that are second-order approximations for any utility function and are thus less susceptible to substitution bias.

If most new goods do not experience price declines comparable to those experienced by computers, the 0.5 percent figure is an overestimate of the size of the new goods bias. The main reason computer prices seem to have been examined so frequently is because they have declined at such extraordinarily rapid rates. New goods bias could well be a lot higher or a lot lower than their calculation suggests; we simply do not know.

List versus transactions prices

As we have already noted, the price information that goes into the CPI is collected by BLS field representatives through visits or telephone calls. The BLS puts great emphasis on obtaining price quotes that reflect the actual prices paid by consumers, and to this end, it makes a number of adjustments to some of the raw price data to obtain better estimates of transactions prices. For example, in pricing new cars, the BLS agents obtain estimates of the base price for the vehicle, along with estimates of the prices of various options, dealer preparation, and delivery. The BLS agents also obtain estimates of the average concession or markup during the previous thirty days to arrive at an estimate of the transaction price of the vehicle. The BLS also tries to take account of manufacturers' rebates, bonus merchandise, quantity discounts, and utility refunds when pricing many other goods and services.[32] However, no adjustment is made for the use of cents-off coupons by consumers, except when the coupons are attached to the product for immediate redemption at the time of purchase.

There seems to be no research on how accurately the prices that are used to construct the CPI reflect the actual prices paid by consumers.[33] It would appear that the BLS does make a reasonable attempt to ensure that the prices are accurate, but the failure to account for the use of cents-off coupons does raise some questions. Data on coupon use is difficult to come by, although we can get some sense of their potential importance from Nielsen Clearing House (1993). According to the Nielsen Report, in 1992 consumers redeemed about

[32] *U.S. Department of Labor (1992, 193–96).*

[33] *In contrast, a number of studies address the list–transaction price problem for the PPI.*

7.7 billion manufacturer-issued coupons, whose face value averaged 58 cents, for total "savings" of $4.5 billion, which is slightly less that 1 percent of consumer spending in the relevant categories. Somewhat more than 14 percent of total grocery volume was purchased with a coupon in 1992. Growth in the average face value of coupons redeemed has consistently exceeded growth in the CPI since 1980. It is an open question whether failure to allow for the use of cents-off coupons by consumers leads to an upward bias in the CPI and, if so, by how much.

Treatment of durable goods

The theoretical basis of the cost-of-living index and the CPI is essentially a static theory. The appropriate treatment of durable goods in such an index requires the measurement and pricing of the flow of services obtained by the consumer from the good over time. That is, since a durable good yields a flow of consumption services valued by the consumer over several time periods, we do not want to price the purchase of the good but rather, the flow of services that it yields each time period.

In 1983, the BLS switched to the rental equivalence concept to measure housing costs in the CPI (1985 for the CPI–W). Part of the impetus for this change was the large discrepancy that emerged in the late 1970s between the CPI and the deflator for personal consumption expenditures (PCE) in the national accounts due to their different treatment of housing costs. It became generally recognized that the rental equivalence approach employed in the construction of the PCE deflator was superior on theoretical grounds.[34] Before the change, the BLS was accused of mixing the consumption and investment components of housing costs. The appropriate concept for a cost-of-living-based index is the cost of the flow of housing services consumed over the measurement interval. However, the rental equivalence approach is not without its problems. There are important differences between the markets for owner-occupied homes and the markets for rental units, not least of which is the quality. Prior to the 1987 revision of the CPI, the BLS simply took figures from the CPI's rental component to estimate the implicit rent of owner-occupiers. Since 1987 the BLS has used rents from houses in the same geographic area and with similar characteristics to those of owner-occupied houses to calculate the owners' equivalent rent index.

Armknecht and Ginsburg (1992) describe research currently being undertaken at the BLS to shift the treatment of autos in the CPI to the theoretically more appropriate flow-of-services approach. Under ideal circumstances, all durable goods would be priced on a flow-of-services basis. In reality, this is not possible, primarily because there are no rental markets for many types of durable goods.[35] For autos, however, two very active and distinct rental markets may facilitate the adoption of a rental equivalence approach. Armknecht and Ginsburg point out that car use in the traditional (short term) rental market is very different from normal use, making it unrepresentative of the general population. However, the long-term rental market for auto leases may provide more appropriate measures of the rental equivalence of auto services. The BLS currently is examining the feasibility of pricing auto transportation services on this basis.

Measuring the prices of services

Triplett's 1975 survey reviews a small number of studies that attempt to assess the quality of the CPI service price indexes. Four of the six studies he reviews examine the medical services component of the CPI, and three of these four find upward bias in the CPI components. However, the main conclusion that Triplett draws from these studies is that the appropriate pricing concept in the medical services area is not very well defined. Should we be pricing treatments or cures? Pricing a cure may well be the appropriate approach, but, as Triplett notes, cures have multiple characteristics that are difficult to value. For example, how should we compare the cost of treating appendicitis by

[34] *See, for example, Blinder (1980), Gordon (1981), and Dougherty and Van Order (1982).*

[35] *As Armknecht and Ginsburg note, there is no rental market for shoes.*

surgery versus treating it with drugs when the latter treatment is accompanied by an increased risk of a ruptured appendix? Triplett concludes his 1988 review by noting that "...existing research on the subject is insufficient to indicate whether the medical care components are upward biased" (Triplett 1988, 70). However, the BLS handbook quite explicitly states that in many instances quality changes are treated as price changes, either because the BLS is unaware of the quality change or has no method for dealing with it. (U.S. Department of Labor 1992, 193). In instances where quality adjustment is feasible, it is carried out.[36]

Kroch (1991) reviews the problems of price measurement in the service sector and argues that the true rate of service-sector inflation is probably lower than the measured rate and closer to the rate in the goods sector. Kroch argues that the slower rate of inflation for medical equipment (which is adjusted for quality changes) than for medical services (for which relatively few quality adjustments are made) is suggestive of an upward bias in the CPI medical services category. Kroch's comparison of the inflation rates of the two series suggests that medical services inflation was overstated by as much as 1 percent a year during the 1980s. However, it is not clear what one can infer from a comparison of the rates of increase of input and output prices. For example, the rate of inflation for capital equipment used in the auto insurance industry, which is a heavy user of computers, is falling rapidly, which is not generally true of auto insurance premiums.[37]

Kroch also argues that the educational price category overstates inflation when compared with an index of tuition for higher education. The last category of services that Kroch considers is the rental equivalence measure of owner-occupied housing, and while he suggests that the failure of the rental equivalence index to track house prices in recent years may mean that the CPI is overstating inflation in the housing services category, he refrains from drawing a conclusion.[38]

It is, of course, important to remember that despite the difficulties that may accompany price measurement for many services, the influence of these problems on the overall CPI is determined by the importance of the problem categories in the consumers' budget. Thus, even if it were true that inflation in the medical care component of the CPI is overstated, the fact the medical care only accounts for 4 percent of consumers' expenditures would greatly limit the influence of mismeasurement in this component on the overall CPI.[39]

The categories of the CPI that Kroch argues may be overmeasuring inflation together account for only 5.6 percent of budget outlays in the base period.

Conclusions about measurement bias in the CPI

The point of departure for this review of the CPI is the earlier survey by Triplett (1975), with its conclusion that, as of the mid-1970s, not enough was known to determine whether there was a clear overall bias in the CPI or determine its sign. Triplett repeats this opinion in his unpublished 1988 survey. Have we learned anything in the intervening period that would lead us to draw different conclusions?

In the almost twenty years since Triplett's first survey, there has been remarkably little new

[36] *Recently, Armknecht and Ginsburg (1992) have reviewed the manner in which the BLS has tried to deal with the increasing importance of services in consumers' budgets. They also have reviewed research currently under way to improve measurement and quality adjustment of services prices. They discuss research that attempts to apply hedonic techniques to the measurement of the price of hospital room stays and note the problem of properly accounting for and measuring differences in the level of nursing care among hospitals as a major obstacle to the implementation of hedonic methods in this area.*

[37] *This example was suggested by Jack Triplett.*

[38] *However, the study by Rogers, Henderson, and Ginsburg (1993) suggests that the housing component of the CPI has performed quite well in recent years.*

[39] *Kroch notes that nearly two-thirds of health care services consumed in the United States are not part of the consumer budget because they are provided through employer-paid health plans rather than paid for directly by consumers. Hence, medical care prices are given only a 4-percent weight in the CPI. This figure includes household payments for health insurance. By contrast, household consumption of health services accounts for more than 12 percent of personal consumption in the National Income and Product Accounts. See Kroch (1991, 32).*

research on the problems of price measurement. Probably the most important single contribution to the field of price measurement in recent years is Gordon's (1990) study of producer durables prices, which also includes some analysis of consumer durables prices. For the CPI, the most significant recent studies have been those of Manser and McDonald (1988) on substitution bias and Reinsdorf (1993) on outlet substitution bias. There are no recent studies of quality bias for the nondurables and services components of the CPI. For example, we still have no sense of how large the potential bias is in the measurement of health care costs.[40]

It seems clear that the issue of substitution bias is the closest to being settled. We probably can conclude with some confidence that the substitution bias arising from the use of the fixed-weight index is currently 0.2 percent a year at most. Recently, the issue of outlet substitution bias has received a lot of attention, primarily as a result of the work of Reinsdorf (1993). In view of this, we give it more detailed coverage in our review of the recent literature and argue that it needs to be backed up by further work before the figure of an upward bias of as much as 2 percent a year can be accepted as valid.[41] Note that the 2 percent figure is for the categories studied by Reinsdorf (food at home and gasoline) and does not apply to the CPI as a whole.

We note that some categories of the CPI that Triplett cites as having potential downward bias, such as housing, are now treated differently, and aging bias is less likely to cause inflation of housing costs to be understated. Apparel remains a problem, although it is interesting that the studies by Armknecht and Weyback (1989) and Liegey (1993) find both upward and downward bias in this category. Auto prices are still biased downward, for the reasons Triplett states, and will remain so until the BLS changes its methodology. We have no firm evidence on the size and nature of the biases in pricing medical care and so cannot draw any firm conclusions about this category.

Lebow, Roberts, and Stockton (1992) conclude their survey of measurement bias in the CPI by noting that under *extreme assumptions*, the upper bound on measurement bias is about 1.8 percent a year. They arrive at this figure by adding the various biases that have been identified and quantified by other authors. While calculations of this sort are suggestive, it is important to consider the limitations and caveats regarding them.

Specifically, we need to ask whether calculations of this sort may give us figures on the overall bias in the CPI that are too high because of double counting of some of the biases. Can we simply add together estimates of the quality adjustment bias and the new goods bias, given that the distinction between the two is elusive? Is it possible that traditional substitution bias and quality adjustment bias are also aspects of the same phenomenon? The same question can be raised for the outlet substitution bias discovered and quantified by Reinsdorf (1993): how do we disentangle this effect from other, more traditional forms of bias? How much of the difference in prices between conventional and low-cost retail outlets is due to a list–transactions price problem that stems from the BLS's failure to account for the use of cents-off coupons at conventional outlets?

As Gordon (1990) notes in his study of producer durable prices, and Triplett emphasizes in his 1975 and 1988 surveys, the problem is that many potential pitfalls of the different price indexes are considered in isolation from one another, without any regard to the possible interaction among them. This comment is not to criticize the calculations carried out by Lebow, Roberts, and Stockton. Such calculations are essential if any sort of conclusions are to be drawn about the potential biases in the most closely watched price index. However, it is important to be aware of, and at some point do something about, the limitations that surround calculations of this type.

In view of the paucity of evidence on the various potential biases in the CPI, we are inclined to think that it is better to err on the side of con-

[40] *Thus, Tregarthen (1993) points out that recent concerns over the rising cost of health care may be mistaken, in part because of the failure of the BLS to properly account for quality change in health care and in part because of the reliance of the BLS on list rather than transaction prices in pricing the health components of the CPI.*

[41] *It is important to note that Reinsdorf himself considers the 2 percent figure to be at best a ballpark estimate rather than a point estimate and that it may be capturing phenomena other than outlet substitution.*

servatism in guesstimating the size of the overall bias. A figure of less than 1 percent thus strikes us as a plausible estimate of the overall bias. The true figure may be a lot larger or a lot smaller; at present we simply do not know. The more agnostic position that Triplett has adopted in his surveys is harder to defend, as the evidence seems to indicate more instances of upward than of downward bias in the CPI. However, Triplett's arguments are an important antidote to those who are inclined to accept uncritically the position that the CPI consistently overstates inflation.

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The Texas Construction Sector: The Tail That Wagged the Dog

In the first half of the 1980s, Texans joked that the construction crane should replace the mockingbird as the official state bird. Throughout the state, the construction boom made the steel-necked crane a more common sight than the state bird. In the mid-1980s, however, the construction crane virtually disappeared from the Texas landscape as building activity declined dramatically. While this boom and bust in the Texas construction sector is well-known, its causes and effects are less well understood.

In this article we examine the role construction played in the volatility of the Texas economy during the late 1970s and in the 1980s. While the roller coaster ride in oil prices was a widely acknowledged source of economic instability, the construction sector also may have played an important and independent role in the state's changing fortunes. While swings in the state's economy followed oil price movements fairly closely, the construction sector often moved differently from either oil prices or aggregate economic activity.

The volatility of the Texas construction sector in the 1980s may have originated from many different sources. One likely source was a series of tax law changes that made investing in real estate more lucrative in the first half of the decade. Another source of volatility in the real estate market may have been large swings in interest rates. In this article we attempt to sort out the different factors that may have led to the huge buildup and subsequent crash of the Texas construction industry.

We use an econometric model to analyze the roles residential and nonresidential construction played in the state's economic fluctuations in the 1980s.[1] Understanding the construction sector's role in the Texas economy, or in regional economies in general, is critical to understanding regional business cycles. Is the construction sector a source of regional fluctuations, or does it respond to other shocks in the economy? What causes boom and bust cycles in construction? How long after a shock to the construction sector will the regional economy feel its effects?

Our results suggest that while changes in oil prices and the U.S. economy generally had the largest effect on the volatility of the state's economy, movements in construction activity were also important. Our results also indicate that changes in oil prices, tax laws, and interest rates were major factors behind the volatility of the Texas construction sector.

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[1] *In this article, we do not examine nonbuilding construction, which includes roads, highways, and sewer systems. Data for this series were unavailable.*

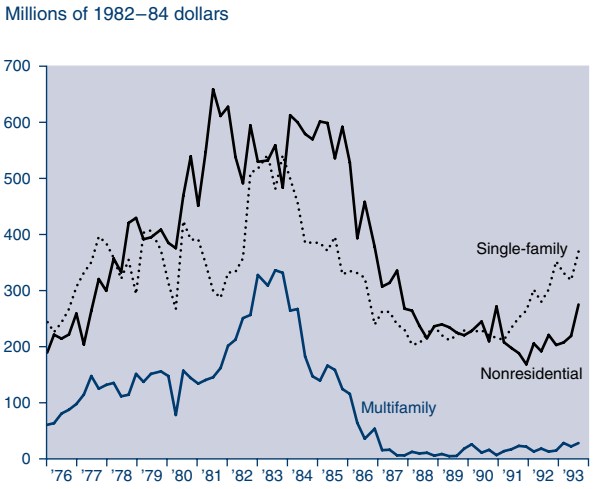
Construction in the 1980s: If you build it, they will come

During the 1980s, the construction sector's growth pattern often deviated from that of the overall Texas economy. The divergence was particularly noticeable in the early 1980s when the state's economy was in recession and the construction sector was still growing quite strongly. This strong expansion of the construction sector, combined with weak overall economic activity, eventually led to skyrocketing vacancy rates and a real estate bust. Although it may appear that construction grew without regard to demand, several other factors may have led to the unusual pattern of construction activity in the 1980s.

The Texas construction boom began in the mid-1970s and continued for almost ten years (*Figure 1*). At first, the strength in construction activity seemed motivated by strong gains in economic activity. Between early 1974 and early 1981, inflation-adjusted oil prices nearly tripled and the Texas economy expanded rapidly. The relationship between oil prices and the Texas economy is highlighted in Figure 2, which shows movements in the relative price of oil and detrended nonfarm employment.[2] During the same period, nonresidential construction activity more than quadrupled, while office vacancy rates fell from 15 percent to 7.6 percent in Dallas and from 7.8 percent to 5.7 percent in Houston.[3]

In 1982, however, the construction sector diverged from the rest of the economy. While oil prices fell and the Texas and U.S. economies turned downward, Texas construction activity surged (*Figure 3*). Throughout the mid-1980s, the high level of construction activity did not seem to be supported by the Texas economy's weak growth. Although declining interest rates may have motivated some construction activity, the amount of space added during this period far exceeded the demand, as shown by the rising vacancy rates in Table 1.

Figure 1
Texas Real Building Permit Values



SOURCE: U.S. Department of Commerce.

Browne (1992) suggests that Texas construction sector's growth in the first half of the 1980s was much higher than what economic conditions would have predicted. According to Browne, the share of construction in the Texas economy was higher than expected given the existing interest rates, employment and population growth, and trend factors.

The passage of the Economic Recovery Tax Act of 1981 (ERTA) may have led to much of the growth in construction activity during the period 1982 to 1985. The act created significant tax breaks for investors in income-generating properties, such as apartments and office buildings. The most noteworthy element in the 1981 tax law was a major change in business depreciation allowances.

Under the new law, tax lifetimes of certain depreciable assets—such as real estate properties other than single-family housing—were significantly reduced. This change had the effect of reducing the effective tax rate on the lifetime income generated by the property and allowed for accelerated recovery of investments.[4] The tax law was espe-

[2] *Detrended employment is calculated as the residual of employment regressed on time and a constant term. If employment grows slower than trend growth, the detrended employment line in Figure 2 will show a decline.*

[3] *These vacancy rates for Houston and Dallas were supplied by CB Commercial, Torto Wheaton Research.*

[4] *For an explanation of how accelerated depreciation reduces the effective tax rate, see Musgrave and Musgrave (1989).*

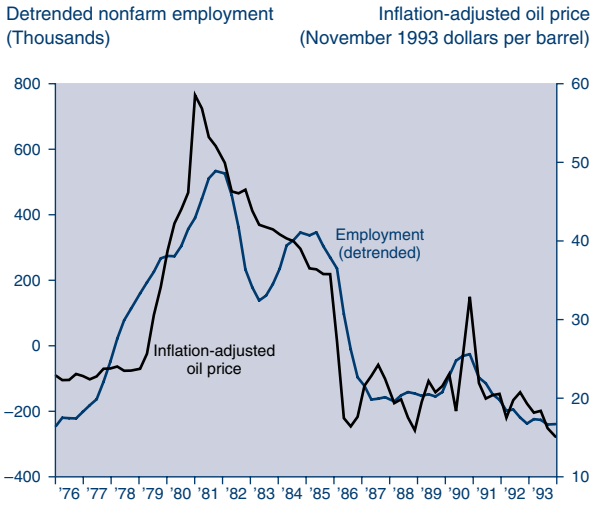
cially attractive to high-income investors who could invest in real estate through a limited partnership and use any losses to shelter taxes on other income.

Follain, Leavens, and Velz (1993) and others suggest that the buildup of real estate in the 1980s may have been exacerbated by what some have identified as a lending frenzy. In the early 1980s, when tax law changes made real estate investing more profitable, several events occurred that gave financial institutions a larger pool of available funds to lend to real estate investors. The Depository Institutions Deregulation and Monetary Control Act of 1980 accelerated the deregulation of deposit interest rates by providing an eventual phase-out of interest rate ceilings on time and savings deposits. In addition, the Garn–St Germain Depository Institution Act of 1982 created a new account, the money market deposit account, and as these accounts became available, a flood of money poured into them.[5] Meanwhile, a monetary easing initiated a decline in interest rates and added to banks' liquidity.

The increase of available funds and the pursuit of real estate lending by thrifts and commercial banks led to the financing of income-producing real estate to a point of extreme oversupply. The lending frenzy may have been even more pronounced in Texas than elsewhere in the country. Texas lending institutions that had been badly burned by energy loans were searching for new investments, and they chose real estate. As an example, apartment vacancy rates in Texas rose rapidly during the period 1981 to 1983, while Texas apartment construction more than tripled.

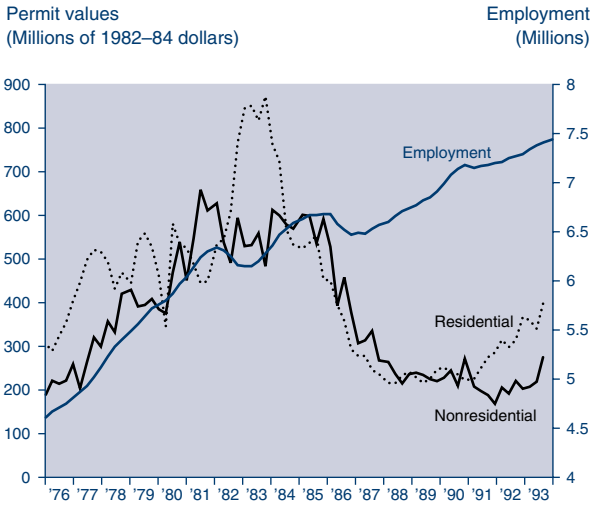
In 1986, the Texas construction sector entered a prolonged decline. Several factors may have initiated the decline, including a plunge in oil prices and a sharp recession in the Texas economy. Possibly the most important factor, however, was the 1986 Tax Reform Act (TRA). TRA removed the tax depreciation advantages given to real estate investors five years earlier by extending the tax depreciation lifetime for income-producing real estate and requiring straight-line depreciation. This method replaced the more accelerated 175 percent declining-balance method used under ERTA. These changes significantly reduced the tax savings generated by depreciation allowances to real estate investors.

Figure 2
Real Oil Prices and Texas Employment



SOURCE: Bureau of Labor Statistics and Federal Reserve Bank of Dallas.

Figure 3
Texas Real Building Permit Values and Nonagricultural Employment



SOURCE: Bureau of Labor Statistics, Federal Reserve Bank of Dallas, and U.S. Department of Commerce.

[5] *Spong (1990).*

Table 1
Vacancy Rates

Percent

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Rental Housing										
United States	5.0	5.3	5.7	5.9	6.5	7.3	7.7	7.7	7.4	7.2
Dallas	5.4	4.7	9.0	7.7	13.9	17.2	16.2	17.9	14.6	12.3
Houston	6.4	7.6	13.9	15.4	18.1	18.0	18.3	14.4	12.5	9.6
Homeowner										
United States	1.4	1.5	1.5	1.7	1.7	1.6	1.7	1.6	1.8	1.7
Dallas	2.2	1.4	2.0	2.2	1.6	2.1	3.7	3.9	4.1	2.1
Houston	2.2	4.1	3.4	5.4	3.6	3.7	3.4	2.3	2.4	2.1
Office - Downtown Areas										
United States	4.8	10.3	12.4	14.7	16.5	16.4	16.3	16.2	16.7	17.1
Dallas	4.8	10.0	14.6	17.2	17.5	21.6	24.5	23.5	22.4	24.7
Houston	1.3	5.8	14.6	20.9	20.2	20.0	21.9	19.4	18.5	17.7
Industrial										
United States	3.8	4.8	4.9	4.7	5.0	5.8	5.5	6.0	6.4	7.4
Dallas	8.1	7.3	6.9	4.6	6.1	7.0	6.9	8.4	7.2	8.8
Houston	5.7	4.6	5.6	7.7	14.1	14.9	12.7	9.6	9.8	9.3

SOURCE: Taken from Browne (1992, 37). Indirect sources: Housing–U.S. Bureau of the Census; office and industrial–Coldwell Banker.

TRA also included several provisions designed to restrict tax shelter investment. Passive-loss limitations were enacted that disallowed income tax deductions from active income for net losses of passive income, such as limited partnership investment. Passive-loss limitations likely had the largest impact on multifamily real estate, which had benefited greatly from limited partnership deals under ERTA.[6]

Also in 1986, a sharp decline in oil prices weakened the Texas economy, and it fell into a deep recession while the national economy continued to grow. Texas employment fell by approximately 250,000 that year, and people began leaving the state. Net out-migration and the impacts of TRA put increased pressure on already high apartment and office vacancy rates. The resulting decline in construction was severe. Although construction accounted for only 6.7 percent of Texas employment in 1985, it accounted for 40 percent of the job decline during 1986, or almost 100,000 jobs.

Despite a turnaround in the Texas economy in 1987, construction activity continued to decline throughout the late 1980s, and the sector remained out of sync with the state's economy. Activity in the single-family housing sector leveled out by 1988 but did not bottom out in the nonresidential sector until 1991. Apartment construction almost disappeared in the late 1980s and only began to show signs of resurgence in the early 1990s. The prolonged decline in construction activity, how-

[6] *Follain, Leavens, and Velz (1993) point out that the decline in multifamily construction in Dallas began before TRA's passage and may be attributed to unrealized expectations of high oil prices.*

ever, helped reduce some of the excess space built during the boom, and by the early 1990s, apartment and homeowner vacancy rates had fallen from the high levels of the mid-1980s. Nonresidential vacancy rates, however, remained elevated, especially in Dallas.

Since 1991, construction activity has become more in line with the Texas economy and has become an important part of the state's growth. Lean home inventories and falling interest rates contributed to a strong rebound in single-family construction beginning in 1991. In addition, multifamily and most nonresidential vacancy rates have tightened, and construction activity in these sectors has begun to pick up. Nevertheless, construction activity today is at much lower levels than in the heydays of the early 1980s.

Empirical analysis

The above summary of the Texas economy in the past twenty years illustrates that cycles in the construction industry have not necessarily been synchronized with the overall economy. Changes in tax laws and interest rates may have been important factors behind changes in the construction industry, while oil price changes were important for the overall Texas economy. In this study, our main interest is in determining whether the construction sector was an important factor behind business cycles in the Texas economy and whether it was the Texas economy or other factors such as oil prices, the U.S. economy, or changes in tax laws and interest rates that were the driving forces behind the swings in the Texas construction sector in the late 1970s and in the 1980s.

To examine the relationship between the construction sector and the Texas economy, we employ a VAR methodology.[7] We study the interrelationships between the regional construction sector, the overall regional economy, oil prices, and the national business cycle. To capture the different types of Texas construction activity, we use nonresidential, single-family, and multifamily permit values. We also allow for external factors such as interest rates and tax laws whose effect on construction is independent of changes in the state's economy.[8]

We test whether there is a long-term stable relationship between Texas personal income and the construction sector variables. We then measure the impact that shocks to the Texas economy have had on the construction sector. We also measure the impact of shocks to the construction sector on the Texas economy and trace the persistence of these shocks through time.

Our results suggest that the construction sector, particularly single-family building, was an important factor behind the volatility of the Texas economy in the late 1970s and in the 1980s. Oil prices played an important role in the dynamics of both the state economy and the construction sector. As expected, tax laws had at least a moderate effect on the volatility of the multifamily and nonresidential sectors. Interest rates played a key role in the volatility of the single-family sector.

What lies behind the boom–bust cycles Of the Texas construction sector?

Our results show that most of the volatility in the Texas construction sector resulted from changes in oil prices, tax laws, and interest rates rather than changes in the Texas economy (that is, changes in the Texas economy not explained by past changes in the other variables and itself). Shocks to the Texas economy had the most impact on multifamily residential construction.

Oil price shocks played an important role in the volatility of the two income-generating sectors of construction—nonresidential and multifamily. This result is consistent with the view that oil price shocks influenced investors' expectations about future growth in the Texas economy. These expectations likely led to decisions to build apartment complexes and industrial and commercial buildings.

[7] *The details of the econometric model and empirical analysis are in the Appendix.*

[8] *Browne (1992) and Moscovitch (1990) use a regional base approach to determine the importance of construction to the regional economy. The regional economic base approach assumes that construction, over longer periods of time, moves in response to growth in regional export or "base" industries such as manufacturing and mining. We do not use the regional base approach. As discussed in Krikelas (1992), the regional base approach has several problems, such as difficulty in defining export industries and focusing solely on external demand.*

Table 2
Sources of Long-Run Forecast Error Variance In Construction Variables, 1976–90

	Value of Building Permits (Percent)		
	Nonresidential	**Multifamily**	**Single-family**
Oil prices	56.9	31.1	7.2
Tax laws	7.1	12.2	1.1
Interest rates	7.2	10.3	34.4
U.S. personal income	6.9	4.3	.7
Texas personal income	.3	14.8	2.4
Construction measure	21.5	27.2	54.2

NOTE: Each column shows the source of variance for the respective construction variable used in the model. The construction measure listed in the table refers to the construction sector listed at the top of the column. For example, the first column shows that 21.5 percent of the forecast error variance in nonresidential construction was due to shocks in itself.

While shocks to long-term real interest rates generally were important for all construction sectors, they had the largest impact on single-family construction. For example, Table 2 shows that shocks to interest rates were responsible for 34.4 percent of the unexpected changes in single-family construction. This is likely because residential borrowers have limited sources of financing (such as savings and loans, mortgage companies, and banks), and swings in real interest rates can have a large impact on the number of individuals qualified to borrow.

Our results also suggest that the change in tax laws in the 1980s had an important impact on multifamily construction and, to a lesser degree, on nonresidential construction. Shocks to the Texas economy appear to have had an important impact on the multifamily sector but showed little impact on the two other sectors.

Finally, much of the source of volatility in the three different construction sectors is explained by shocks to the sectors themselves. This implies that much of the movements in these sectors is unexplained by the other variables included in the models. Other factors such as the lending frenzy may have had an important impact on construction during this period.

Construction's role in the Texas economy

While changes in oil prices and the U.S. economy generally had the largest impact on the Texas economy in the 1970s and 1980s, the construction sector, particularly single-family housing, also played an important role.

Our results show that shocks to oil prices and the U.S. economy were major sources of volatility for the Texas economy, regardless of the construction variable used (*Table 3*). These shocks accounted for at least one-third of the variation in the Texas economy with single-family permit values as the construction variable, and up to 75 percent with nonresidential permit values. For example, Table 3 shows that, in the model with multifamily permit values, oil price shocks accounted for 28.9 percent of the unexpected changes in Texas personal income and shocks to the U.S. economy explained 21.7 percent.

Unexpected shocks to residential construction, especially single-family construction, had a much greater impact on the Texas economy than shocks to nonresidential construction. For instance, shocks to single-family construction explain 54 percent of the changes in the Texas economy during the period in question. In the multifamily housing

Table 3
Sources of Long-Run Forecast Error Variance In the Texas Economy, 1976–90

	Measure of Construction Used (Percent)		
	Nonresidential	Multifamily	Single-family
Oil prices	40.9	28.9	16.0
Tax laws	4.6	10.4	9.0
Interest rates	13.9	9.7	.8
U.S. personal income	34.4	21.7	19.4
Texas personal income	1.8	17.9	.8
Construction measure	4.3	11.5	54.0

NOTE: Each column shows the source of variance for Texas personal income for the three different construction variables used in the model. For example, the first column shows that 40.9 percent of the forecast error variance in Texas personal income was due to shocks to oil prices when nonresidential permit values are used as the construction variable. The variable construction measure refers to the construction sector listed at the top of the column.

model, the construction measure had a smaller effect, but was still two and one-half times greater than the effect of nonresidential construction.

Our finding that shocks to the residential sector have a larger impact on the Texas economy than the nonresidential sector is consistent with conventional wisdom. Residential construction is much more closely tied to the regional economy than the nonresidential sector. Moreover, the residential sector represents more than 50 percent of total construction, and shocks to the residential sector in the period under study have been quite large, as illustrated by Figure 3.[9]

How long do shocks last?

Our results indicate that shocks to the construction industry take a long time to work their way through the Texas economy. In addition, we find that the three construction sectors responded differently to shocks in the Texas economy during the period under study.

Our results show that shocks to the construction sector have long-lasting effects on the Texas economy of five years or more. Within the construction sector, shocks from nonresidential and single-family housing were shorter lived than those from multifamily housing. The Texas economy adjusted to a shock in the nonresidential and single-family sectors in about five years, while it took more than ten years to adjust to a shock in the multifamily sector.

The adjustment time of the construction industry to changes in the Texas economy varies with the type of construction. The single-family residential and the nonresidential sectors adjusted relatively quickly to changes in the Texas economy. Both sectors adjusted to shocks within four years. Adjustment to oil price and depreciation rate shocks took just as long. However, all shocks to the multifamily sector were very persistent, lasting more than ten years. This finding is consistent with the prolonged weakness seen in the multifamily sector since 1986 (*Figure 1*).

[9] *Although Figure 3 shows the actual changes in the series and not the shocks, a separate analysis of the error terms from the VARs shows that the variance of the shocks to the single-family and multifamily sectors were larger than that of the nonresidential sector.*

Conclusion

While the oil industry played the major role in the volatility of the Texas economy over the past twenty years, the construction industry also played an important role. Our results suggest that different sectors of the construction industry played differing roles in the region's economy. We find that over the past twenty years, unexpected shocks to single-family construction had a larger impact on the Texas economy than shocks to multifamily or nonresidential construction.

Our results also indicate that changes in oil prices, tax laws, and interest rates affected the income-generating construction sectors (nonresidential and multifamily) independently of changes in the regional economy. Changes in interest rates were the most important factor for the single-family housing sector. We also find, however, that between 20 percent and 50 percent of the shocks to the construction sectors were not explained by shocks to the interest rate, tax laws, oil prices, Texas personal income, or U.S. personal income. This finding leaves room for other explanations for the large swings in construction, such as the lending frenzy theory proposed by some economists.

The adjustment of the Texas economy to shocks in the construction sector takes many years. Shocks from the nonresidential and single-family housing sector are shorter lived, lasting five years, while shocks to multifamily housing are more persistent, lasting more than ten years. Similarly, nonresidential construction and single-family housing adjust more quickly to shocks to the Texas economy, while multifamily housing does not show much adjustment even after ten years.

Our results have implications not only for Texas but for other states as well. The residential construction expansion Texas has experienced in the past few years will likely have positive effects on the state for years to come. For states that experienced negative construction shocks in the late 1980s, our results suggest that the effects of these shocks are still being felt.

Appendix

Empirical Analysis

To examine the relationship between the construction sector and the Texas economy, we employ a VAR methodology. A VAR is a system of equations in which lagged values of the dependent variables are used as explanatory variables. We study the interrelationships between the regional construction sector, the overall regional economy, oil prices, the national business cycle, interest rates, and tax law changes. We allow for external factors such as interest rates and tax laws to affect construction independently of changes in the state's economy.

In our analysis, the oil price variable (*OIL*) is the refiner's acquisition cost, adjusted for inflation. The interest rate (*INT*) is a ten-year utility bond rate, minus expected inflation.[1] The tax policy variable (*DEPR*) is the present value of the tax savings generated by depreciation allowances and is from Follain, Leavens, and Velz (1993). U.S. personal income minus Texas personal income is used as the measure of U.S. economic activity (*US*), and the measure of Texas economic activity (*TX*) is Texas personal income.[2] The data used in our analysis are quarterly and span the years 1976–90. All variables except *INT* and *DEPR* are expressed in dollars and are deflated by the U.S. consumer price index.

To capture the different types of Texas construction activity, we use single-family (*SFPV*), multifamily (*MFPV*), and nonresidential (*NRESPV*), permit values, as this data is the most consistent across the different types of residential and nonresidential construction activity. A separate system of equations is estimated for each of the three different measures of Texas construction activity.

Prior to estimating the VARs, we perform several diagnostic checks to assess the correct specification for the various series. We test for stationarity using Dickey–Fuller tests, and find that all of the series are integrated of order of one. Thus, the first differences of the series are stationary and any shock to the series is permanent.

In addition, we test the models for cointegration. Time series are cointegrated if they move together in the long run; in other words, there is a stationary, long-run relationship between the series. Estimating a VAR in first differences when cointegration is present can result in overdifferencing and a loss of information about the long-term relationship between series.

We check for cointegration in the three systems of equations in which each system is distinguished by a different construction variable, and find cointegration in all three systems. We account for cointegration by specifying an error-correction model in which changes in the dependent variable are expressed as past changes in both the independent and dependent variables plus an error-correction term.[3] The error-correction

[1] The expected inflation rate is a ten-year expected inflation series based on a survey of economists prepared by the Federal Reserve Bank of Philadelphia.

[2] We also use total nonagricultural employment as a measure of U.S. and Texas economic activity to analyze the sensitivity of results to the measure of economic activity employed. The results are not qualitatively different.

[3] Engle and Granger (1987).

(Continued on the next page)

Appendix

Empirical Analysis—*Continued*

term specifies the adjustment to deviations from the long-run equilibrium relationship.

We use variance decomposition to measure the impact that shocks to the Texas economy have had on the construction sector and vice versa. Variance decomposition apportions the variance of forecast errors in a given variable to shocks to itself and shocks to the other variables. The method we use to calculate the variance decomposition is the Choleski decomposition. This method decomposes the residuals (μ) into sets of impulses that are orthogonal to each other (v). Orthogonalization takes the covariance between the residuals into account. If the covariance between the residuals is sufficiently high, the ordering of the dependent variables can affect the results. The structure we employ for the variables is specified such that it allows a one-way contemporaneous relationship between the construction variables and Texas economic activity variables. The structure is as follows:

(1) $$\mu_{OIL} = v_{OIL}$$

(2) $$\mu_{DEP} = c_{21}\mu_{OIL} + v_{DEP}$$

(3) $$\mu_{INT} = c_{31}\mu_{OIL} + c_{32}\mu_{DEP} + v_{INT}$$

(4) $$\mu_{US} = c_{41}\mu_{OIL} + c_{42}\mu_{DEP} + c_{43}\mu_{INT} + v_{US}$$

(5) $$\mu_{TX} = c_{51}\mu_{OIL} + c_{52}\mu_{DEP} + c_{53}\mu_{INT} + c_{54}\mu_{US} + v_{TX}$$

(6) $$\mu_{CONS} = c_{61}\mu_{OIL} + c_{62}\mu_{DEP} + c_{63}\mu_{INT} + c_{64}\mu_{US} + c_{65}\mu_{TX} + v_{CONS}$$

In equations 1 through 6, μ_i represents the current innovation in variable i and the innovation process, v, is assumed to be orthogonal. An innovation is a shock, or a change in a given variable that is not anticipated by the model. The above structure implies that unexpected changes in oil prices do not contemporaneously arise from any of our specified variables. Innovations in oil prices, depreciation rates, and interest rates affect the innovations in the U.S. economy contemporaneously, but the U.S. economy does not affect these variables contemporaneously. Current innovations in the Texas economy variables are affected by current innovations in oil prices, depreciation rates, interest rates, and the U.S. economy variables but not the construction variables. Although innovations in the construction variables affect the Texas economy variables, they are not contemporaneous—they work their effects through the system over time.

Finally, to examine the long-run dynamics of the shocks to construction and the Texas economy, we calculate impulse response functions. The impulse response function traces over time the effects on a variable of a given shock to another variable. The persistence of a shock tells us how fast the system adjusts back to equilibrium. The faster a shock dampens, the faster the adjustment. The Choleski decomposition is used to calculate the impulse response functions. We analyze the effects of a one-time, one standard-deviation shock to the first difference of each variable. We then trace the effects of this shock on each of the variables.

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Is NAFTA Economic Integration?

Some analysts consider the North American Free Trade Agreement (NAFTA) part of a larger economic integration process that goes beyond narrowly defined trade policy (Pastor 1992, Weintraub 1993b). Because of U.S. initiatives, issues with only tenuous direct connections to trade have come under negotiation. A harmonization of national policies that appears tantamount to a broad movement toward integration seems to be under way.

But is it? NAFTA clearly makes trade freer on a broad front among the signatories and will result in the efficiency enhancements typical of trade openings. However, in many cases, what may at first look like integration appears on further scrutiny simply to be a continuation of a Hegelian dialectic over trade policy.[1]

To show why a Hegelian dialectic appropriately characterizes what took place with NAFTA and the parallel agreements and why economic integration seems a less appropriate characterization, we begin by considering the antecedents of the NAFTA negotiations. The events that precipitated NAFTA began, at the very latest, in the 1970s.

Conflict and innovation in recent U.S. trade postures

From the end of World War II until the late 1970s, U.S. trade policy involved an unconditional interpretation of the most favored nation (MFN) clause of the General Agreement on Tariffs and Trade (GATT).[2] The United States was the world's principal proponent of a multilateral approach to international trade liberalization.

But by the late 1970s, the United States had become frustrated with GATT. The sources of frustration were the caravan effect (GATT negotiations emulate a caravan that moves only as fast as its slowest camel); the free-rider problem (some countries, chiefly the less developed ones, have benefited from the multilateral system without much lowering their own barriers); and the rise of trade-related issues not covered by GATT, such as direct foreign investment, trade in services, and intellectual property rights (Primo Braga 1989, 245).

Over time, these three problems became more frustrating for the United States. While the caravan effect is self-explanatory, both the free-rider problem and trade-related issues not covered by GATT deserve more detailed attention.

Although many countries had entered GATT because they wanted open foreign markets, they were often less interested in opening their own. For the less developed countries (LDCs), whose competitive positions against the developed nations were unfavorable in many industries, these predilections were considered understandable. GATT allowed the LDCs to surrender less protectionism than the industrialized nations and offered LDCs special openings to the developed countries under

[1] *We use the term Hegelian dialectic, in the context of trade policy, to signify the process by which innovations in trade liberalization are countered by innovations in protectionism and are succeeded by some synthesis that is temporarily acceptable to each of the two competing sides, followed by yet another innovation in liberalization, countered by yet another innovation in protectionism, followed by yet another synthesis, and so on. It should be noted that Kane (1988) poses the evolution of financial regulation in the same way, while Gruben (1992) describes NAFTA as a game that leads to a dialectical progression.*

[2] *The MFN clause requires a member nation that lowers tariffs on specific products from a given country to lower them to all nations. However, less developed countries receive "special and differential treatment" that exempts them from certain aspects of the MFN in the interests of economic development. In supporting the unconditional interpretation of the MFN, the United States persistently has contested the policy of special and differential treatment.*

the generalized system of preferences (GSP).[3] But to some countries, these special opportunities were not enough. A historical peculiarity of GATT offered countries a freeway to still more protectionism.

Because pre-World War II protectionists had focused their energies on tariffs, tariffs are what GATT had been designed to lower. Over time, many GATT signatories simply replaced their tariff barriers, which are discouraged by GATT, with other, GATT-legal barriers. Quantity restrictions, expressed through quotas and permits, became commonplace, as did regulations and standards concerning "product quality." Export subsidies became popular. Detailed regulations against direct foreign investment surfaced. Some countries became harbors for intellectual piracy, maintaining weak patent and copyright protection in order to become centers for unlicensed production.

During the 1980s, particularly in LDCs, these innovations in protectionism proliferated in response to terms-of-trade shocks and foreign debt problems. Surmising that the raw materials price booms of the 1970s would continue in the 1980s, many LDCs had devised debt-led growth strategies and found foreign bankers to support them. But at the end of the 1970s, a shift in U.S. monetary policy triggered a sudden rise in interest rates, making debt a tortuous route to any goal. At the beginning of the 1980s, the prices of the LDCs' traditional raw materials exports entered a protracted slump. To address their new balance-of-payments and debt problems,[4] many LDCs adopted philosophies more reminiscent of eighteenth-century mercantilism than of GATT, and they expressed them through GATT-legal nontariff innovations.

Meanwhile, certain technological developments caused the United States to find foreign protectionist innovations increasingly baneful. Since the 1960s, innovations in transportation and communications had inspired a rise in "production sharing," in which firms located one portion of a total manufacturing operation in Taiwan, another stage in Singapore, and perhaps another in Mexico. By the 1980s, further revolutions in communications and in production technology had allowed a surge in opportunities for U.S. trade in services. This surge prompted the United States to push its trading partners to permit more such trade.

Trade in services, however, involves complications that are less common in the goods trade. Much services trade operates most efficiently in locations where producer and consumer physically meet. For trade in services, someone must travel, typically the seller. The service producer prefers to locate itself and its capital-goods inputs at the market, so the buyer will not have to travel to use them.

But in international trade, locating at the market means that the host country's investment rules have an overriding effect on sales opportunities. Rules that restrict foreign investment hinder U.S. services trade. Moreover, because many U.S. services exports involve specialized technological knowledge—embodied in machinery, in software, or in employees—the development and profitability of such trade often depends on the protection of intellectual property rights. The risk of technology theft has a chilling effect. By the 1980s, the accelerating pace of technological development, together with the increasing ease of pirating new technology, made such risk steadily greater.[5]

Since these factors made opening trade more attractive to the United States at the same time that LDC innovations in protectionism were raising trade barriers, the United States launched a program of what came to be called "aggressive reciprocity."[6] Section 301 of the Trade Act of 1974 and

[3] *The GSP allows virtually duty-free entry of designated products from designated developing countries (the LDCs) into the United States and other developed nations.*

[4] *Latin America's debt-led commercial policies, which mixed export incentives with import restrictions, did help Latin America begin to generate balance-of-trade surpluses from 1983 on. Even so, the region's external debt continued to mount. That is, the regional surplus in the balance of goods and nonfactor services remained too small to offset the deficit in the factor services balance (interest, profits, and dividends) (Primo Braga 1990).*

[5] *For a discussion of the acceleration in technology, the rising ease of appropriating it without permission, and other issues related to the United States' increased interest in the protection of intellectual property, see Mody (1990).*

[6] *It is important to note that the United States continued its program of aggressive reciprocity even after Latin American countries began to lower their trade barriers in the broad-based liberalization efforts of the late 1980s and early 1990s. This pattern is one of many that raise questions as to how many of the United States' announced efforts on behalf of free trade are really acts of disguised protectionism.*

its revision, "Super 301," under the Omnibus Trade and Competitive Act of 1988 allowed the United States new maneuverability in threatening unilateral trade retaliations. The United States used these threats to extract trade openings from other countries and to induce trading partners to tighten their intellectual property protection. (Such was the case, for example, with Brazil and computer software.)

Innovative protectionists soon contrived to apply measures expressly designed to open trade to quite different purposes. For example, the United States used Section 301 and Super 301 to negotiate "voluntary" export restraints, a U.S. innovation in protectionism in which exporting countries "volunteer" to restrict their exports to the United States. Foreigners slow in volunteering were not long in receiving U.S. threats of 301-based trade sanctions. The United States also stepped up countervailing actions, such as raising duties, against countries it charged with dumping or other "unfair" trade practices.[7] In many cases, the merits of these charges have been questionable (Bovard 1992).

In sum, in the context of U.S. trade policy, two types of dialectics were operative. First, a dialectic operated between forces in the United States that wanted free trade abroad but not so much at home, and foreign countries that also wanted free trade abroad but not so much at home. That is, as one side developed innovations in both liberalization and protectionism, they were countered by those of the other side.

Second, the realignment in trade patterns that inspired the United States' initiatives at the GATT negotiations also changed who wanted protectionism and who did not. Some U.S. firms that had favored protectionism discovered that changes in production technology and in markets had made freer trade agreeable. Other traditional protectionists found that these same changes favored increased protectionist efforts.

To illuminate this redistribution of protectionist pressures, some details of the dynamics of production-sharing deserve attention. Production sharing simply meant that it became more common for U.S. firms to export partially manufactured products for further processing abroad, and then to import, perhaps for further processing in the United States before final sale.

As such trade developed, firms and industries carrying out production sharing inclined increasingly toward trade liberalization at home (Gonzalez and Velez 1992). After all, producers who import their inputs often benefit from low trade barriers. Manufacturing firms' lobbying efforts on behalf of protectionism began to diminish (Magee 1990). Moreover, U.S. production-sharing manufacturers became more interested in negotiating liberalized foreign investment laws in foreign countries that made attractive platforms for production-sharing operations. These interests were consistent with those of U.S. service-exporting firms, even though the latter intended to sell abroad the products of their foreign operations.

On the other side of the dialectical process, U.S. labor groups viewed increased U.S. manufacturing operations abroad as signifying fewer union jobs in the United States. Accordingly, unions increased both direct and indirect pressure toward restricting trade.

In an innovative example of indirect pressure, U.S. labor organizations began to ally with groups that were concerned about environmental problems abroad. These allied organizations accused U.S. firms of moving operations abroad to take advantage of looser environmental laws or enforcement. They petitioned Congress for measures that might impede firms from reexporting to the United States. Such measures could not only discourage some firms from continuing to operate abroad, even if environmental considerations had not been the motive underlying their locations, but could discourage others from establishing foreign operations in the future.[8]

NAFTA as the next step

These redistributions of pressures for and against trade liberalization manifested themselves

[7] *Between 1970–75 and 1980–85, U.S. countervailing actions went up by more than 1,000 percent (Nam 1987).*

[8] *An example of another alliance between environmentalists and protectionists appears to have surfaced in debates over NAFTA. An anti-NAFTA advertisement in the September 21, 1993,* New York Times *sponsored by Public Citizen,*

further in the establishment of the negotiating frameworks that would lead to NAFTA. The opportunities for a free trade agreement had increased with the decline of protectionist pressures from U.S. manufacturers. U.S. labor organizations, however, urged negotiation for parallel agreements without which, unions argued, NAFTA itself would promote a type of competition that was destructive.

The progress of the parallel negotiations offered much evidence to suggest that protectionists saw the discussions of side agreements as a second chance to sink NAFTA. As one after another agreement was reached on environmental and other issues, none was adequate. Disparities between U.S. and Mexican labor and environmental laws—or their enforcement—increasingly attracted charges of "social dumping" (AFL–CIO 1992).

One major sticking point in the parallel negotiations implies a great deal about whether the U.S. agenda involved integration or whether it reflected the protectionist side of a dialectical process. Although all three parties concurred that violation of the parallel covenants ought to incur penalties, the United States was unique in arguing that the penalties ought to include selected revivals of protectionism. Canadian and Mexican negotiators, perceiving a contradiction in the use of protectionism to achieve free trade, favored fines.[9] Moreover, some of NAFTA's moves toward what has been referred to as integration can also be seen as attempts by U.S. protectionists to broaden their efforts against freer trade by pushing issues that Canadians and Mexicans may perceive to involve their national sovereignty.

In any case, the efforts of pro- and antiprotectionist forces have jointly determined NAFTA and will likely determine how the agreement will evolve over time.[10] To more fully elucidate these competing forces—and the likely outcomes of their conflict over the life of the agreement—we selectively discuss NAFTA itself, its expected effects, and the political forces that will influence its implementation. We also consider in more detail the emergence of the parallel agreements.

The negotiated NAFTA: Liberalization and protectionism

In arguing that NAFTA may signify something besides economic integration, we have focused on the parallel agreements because they reflect both protectionist and liberalizing pressures. But NAFTA itself reflects the same opposing forces.

NAFTA does not free trade, but it certainly liberalizes it. Over a fifteen-year period, NAFTA initially reduces and ultimately eliminates all tariffs and most nontariff barriers between Canada, Mexico, and the United States. Moreover, NAFTA is a GATT-forward agreement; no signatories can increase their tariffs on imports from countries within or outside the free trade area.

Although full elimination of tariffs will take fifteen years (*Table 1*), about 68 percent of goods imported from Mexico could enter the United States without tariffs as soon as the agreement goes

Sierra Club, Friends of the Earth, the Humane Society of the United States, and other environmental groups declares:

> *Take the Marine Mammal Protection Act. It specifies that yellowfin tuna cannot be imported from countries that violate a U.S. law that limits the number of dolphins killed while catching the tuna. Mexico currently violates this law. But under NAFTA, the manner in which a product is produced (in other words, the way fish are caught) cannot alone prevent their import. Good-bye dolphin protection.*

Offering a rather different perspective, Jan Gilbreath (1993, 10) notes:

> *The United States in 1990 outlawed Mexican tuna to protest fishing practices that had resulted in thousands of dolphin deaths. Nearly four years later the U.S. embargo continues—despite the fact that Mexican dolphin kills today are negligible. That Mexico, the world's fourth largest tuna producer, could respond so dramatically to U.S. environmental concerns and still fail to break down an environmentally inspired trade barrier has prompted many policymakers to question whether the tuna–dolphin issue has shifted from a U.S. policy of protecting global resources to one aimed at protecting a domestic tuna industry.*

[9] *In a compromise, the final draft of the parallel agreements contains provisions for fines against the governments of offending countries. If these fines are not paid, tariffs will be imposed.*

[10] *As an example, in an attempt to secure votes sufficient to ratify NAFTA, the Clinton administration entered into NAFTA-related agreements that were not part of NAFTA in order to reerect barriers in orange juice trade that NAFTA would have lowered.*

Table 1
NAFTA: Schedule of Tariff Elimination

Category Date	U.S. imports from Mexico (Percent of total)	Mexican imports from the United States (Percent of total)
Duty-free before agreement	13.9	17.9
Additional opening effective on NAFTA start data: January 1, 1994	53.8	31.0
Additional opening five years after	8.5	17.4
Additional opening ten years after	23.1	31.8
Additional opening fifteen years after	.7	1.4
Total Value	$28.9 billion	$14.2 billion

SOURCE: USITC (1993, 1–3).

into effect. At the same time, 50 percent of U.S. exports to Mexico are now tariff-free. Other, less obvious merchandise trade barriers also were removed. In the traditional in-bond, or *maquiladora*, industries' performance (export) requirements[11] and restrictions on domestic sales evaporated when the agreement went into effect.

Moreover, NAFTA addresses much more than merchandise trade. In a trinational context, the agreement realizes the United States' long-held goals of liberalizing trade in services and foreign investment rules abroad, and it tightens the protection of intellectual property. It is important to note that, in this context, NAFTA represents an achievement the United States has had more difficulty realizing in a broader multilateral context.[12]

Although NAFTA opens Canada and the United States, it accomplishes its most significant liberalizations in Mexico. NAFTA expands Canadian and U.S. companies' ability to establish or purchase a business in Mexico and facilitates their ability to sell out if they want to leave. NAFTA also loosens previous restrictions on expanding operations for such companies, and it removes restrictions on profit remittances to foreign countries. Local content requirements are eliminated, although NAFTA-wide content rules will exist. Through NAFTA, Mexico extends temporary work permits to service providers from Canada and the United States and removes licensing and performance criteria.

Despite much liberalization, however, NAFTA initially retains protectionist elements, some of which persist indefinitely. NAFTA protects sensitive sectors—such as agriculture, minerals, banking, textiles, and apparel—by stretching out the phase-in time. This protection is temporary.

But as the synthesis of liberal and protectionist pressures, NAFTA contains other types of protection that are not only permanent but also raise trade barriers above pre-NAFTA levels.[13] In a number of sectors—notably automobiles, textiles, and apparel—NAFTA imposes North American content rules, some of which appear to increase pro-

[11] *For example, before NAFTA, U.S. automobile manufacturing subsidiaries in Mexico had to export at least two units of value added for every unit imported. NAFTA eliminates such requirements.*

[12] *At the 1982 GATT ministerial meetings, the United States attempted to launch a new round of negotiations focused on these issues but was defeated. These same issues have been addressed at the subsequent Uruguay Round but, from the perspective of U.S. goals, with limited success.*

[13] *See Morici (1993), Johnson (1993), Barry and Siwicki (1993), and USITC (1993).*

tectionism. Under the Canada–United States Free Trade Agreement, for example, automobiles could be imported duty-free if they contain at least 50 percent Canadian–U.S. inputs. For auto imports to receive NAFTA benefits, the North American rule is 62.5 percent. For textiles or apparel to qualify for "free" trade under NAFTA, all components—starting with the yarn or fiber—must be made in North America.[14] This NAFTA covenant extends and strengthens the protectionism inherent in the broader, multinational Multifiber Agreement.

Nevertheless, NAFTA unequivocally liberalizes trade in North America. It is also noteworthy that the agreement offers only minimal opportunities for trade diversion, in which efficient non-NAFTA producers would be squeezed out of trade with NAFTA countries simply because the treaty reduces trade barriers among North American countries only (Primo Braga 1992). However, the increase and permanence of domestic content requirements signals that protectionism has found a place even in the North American Free Trade Agreement.

Trade-related effects on the United States: Output and employment

Although the most famous description of NAFTA's ultimate effect is the "sucking sound" of jobs going to Mexico, more serious attempts to gauge the effects of NAFTA exist.[15] These studies do not all take the same approach, and their results vary considerably.[16] Some studies involve static models. A few are dynamic. Some accommodate capital flows, but most do not. Others are historically based. However, the majority involve computable general equilibrium (CGE) models, are highly disaggregated, and find positive but small welfare and output effects for the United States.[17] After all, Mexico begins NAFTA as a small market relative to Canada, and the United States has already signed a free trade agreement with Canada.

Most CGE models assume either rigid wages and flexible employment, or flexible wages and full employment. The rigid wage models typically find small percentage gains in employment, while the flexible wage models find gains in wages. Both types, of course, show similar income gains. In a model that a little more fully accommodated characteristics of the real world—with somewhat flexible wages and less than full employment—the effect of NAFTA will probably include less employment growth than the rigid wage models, less wage growth than the full employment models, and about the same income growth as either.

Static CGE models without capital flows typically show the smallest effects, regardless of NAFTA country.[18] Some static CGE models incorporate increasing returns to scale.[19] As output grows, income grows even more. Even these show only small percentage gains in real income, real wages, and employment. The empirical importance of scale effects, as opposed to pure improvements in efficiency from greater competition, remains small (Tybout and Westbrook 1993 and Backus, Kehoe, and Kehoe 1991). Dynamic models portend larger effects on growth, especially for Mexico (Young and Romero 1991).

Two other branches of the literature are less consistently sanguine about the effects of NAFTA for the United States. The first branch, whose foremost representative is Leamer (1991), offers arguments based upon factor price equalization through trade and migration. These arguments are consistent

[14] *Exceptions include silk and flax (Barry and Siwicki 1993, 138).*

[15] *Space precludes a systematic treatment of these studies, but more comprehensive overviews than what we offer can be found in Lustig et al. (1992) and Globerman and Walker (1993). We have provided in the references an extensive list of studies that address NAFTA's effects on the United States.*

[16] *Although most of these studies were performed before the text of the agreement was finalized, we agree with Weintraub's (1993a) conclusion that nothing in the agreement would substantially change the results of these studies.*

[17] *These include Hinojosa-Ojeda and Robinson (1991), Hinojosa-Ojeda and McCleery (1990), KMPG Peat Marwick (1991), Brown, Deardorff, and Stern (1991a and 1991b), and USITC (1991). See Brown (1992) for a survey.*

[18] *See Brown (1992, 35–37), Hinojosa-Ojeda and Robinson (1991 and 1992), Hinojosa-Ojeda and McLeery (1990), and Roland-Holst, Reinert, and Shiells (1992).*

[19] *Roland-Holst, Reinert and Shiells (1992) and Brown, Deardorff, and Stern (1991a and 1991b).*

with the Stolper–Samuelson theorem that opening trade will decrease low-skilled wages in the United States because Mexican exports are intensive in low-skilled labor. However, Hinojosa-Ojeda and Robinson (1992) argue that the relative sizes of the U.S. and Mexican economies and NAFTA's long phase-in period mean the Stolper–Samuelson effect will be small; it would be swamped by the other, growth-enhancing effects of the agreement.

A second branch of the literature regards NAFTA from an historical point of view. Although some of this literature (Hufbauer and Schott 1992; Weintraub 1991) offers conclusions consistent with those of the CGE models, a series of briefing papers from the Economic Policy Institute (EPI) does not.[20] These papers derive historical parallels, abstracting from individual industry experiences, to hypothesize about the U.S. macroeconomy. Their narratives typically assume, for example, that what has happened in the automobile industry is an accurate guide to what will happen in the U.S. macroeconomy. For the Economic Policy Institute, the results of NAFTA for the United States are negative.

An interesting artifact of the EPI papers is their argument that "free trade" over the last fifteen years has, despite U.S. employment growth during that time, been a principal cause of the movement of jobs to other countries. In fact, there is evidence to suggest that U.S. policy has been increasingly protectionist over this period, although the Economic Policy Institute authors may view the increase as too small to budge the United States from free trade. However, the authors do not discuss the empirical evidence presented by Gruben (1990a and 1990b) and Truett and Truett (1993) that jobs that went to Mexico during this period would otherwise have gone to Asia. The Economic Policy Institute authors not only dismiss the United States' increases in employment and declining unemployment rates during this period, but they do not deal with the claim that jobs move to other sectors in an economy rather than to other countries.[21]

Nevertheless, arguments that picture massive movement of jobs to Mexico seemed to carry weight even after NAFTA passed. Moreover, the idea that foreign countries are taking jobs to which Americans are entitled continues to be a focal point of the larger U.S. protectionist movement.

Sectoral effects

If most studies of the impacts of NAFTA suggest overall expansion for the United States, why did protectionists turn so much of their energy against the agreement? In a broad sense, the answer is that the opening of trade shifts resources and production from less competitive to more competitive sectors, inspiring renewed political efforts from the less competitive. According to traditional Hecksher–Ohlin–Samuelson analysis, the sectors that will prove most competitive (and therefore gain most from trade) will use the nation's relatively more abundant factors of production relatively intensely.

Compared with most other countries, and certainly with Mexico, the United States has a relative abundance of physical capital (plants and equipment) and human capital (an educated work force). Industries that require relatively low-skilled labor or low levels of physical capital to make tradeable products will find much to dislike about NAFTA unless they can establish operations abroad.

Nevertheless, displacement of workers across sectors of the U.S. economy will likely be small in both absolute and relative terms, because the sizes of the economies and work forces of Mexico and Canada are small compared with those of the United States. Most studies suggest that U.S. sectors that lose include sugar refining, fruits and vegetables, apparel, and household appliances. Sectors that gain include chemicals, instruments, machinery and equipment, motor vehicles, instruments, and rubber and plastic. Neither the output and employment gains of the winners nor the losses of the losers appear to be large, according to most models, but losers appear to find cold comfort in such estimates.

Finally, an important reason reactive antiliberalization lobbying is typically strong—regardless of the nature and benefits of the particular trade

[20] *See, for example, Faux and Lee (1992) and Blecker and Spriggs (1992).*

[21] *For more detailed critiques of the Economic Policy Institute papers, see Hinojosa-Ojeda and Robinson (1992), Weintraub (1992), and Gruben (1993).*

initiative—is that it is easier for those who are likely to lose their jobs to know they are likely to lose them than for those who may gain jobs to know they would be the ones to gain them. After all, even if new jobs are created, someone else might get them.

Services

As technological advances have increased opportunities for U.S. trade in services, the United States has intensified efforts to negotiate openings for it. Services trade negotiations demand a different focus from goods trade negotiations because service trade protectionism differs from goods trade protectionism. Domestic services providers cannot be protected by tariffs and quotas. Imports of services are not easily detected by customs officers at international borders.

Instead, services trade protectionism emphasizes laws that focus not on the product, but on the producer. Some countries outlaw foreign-owned service companies of various types and prohibit foreigners from acquiring controlling ownership in existing domestic companies. Some bestow monopolies on particular domestically owned producers. Some regulate foreign-owned companies differently than domestically owned firms of the same type. As a final complicating factor, one country's regulations for its service firms will typically differ substantially from another country's regulations for its service firms. The ideal solution is to harmonize regulations.

In many cases, NAFTA's services openings reflect less protectionism than the clauses for goods trade. NAFTA does not create full harmonization, but it moves in that direction and it particularly opens Mexico. NAFTA provides for national treatment, which means that a U.S. firm in Mexico is supposed to be treated regulatorily as if it were a Mexican firm. National treatment under NAFTA is not de jure, but de facto. That is, foreign firms may still face different regulatory treatment than domestic firms, as long as the effect of the regulations is equivalent and does not place foreign firms at a competitive disadvantage.

The services that received the most attention in the NAFTA negotiations were finance, insurance, transportation, and telecommunications.

NAFTA does not change requirements for foreign banks' entry into the United States and Canada, but the opening of the Mexican financial system is among the agreement's most significant achievements. Because the standards for entry are tied to the size of the Mexican banking system, they will change over time. But in the context of the size of the Mexican banking system at the end of 1992, entry into Mexican banking by Canadian or U.S. firms would require the commitment of reserves and paid-up capital of between $20 million and $60 million. Requirements will likely go up, not down, in the future. Although this means U.S. banks may be slow to move into Mexico, their presence there will grow over time. Requirements for entry into brokerage, bonding, insurance, leasing, and warehousing are more liberal. One would expect more initial entry by U.S. specialists in these areas.[22]

Transportation services on both sides of the border stand to gain under NAFTA, especially in trucking. Eighty-two percent of freight in Mexico is moved by road (USITC 1991, 4–48). Mexican exports of trucking services to the United States will likely increase if border and inland infrastructure improvements continue to take place in Mexico.[23] The longer term implications of NAFTA include increases in U.S. trucking services as well, but NAFTA will have only a marginal effect on other transport services. Other transport services will be affected only marginally by NAFTA (USITC 1991, 4–48). Clearly, trade in goods is transport-service intensive and infrastructure development on both sides of the border will be needed.

Trade in telecommunications and related goods trade received a large boost from the privatization of Telefonos Mexicanos (TELMEX) in 1991. Basic telephone services are the main service traded between the United States and Mexico, with the United States being a net importer of these services. NAFTA should shift the balance of trade in favor of the United States in the basic services,

[22] *For an extensive treatment, see Gruben, Welch, and Gunther (1993).*

[23] *In recent years a large share of infrastructure investment in Mexico has been private. Toll roads are a particularly commonplace example.*

especially in related equipment, as the investment in this sector increases over the coming years.

Intellectual property rights protection

Because of the importance of intellectual property protection in facilitating services trade and foreign investment, NAFTA's coverage of this topic has received much notice. Moreover, it has been argued that the provisions on patent and trade secrets offer the highest standards of protection achieved in any trade negotiations (USITC 1993, 3–7).

One of the most significant provisions of this section, and in NAFTA in general, is the codification of national treatment. This codification ensures that the intellectual property of firms from any two NAFTA countries will be legally treated in the third as if it had been developed in that country.

A second important general provision is the strict limitation on the use of compulsory patent licenses, which has affected Canada's process for patenting pharmaceutical patents.

A third important detail obligates the signatory countries to enforce intellectual property rights against infringement not only internally but also at the border. That is, NAFTA includes sanctions not only against the production of pirated products, but against their importation.

Despite these and other provisions, including those for judicial procedures to ensure enforcement, Canada, Mexico and the United States all offered strong intellectual property protection before NAFTA was signed. Indeed, NAFTA implies few significant changes in U.S. intellectual property laws and will not much change Mexican patent law, which was upgraded in 1991 to a level consistent with those of major industrial countries.[24]

One of the most important aspects of intellectual property protection in NAFTA is that it helps ensure the durability of Mexico's new intellectual property law. Still, differences between the Mexican, Canadian, and U.S. legal systems offer opportunities for complications.

Under Mexican law, precedent does not automatically control the implementation of law. Protection in most cases is extended to a firm or individual only if that party successfully litigates the issue. The costs of gaining effective protection are accordingly high. Under NAFTA, the effects of such divergences in legal systems may be reduced, but there is clearly much to suggest that NAFTA's service-related clauses do not constitute harmonization.[25]

Migration

From the United States' point of view, a raison d'être of NAFTA is the hope that it will ease pressures on migration from Mexico to the United States. Because trade openings tend to equalize real wages across countries (factor price equalization), the argument goes, incentives for cross-border migration would decline.

Results reported by the United States International Trade Commission (1991) from partial equilibrium models show such convergence, most of it from an increase in Mexican wages. Hinojosa-Ojeda and McCleery (1990) model migration, trade, and capital flows with dual labor markets (high wage and low wage) in both the United States and Mexico, and add a maquiladora sector. According to their results, NAFTA would decrease migration because wages would rise more in Mexico than in the United States.

The picture clouds when one incorporates Mexico's large and inefficient *ejido* (or collective farm) system, as do Levy and Van Wijnbergen (1992) and Hinojosa-Ojeda and Robinson (1991). Under NAFTA, U.S. exports of maize and soybeans could not only offer competition to the ejidos but could accordingly induce worker dislocation in this system. The result could involve increases in migration to the United States.

The Mexican government's recent restructuring of the ejido system, to facilitate infrastructure and capital goods investment through partnership or leasing agreements with business organizations, may allow more competitive operations. However, these same steps may induce some ejido farmers

[24] *Mexico, however, must amend its law to reverse the burden of proving infringement of process patents, placing the burden on the accused infringer.*

[25] *See Alejandro Junco (1991). Under Mexican law, precedent is extended when favorable decisions are delivered in five consecutive cases.*

to take their money and leave, even if the extra income might also motivate them to remain in Mexico instead of migrating to the United States.

The long phase-in period of NAFTA for agricultural products typical of the ejidos, however, gives the farmers more time to make their deals and their decisions before competition intensifies, which will smooth and slow the transition.

Beyond NAFTA: The environmental, workplace, and adjustment agreements

In the parallel agreements and even in NAFTA itself, the United States has pushed its agenda in directions that blur the demarcation between trade issues and public policy actions that only indirectly affect trade. In some contexts, it is easy to see why this blurring could occur. For example, if a country's zealous health standards on food imports could be seen as impediments to trade, why not differences in environmental protection and workplace standards?

Workplace conditions and environmental protection have been pushed to the forefront of the NAFTA debate. During the vote on fast-track status, President Bush committed to trilateral side or parallel negotiations on the harmonization of environmental policies, labor laws, and worker retraining or other adjustment assistance. Upon assuming office, President Clinton voiced his support for NAFTA with the caveat that the side agreements be completed before the treaty would be submitted to Congress for ratification.

Environmental concerns

All three NAFTA countries consider environmental problems to be important policy issues. Mexico's pollution problems, especially those in Mexico City and along the border, have become acute. In the NAFTA negotiations, a principal environmental concern has been that loose regulations constitute an unfair trade advantage. The question, then, is what are the likely environmental effects of NAFTA?

Two common fears about NAFTA are that the consequent economic growth in all three countries, but especially Mexico, will cause more pollution and that Mexico will be a haven for polluting U.S. manufacturers. Plausible as conjectures, these issues seem less compelling in light of recent research and current Mexican policy efforts.

Grossman and Krueger (1991) statistically model the interaction of trade, growth, and pollution in a cross-section of countries. They show that, when per capita income in a country is very low, higher output (and therefore income) generates higher pollution. But beyond a per capita income of $5,000,[26] pollution control becomes a normal good. Further increases in income cause pollution to fall.[27] Since Mexico's per capita income in 1988 was almost exactly $5,000, Grossman and Krueger's results suggest that the increased growth in Mexico due to NAFTA will improve Mexico's environment.

The evidence likewise suggests that laxer environmental regulation was not significant in motivating U.S. firms to relocate in Mexico. Environmental abatement costs in the United States are low, averaging between 1 percent to 2.5 percent of total production costs (Grossman and Krueger 1991, 25, and Cropper and Oates 1992). Moreover, firms that relocated typically had lower abatement costs in the United States before moving than those that did not relocate (Grossman and Krueger 1991, 27). This correlation may be spurious. But if one considers that heavy industry typically both pollutes more and requires higher job skills than light industry, and that firms that move to Mexico go there for lower-skilled workers, this result seems less implausible.

Nevertheless, some U.S. firms have indeed moved to Mexico because of stepped-up environmental regulation in the United States. Some California furniture companies, for example, moved operations to Mexico after California tightened regulations on paint coatings and solvents (Grossman and Krueger 1991, 22). However, the number was small relative to the total number of furniture producers in the state of California, let alone in the rest of the United States.

[26] *Expressed in 1985 U.S. dollars.*

[27] *Other studies reviewed by Globerman (1993) find a similar relationship.*

Some of the environmental concern stems from two inaccurate assumptions. The first is that Mexico continues to be lax in environmental regulation; the second is that NAFTA does not address environmental issues. The first assumption ignores improvements in Mexican policy over the last decade. Under the Salinas administration, the budget for the Mexican environmental authority (SEDESOL) grew from $4 million in 1989 to about $68 million in 1992 (Hufbauer and Schott 1993, 92). In 1993, Mexican government expenditures on environmental protection approached 1 percent of gross domestic product. The powers of Mexico's environmental authority have been expanded significantly since its creation, and the government is preparing market-based environmental reforms such as auctioning pollution rights. Moreover, the Mexican government has lately closed a number of polluting factories, most notably PEMEX's Azcapotzalco refinery in Mexico City.

But not all environmental concerns are mistaken. Geographically, an important environmental issue is the U.S.–Mexico border, and with good reason. Environmental damage there is significant. Raw sewage and water problems date at least to the 1950s. With the development of the border's maquiladora plants, beginning in the 1960s, dumping of toxic chemicals has aggravated the dangers. However, the United States and Mexico have already entered into side agreements for the border. The most comprehensive is the so-called Mexican–U.S. Integrated Border Protection Plan, for which the United States has pledged $379 million and Mexico has pledged $466 million (Globerman 1993, 296–97). Some find the effort lacking, but the program is an important step.

NAFTA does address the environment directly. Signatories must commit to a half-dozen additional international environmental agreements, and each country agrees not to lower existing environmental protection, or health and safety standards, to attract investment. Individual countries may maintain stricter standards than NAFTA requires.

However, some of NAFTA's significant environmental components are not in NAFTA proper but in the parallel agreements. Under the dispute settlement mechanism outlined in the parallel agreement on the environment, individuals or groups in one country can file complaints about environmental abuses in another, and representatives from each of the disputing countries will be chosen and will attempt to negotiate a settlement. If this fails, the complaint goes to a panel of experts for adjudication. A country that receives an unfavorable ruling has sixty days to enforce it. If the country fails to enforce, it may incur up to a $20 million fine. If the government of the country fails to pay, the complaining country may level tariffs against the products of the offending industry.

It should be noted that NAFTA-related agreements differ from most trade pacts in that disputes in the latter are almost always required to involve directly trade-related issues. By contrast, according to the office of the U.S. Trade Representative,[28] "any environmental or natural resource issue may be addressed" by NAFTA's environmental commission. The parallel agreement offers more than the usual scope of international adjudication opportunities to those concerned about environmental abuses.

Workplace conditions

U.S. labor organizations typically express concerns that Mexico's workplace regulations—including those related to safety and health, child labor, benefits, and hours of work—will send U.S. firms over the border. However, Mexico's workplace regulations are strong and, in some cases, tighter than those in the United States. Mexican law establishes 14 as the minimum working age. Persons ages 14 through 16 may not work more than six hours per day and are prohibited from working in occupations designated as hazardous. Minors may not work more than a forty-eight-hour week (Weintraub 1993a, 28–29). Mexican regulations on maternity leave, sick leave, and profit sharing are more generous to workers than those of the United States.

Nevertheless, legitimate concerns about enforcement remain. It is these concerns that inspired the parallel negotiations and agreement on labor. The labor commission, which serves as

[28] *This quotation appears in Sheehan (1993).*

the review body for the parallel agreement, has a broad mandate that covers worker benefits, industrial relations, and occupational health and safety.

In NAFTA's labor-related dispute settlement framework, the form of litigation itself offers particularly strong opportunities for protectionist pressures. For example, the dispute settlement process will operate under the influence of a joint advisory committee, along with evaluation committees of experts made up of representatives from labor-supported organizations. This commission is supposed to provide expert advice on regulatory matters and will have a high degree of access to commission proceedings.

Adjustment assistance and retraining

Programs that assist and smooth relocation of displaced workers are fully consistent with the application of the theory of economic welfare to trade policy. But the creation of such programs does not depend on a trade agreement between the United States and other nations. However, not only will fiscal budgetary problems make such programs difficult to pass in the future, but similar promises of adjustment assistance were made during the 1980s but not honored.[29]

Conroy and Glasmeier (1992–93) argue that current policies are inadequately designed and constructed to account for the dislocations that NAFTA will bring. They suggest that the European Economic Community's approaches to funding special adjustment programs be followed. We concur that worker dislocations deserve attention. However, Sala-i-Martin and Sachs (1991) observe that the United States, at least, ensures regions against income shocks. They show that a $1 reduction in a U.S. region's per capita personal income triggers a 34 cent decrease in federal taxes and a 6 cent increase in federal transfers. In the EEC, they note, the comparable tax reduction is only about half a cent. They argue that "the current European tax system has a long way to go before it reaches the 34 cents of the U.S. federal government."

Whither NAFTA?

NAFTA and the parallel negotiations have been described as a move toward greater economic integration, and many of their traits are consistent with it. They offer a framework for harmonizing much more than just directly trade-related rules and regulation.

But in the context of recent U.S. trade history, they may also be seen as part of a dialectical progression in which shifting protectionist and free-trade interests compete to synthesize a new trade policy. U.S. manufacturers' protectionist lobbying diminishes, as labor union pressures increase. Seeking new allies to replace some once-protectionist industrialists, labor organizations associate themselves with environmentalists. Meanwhile, some U.S. manufacturers profess to find new forms of unfairness among their competitors abroad and so do some agriculturalists. In Mexico, policy innovations and new interindustry and intergroup conflicts materialize.

As a result of these conflicting and changing pressures, NAFTA liberalizes trade on some fronts, particularly in services, and increases protectionism on others, as in the rules for increased domestic content in autos and textiles.

Despite NAFTA's soft spots, the agreement offers an important opportunity not only to increase trade in North America, but to signal U.S. commitment to free trade in general—and to free trade in particular with respect to intellectual property rights protection, trade in services, and trade-related aspects of foreign investment.

However, in NAFTA such increased integration as occurs is largely a side effect of a dialectic that continues. At the same time the Clinton administration pushed to open the United States to freer trade with Mexico and Canada, it entered into new agreements with Mexico to restrict the effects of openings in some types of agriculturally related trade, including sugar and fruit juice. Meanwhile, while NAFTA opens trade, NAFTA-related agreements open broader opportunities for protectionists to reduce trade through appeals against environmental and workplace enforcement in areas with little direct effect on the international exchange of goods and services. NAFTA opens trade, but the dialectic goes on.

[29] *Smith (1990) and Faux and Lee (1992).*

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Solving the Mystery of the Disappearing January Blip in State Employment Data

Interest in improving preliminary data to reduce the size of revisions has grown in recent years.[1] Data revisions can affect empirical research, current analysis, and forecasting. For example, policymakers at the local, state, and national levels must estimate tax revenue for the coming year to enact an appropriate budget. Data that show a strong economy but are later revised to show a much weaker economy can send officials scrambling to find alternative revenue sources and/or spending cuts.

While a multitude of timely economic data exists at the national level, data at the regional level are more limited. The time series most widely used to measure and monitor regional economic performance is nonfarm payroll employment.[2] These data are produced monthly by state agencies, in cooperation with the U.S. Department of Labor, Bureau of Labor Statistics (BLS), under the Current Employment Statistics (CES) program.

This article describes a new two-step procedure that eliminates the January blip often found in state employment data. This procedure, first proposed in Berger and Phillips (1993), was recently recognized by the BLS, which now uses it to produce the agency's seasonally adjusted state employment data published at the one-digit Standard Industrial Classification (SIC) level. This article should help analysts who seek to use state employment data at a finer level of detail than the one-digit SIC level or who wish to seasonally adjust metropolitan area employment data from the BLS' establishment survey.

Each year, with the release of January data, the source agencies revise state employment data from April of two years earlier to March of the previous year to adjust the data to conform to population estimates. The average annual revision in the CES data for most states is quite small.[3] (See the last column of Table 1.) However, revisions in the *monthly* changes often are quite large. The largest revision across states is in the change from December to January. As shown in the table, all states except California show a large negative revision in the December to January change, with an average revision of –0.6 percentage points across all states. The January revision is the biggest of the monthly revisions in thirty-eight states and is larger than the average revision across months in every state.

The large revision in January means that the most current estimate of the December–January change (that is—the estimate that has not yet been subject to annual revision) is typically smaller than the historical change. In the seasonally adjusted data, this is manifested as a large jump in the most current January estimate. This large spike is usually followed by a series of three to five monthly declines. The January jump is revised

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[1] For example see Neumark and Wascher (1991), Mankiw and Shapiro (1986), and Koenig and Emery (1994, 1991).

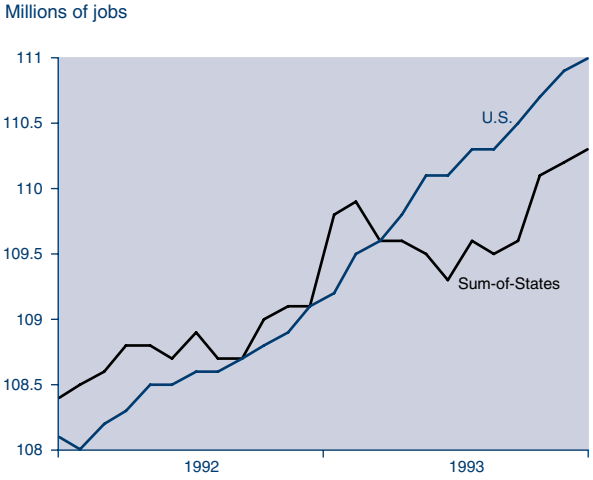
[2] For brevity's sake, we will subsequently use the simpler expression "employment" to refer to the more precise "nonfarm payroll employment."

[3] For convenience, we refer to Washington, D.C., as a state.

away when the annual revision takes place, and then another spike typically occurs with the release of new preliminary data for the subsequent January.

The January spike is apparent in Figure 1, which plots the sum of seasonally adjusted state data. As the chart shows, the view of the economy from the perspective of the state data is quite different from that of the national data. In mid-1993, many state analysts may have thought that their economies had experienced an earlier surge but had since begun to turn down, yet the national series showed continued gradual improvement.

Figure 1
U.S. and Sum-of-State Employment (Before Adjustment)



NOTE: Chart reflects data that was released in early February 1994.
SOURCE OF PRIMARY DATA: Bureau of Labor Statistics.

In searching for the cause of the large revisions to the monthly estimates, we find that the seasonal pattern is different in the two sources of data the BLS uses to construct the regional CES employment series. The bulk of the CES employment series is based on reports filed by firms covered by unemployment insurance, while the most recent ten to twenty-two months of data are based on a survey of business establishments. The difference in seasonal patterns in the two data sources is the reason for the recurring January jump found in many of the seasonally adjusted state CES series.[4]

For each state, we test whether the seasonal pattern is different in the two sources. We find that the seasonal patterns in the two sources were statistically different in forty-six states. We then calculate appropriate seasonal factors for each of these states. After applying the appropriate seasonal factors to the two separate parts of the CES series, employment in the forty-six states appears much smoother and does not exhibit a January jump. Figure 2 shows that after using this two-step seasonal adjustment approach, the sum-of-state data shows a much smoother pattern[5] and the direction of change is much more similar to the employment data published for the nation.[6]

[4] *The reason the UI and ES series have different seasonal patterns is not known with any degree of certainty. For the purposes of this study, the reason does not matter. However, we can speculate that the seasonal decline in employment that occurs each January is underestimated by the Establishment Survey because of its well-known underestimation of employment growth due to new firm formation. To the extent that the holiday season pattern of increasing fourth-quarter employment followed by a significant January decline reflects firms' coming into and going out of existence, then the pattern would be accurately captured in the UI data but not in the ES data.*

Additionally, if there is under-sampling of small firms in the ES that is not corrected with sampling weights and a disproportionate amount of the holiday season "action" happens in small firms, then the ES will again underestimate the true seasonal pattern.

[5] *A well-known measure of smoothness is the sum of squares of the first difference of a series. That is:*

$$S = \sum_{t=2}^{t} (x_t - x_{t-1})^2$$

where X_t is the series in question. The smaller is S, the smoother is the series X_t. According to this measure, the uncorrected sum-of-state series is more than three times as volatile as the corrected version.

[6] *Much was made of the divergence of sum-of-state and national employment. Some analysts had gone so far as to suggest that a downward revision in the national data was looming because of the slower growth in the sum-of-state data. Our investigation shows that such a conclusion is unwarranted. Preliminary national data is a much better predictor of final national data than is sum-of-state data. This may be due primarily to the more aggressive bias adjustment done at the national level that at the state level. This adjustment is done to account for the Establishment Survey's well-known underestimation of employment growth due to failure to account for new firm formation.*

Sources of and procedures for CES

State CES data are constructed by state employment agencies in cooperation with the regional offices of the BLS.[7] The state employment data are constructed independently of the national data.[8]

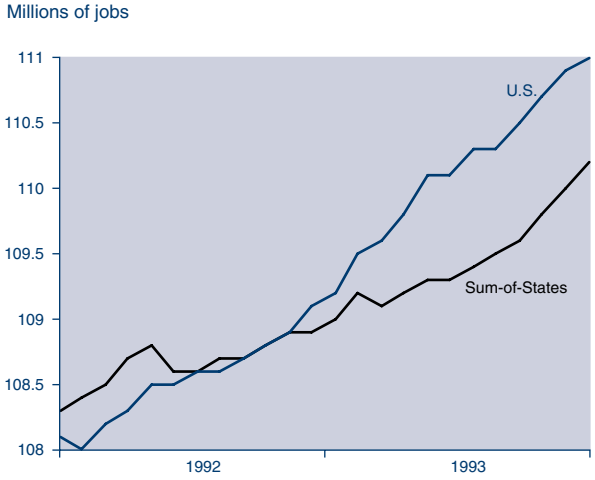
The Establishment Survey (ES) is a monthly survey of more than 370,000 business establishments nationwide that provides employment data for the nation, states, and major metropolitan areas. The national sample represents about 37 percent of all nonagricultural employees. Survey coverage varies by region. For example, 25,500 Texas firms are surveyed, representing about 40 percent of Texas employment.

A more comprehensive picture of the employment situation is given by tax reports filed by employers who are covered under state unemployment insurance (UI) laws. At the national level, about 99 percent of employees on private nonagricultural payrolls are covered by this series. The UI data are reported quarterly, with data for each month, and are available only after a lag considerably longer than that for ES data.

The regional and national offices of the BLS annually adjust the CES data to the UI data. This process is called benchmarking. The regional offices benchmark independently of the national office. The state benchmarks are released in late February or early March and cover the period from April two years prior, to March of the previous year. Then, the series is extended forward using employment growth as measured by the ES. The national series is also benchmarked to the UI data and is released in early June.

Each month, when CES data for a new month are released, data for the previous month are revised—creating a second estimate for that month. In this study, we concentrate on the revision from the second estimate of the CES to the benchmarked value. For the purposes of this article, we are not concerned with the revision from the first to the second estimate. When the benchmark data are released, in addition to revising the post-benchmark data to the new benchmark level, the BLS can also revise the monthly changes in the post-benchmark data to correct errors or incorporate new information. We ignore this intermediate revision, which we call the third estimate of the CES data.[9]

Figure 2
U.S. and Sum-of-State Employment (After Adjustment)



NOTE: Chart reflects data that was released in early February 1994.
SOURCE OF PRIMARY DATA: Bureau of Labor Statistics.

National and regional employment estimates are all benchmarked to the UI data but through different procedures. The national data incorporate only the March-to-March change in the UI data. To estimate the intervening months, the BLS uses a procedure known as the "wedge-back" to spread the March revision evenly across the previous twelve months. This procedure ignores information in the individual monthly changes in the UI data over the period and retains the seasonal

[7] *For more information about the Current Employment Statistics program, see U.S. Department of Labor (1992).*

[8] *State data are released near the end of the month following the reporting month. The amount of industry detail varies by state, with the larger states generally having greater information. For the purposes of this article, we are concerned only with total employment for each state. For Texas, however, we have applied the procedure described here at the finest level of industry detail possible. See Berger and Phillips (1993).*

[9] *As defined here, January, February, and March have no third estimate but instead go directly from the second estimate to the benchmarked value. December, on the other hand, gets a combined second and third estimate when the January data are released.*

Table 1
Average Percentage Point Revision to Nonfarm Payroll Employment Monthly Percent Changes, 1985–1992

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Avg.
Alabama	–.223	.153	.471	.184	.154	.219	.093	.190	.189	–.123	.014	.014	.111
Alaska	–.763	.443	.370	.194	.475	.375	.005	.284	–.254	–.638	–.112	.459	.070
Arizona	–.642	.246	.078	.330	.231	.159	–.557	.296	.218	–.002	.004	.194	.046
Arkansas	–.573	.060	.338	.206	.268	.296	–.366	.175	–.083	–.248	.055	–.026	.009
California	.158	.053	.034	.076	.092	.084	–.039	.026	.002	.038	–.018	.004	.043
Colorado	–.761	.105	.327	.093	.110	.628	–.011	.190	–.079	–.484	–.034	.384	.039
Connecticut	–.547	.055	.164	.094	.181	–.117	–.254	.026	.269	–.105	–.067	.019	–.023
Delaware	–.750	.153	.262	.618	.390	.554	–.220	.352	.075	–.642	.114	–.046	.072
D.C.	–.207	.130	.006	–.147	.266	.021	–.111	.252	.225	–.375	.005	–.006	.005
Florida	–.681	.213	.336	–.185	.221	.192	–.478	.308	.074	–.171	.033	.191	.004
Georgia	–.721	.191	.373	.150	.332	.292	–.129	.248	.241	–.349	.143	.133	.075
Hawaii	–.333	.213	.351	–.112	.285	.206	–.032	.264	.028	.158	.278	.194	.125
Idaho	–.876	.355	.471	.360	.304	.441	.278	.094	–.166	–.482	–.158	.074	.058
Illinois	–.513	–.001	.221	.135	.170	.315	–.152	.094	–.022	–.260	.094	.213	.025
Indiana	–.246	–.112	.226	.080	.064	.110	–.514	.235	.186	–.180	–.083	.058	–.015
Iowa	–.955	.051	.315	.685	.349	.339	–.303	.340	.250	–.518	.064	.320	.078
Kansas	–.567	.002	.213	.363	.186	.107	–.936	.096	.728	–.193	–.005	.230	.019
Kentucky	–.840	–.063	.411	.800	.331	–.244	–.214	.506	.426	–.331	.105	.039	.077
Louisiana	–.862	.092	.355	.714	.614	.055	–.747	.387	.052	–.106	–.053	.188	.057
Maine	–.630	.080	.219	.584	.378	.541	–.186	–.087	.104	.066	–.241	–.061	.064
Maryland	–.638	.160	.317	.260	.284	.430	–.248	.450	.136	–.617	.167	.225	.077
Massachusetts	–.636	.050	.083	.047	.178	.349	–.098	.046	.049	–.357	.058	.149	–.007
Michigan	–.367	.121	.196	.227	.151	.237	.229	.115	.098	.039	.036	.051	.095
Minnesota	–.232	.074	.128	.032	.037	.021	–.171	–.012	–.086	–.070	.132	.174	.002
Mississippi	–.373	.000	.274	.243	.347	.305	–.187	.260	.049	–.249	.045	.021	.061
Missouri	–1.004	.646	.207	.284	.245	.382	–.111	.253	.100	–.226	.022	.119	.077
Montana	–.805	.035	.225	.964	.468	.330	.280	.373	.364	–.545	–.220	–.129	.112
Nebraska	–.540	.018	.269	.228	.204	.431	.295	–.512	–.184	–.493	–.090	.229	–.012
Nevada	–.626	.380	.439	.374	.468	.098	–.264	.399	.163	–.359	.079	–.047	.092
New Hampshire	–.554	.073	.131	.158	.389	.106	.059	–.100	–.275	–.539	.298	.491	.020

(Continued on the next page)

Table 1—*Continued*

Average Percentage Point Revision to Nonfarm Payroll Employment Monthly Percent Changes, 1985–1992

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Avg.
New Jersey	–.231	.142	.137	–.132	.050	.037	.022	–.041	–.089	–.217	.013	–.961	–.106
New Mexico	–.284	–.094	.260	.202	.213	.170	–.059	.431	.002	–.265	–.508	.563	.053
New York	–.554	.052	.120	–.121	.143	.052	–.257	.253	.096	–.124	.094	.014	–.019
North Carolina	–.321	.147	.344	.193	.328	.170	.104	.346	–.269	–.111	–.040	.011	.075
North Dakota	–.587	.082	.060	.438	.322	.002	–.112	.027	–.161	–.131	–.081	.064	–.006
Ohio	–.347	.063	.091	.013	.088	.049	.037	.008	–.033	–.049	–.157	.155	–.007
Oklahoma	–.122	–.179	.335	–.012	.154	–.435	–1.819	1.525	1.338	–.486	.014	.057	.031
Oregon	–.867	.130	.141	.292	.134	.183	.170	.122	.062	–.231	.136	–.007	.022
Pennsylvania	–.329	.138	–.051	.341	.043	–.028	.064	.067	.049	–.247	.051	.099	.016
Rhode Island	–1.076	–.101	.062	.396	.376	.296	–.078	.067	.538	.049	.212	–.020	.060
South Carolina	–.467	.065	.209	.235	.175	.129	–.379	.117	–.062	–.154	.136	.045	.004
South Dakota	–.361	.206	.059	.359	.332	.113	.365	.067	.006	–.276	–.015	.397	.104
Tennessee	–.825	.134	.455	.217	.291	.315	–.289	.402	.214	–.335	.137	.168	.074
Texas	–.631	.163	.359	.207	.190	.163	–.425	.205	.272	–.289	.022	.081	.027
Utah	–.310	.096	.080	.060	.126	.132	–.209	.145	–.146	–.044	.190	.010	.011
Vermont	–1.218	.348	.471	.795	.261	.691	.337	.192	–.568	.069	–.402	.240	.101
Virginia	–.669	.131	.250	.052	.282	.124	–.157	.333	.057	–.299	.051	.089	.020
Washington	–.586	.115	.247	.166	.280	.215	.163	.059	.228	–.482	.165	.084	.054
West Virginia	–.612	–.034	.276	.247	.223	.209	.207	.176	.067	–.558	–.177	.330	.029
Wisconsin	–.721	–.026	.324	.380	.175	.253	–.032	.014	–.031	–.021	.054	.059	.036
Wyoming	–.564	–.146	.086	.102	.568	–.116	.403	.403	.008	–.996	–.220	.369	–.009
Average	**–.568**	**.106**	**.238**	**.245**	**.253**	**.196**	**–.138**	**.205**	**.087**	**–.266**	**.007**	**.112**	**.040**

pattern inherent in the ES. This explains why the problem we are investigating does not appear in the national data.

The method the regional offices of the BLS employ to benchmark state-level data differs from that used at the national level. The regional offices of the BLS incorporate *all* the monthly changes in the UI data. Therefore, if the seasonal pattern in the ES is different from that in the UI data, the state-level CES employment series will exhibit two different seasonal patterns. The bulk of the CES series will have the UI seasonal pattern, but the post-benchmarked part of the data (the most current ten to twenty-two months of data) will have the ES seasonal pattern. While the standard seasonal adjustment methods can account for gradually changing seasonal patterns, they cannot handle abrupt changes such as this. Seasonally adjusting CES employment in the normal fashion is clearly inappropriate in such a case.

Comparing the seasonal patterns of source data

To compare the seasonal patterns of the two source series in the CES, we first need to construct a continuous time series of ES data. Since the published CES data always embody a combination of UI- and ES-related data, no continuous time series of the ES is readily available. For each state, we construct a continuous ES series based on the reported changes in the second estimate of non-benchmarked CES data. With data from the BLS publication, *State and Metropolitan Area Employment and Unemployment*, from January 1984 to December 1992, we construct a series for each state in the following manner:

$$(1) \qquad RTSEMP_T = ESEMP_0 \times \prod_{t=1}^{T} \left(\frac{ESEMP_t}{ESEMP_{t-1}} \right)$$

where $RTSEMP_T$ is the calculated real-time establishment survey series and $ESEMP_t$ is the originally reported second estimate of employment in period t. The time subscript t is equal to zero in January 1984 and continues to December 1992. Because each year a new benchmark is introduced with January data, the first and second estimates for December are split into two different benchmark periods. In calculating this formula, we use the first December estimate in the November–December calculation and the second December estimate (following the new benchmark) is used in the December/January calculation.[10] Use of this procedure avoids level shifts in the calculated establishment survey series.

We then test whether seasonal patterns in the ES data are statistically different from the UI-based data for each state. We do this by regressing each state employment series on individual month dummies, using data from January 1984 to June 1992.[11] For each state, we first test whether the estimated seasonal dummies are jointly different in the ES data than in the UI data. The joint F-test results, shown in the first column of Table 2, show that, at the 10 percent level of significance, the two parts of the CES series have different seasonal patterns in thirty-one states.[12]

Because there is a particularly pronounced January blip in many states, we also perform a separate test on the January seasonal dummy for each state. The t-test results (column 3 of Table 2) show that the January dummy coefficient differs in the two parts of the CES series in forty-five states. Of the twenty states not significantly different according to the F-test, fifteen were significantly different using the January test. We conclude that in forty-six states there is a break in the seasonal pattern in the CES employment series.

For each of the forty-six states whose seasonal patterns differ in the UI-based and the ES-based employment data, we estimate seasonal factors appropriate to each series. The seasonal adjustment procedure used is the X-11 method developed by the U.S. Department of Commerce.

In seasonally adjusting the CES data for each state, we apply the UI-based seasonal factors

[10] *Note that for the purpose of estimating ES-appropriate seasonal factors, the month chosen as the base in constructing the ES series does not matter.*

[11] *Officially, state data were benchmarked through March 1992. However, state employment agencies incorporated enough information from the second quarter UI data during the benchmarking process that the data were effectively benchmarked through June 1992.*

[12] *We accept a somewhat greater risk of type 1 error than is customary. When the series have the same seasonal pattern, estimating separate seasonal factors introduces no bias.*

Table 2

Tests of Seasonal Differences in Unemployment Insurance and Establishment Data

State	Joint F-Statistic	Prob.	T-Statistic for Jan.	Prob.
Alabama	.8280	.6214	1.771	.0783*
Alaska	1.4654	.1410	2.455	.0151*
Arizona	2.8827	.0012*	3.828	.0002*
Arkansas	3.7064	.0001*	4.122	.0001*
California	.1098	.9999	.720	.4722
Colorado	6.4058	.0001*	5.666	.0001*
Connecticut	.9642	.4849	2.436	.0158*
Delaware	1.2236	.2699	2.205	.0288*
D.C.	.4223	.9533	.735	.4632
Florida	4.0937	.0001*	4.486	.0001*
Georgia	4.0516	.0001*	5.199	.0001*
Hawaii	1.1478	.3247	2.529	.0123*
Idaho	3.7633	.0001*	4.592	.0001*
Illinois	1.9335	.0332*	3.322	.0011*
Indiana	2.3309	.0085*	1.674	.0959*
Iowa	10.6669	.0001*	7.706	.0001*
Kansas	5.1580	.0001*	3.247	.0014*
Kentucky	5.9665	.0001*	5.138	.0001*
Louisiana	7.3530	.0001*	5.457	.0001*
Maine	1.4090	.1653	2.488	.0138*
Maryland	3.4942	.0001*	3.752	.0002*
Massachusetts	1.9041	.0365*	3.497	.0006*
Michigan	.5090	.9071	2.109	.0363*
Minnesota	1.0525	.4033	2.039	.0429*
Mississippi	2.7054	.0022*	3.159	.0019*
Missouri	1.7046	.0690*	3.593	.0004*
Montana	3.5030	.0001*	3.722	.0003*
Nebraska	2.3072	.0093*	2.425	.0163*
Nevada	3.5063	.0001*	3.949	.0001*
New Hampshire	.9648	.4843	1.773	.0779*
New Jersey	.8923	.5560	.439	.6613
New Mexico	.8428	.6063	1.041	.2992
New York	2.0672	.0212*	3.685	.0003*
North Carolina	2.7003	.0023*	3.004	.0030*
North Dakota	2.9058	.0011*	4.008	.0001*
Ohio	.8947	.5535	2.519	.0126*
Oklahoma	16.1270	.0001*	.735	.4631
Oregon	3.7308	.0001*	5.841	.0001*
Pennsylvania	1.4357	.1534	2.463	.0147*
Rhode Island	2.3830	.0071*	4.438	.0001*
South Carolina	1.4285	.1565	2.578	.0107*
South Dakota	1.2590	.2468	2.209	.0284*
Tennessee	4.8664	.0001*	5.572	.0001*
Texas	4.6157	.0001*	4.815	.0001*
Utah	.8942	.5540	2.025	.0444*
Vermont	3.5814	.0001*	4.564	.0001*
Virginia	3.1769	.0004*	4.596	.0001*
Washington	3.6974	.0001*	4.551	.0001*
West Virginia	.7725	.6781	1.844	.0669*
Wisconsin	6.4269	.0001*	7.125	.0001*
Wyoming	.9086	.5396	1.237	.2178

* Significant at 10% level.

through June 1992.[13] We seasonally adjust the data since June 1992 using changes in the ES seasonal factors from July forward to extend the UI seasonal factors from June. We use this method to avoid a level shift in the seasonal factors, in a manner similar to the construction of the real-time ES data described previously.

More formally, we linked the ES seasonal factors to the UI seasonal factors using the following simple procedure:

$$(2) \qquad ADSFES_t = SFUI_{692} \times \left(\frac{SFES_t}{SFES_{692}} \right)$$

where $ADSFES_t$ is the adjusted seasonal factor for the ES-based part of the CES series, $SFES_t$ is the seasonal factor derived from the real-time ES employment series, and $SFUI_{692}$ is the seasonal factor for the UI-based employment data at the end of the (unofficial) benchmark period in June 1992. The time subscript t is equal to zero in June 1992 and continues to December 1993.

For most states and regions, the pattern of growth since mid-1992 is less volatile using the two-step seasonal adjustment method than using the standard seasonal adjustment procedure. Table 3 demonstrates the impact of the two-step seasonal adjustment method on first-quarter 1993 growth by state. As the table shows, the seasonal adjustment method used can have a large impact on measured employment growth. On a sum-of-state basis, the two-step method shows employment growth at a 0.85-percent annual rate in the first quarter 1993, versus 2.59 percent using the standard seasonal adjustment method.

Summary and conclusions

In recent years, economists have begun to take a closer look at revisions to macroeconomic time series. This research highlights how revisions may substantially reduce the usefulness of preliminary data for empirical analysis and forecasting. Data revisions at the regional level can be particularly important, since the sources of data are limited and analysts often must rely on just a few key indicators.

This study assesses the annual revisions in a key regional indicator—nonfarm payroll employment from the Current Employment Statistics program produced by the Bureau of Labor Statistics. We find that the month-to-month revisions for many states have been quite large. In particular, the December to January employment change consistently has been revised to show a larger decline than originally reported. This pattern of error results in a January blip in the seasonally adjusted employment data in the current year.

For forty-one states, we find that there is a different seasonal pattern in the two sources of data the BLS uses to create the CES series. For these states, we use a two-step seasonal adjustment technique that first estimates separate seasonal factors for the two different data sources. The two series of seasonal factors are then linked together and used to seasonally adjust the CES series. This two-step method creates a much smoother employment series and eliminates the January blip often found in the state employment data. The procedure developed here should reduce the size of the annual revisions to seasonally adjusted state CES data and should provide a more useful indicator of current economic conditions in most states.

The procedure we describe in this article is now in use at the BLS to adjust state employment data at the one-digit SIC level.[14] Analysts can use the two-step seasonal adjustment procedure presented here to seasonally adjust metropolitan area employment and state data at a finer level of industry detail. In Berger and Phillips (1993), we describe the effects of the procedure on selected industries in Texas. For Texas and Louisiana, we have applied this procedure at the finest level of detail possible. The two-step adjusted data for these two states is available to the public at the one-digit level by accessing the Dallas Fed computer-accessed bulletin board—Fed Flash—at (214) 922-5199. More detailed data are available by contacting the authors.

[13] *See note 12.*

[14] *The BLS data, however, differ slightly from ours because the BLS did not link the ES seasonal factors to the UI seasonal factors. Instead, the BLS simply substituted the calculated ES seasonal factors for the UI seasonal factors in the ES portion of the data. Because the BLS did not link adjust the seasonal factors, its data for some states have a level shift in July 1993.*

Table 3

Seasonally Adjusted First Quarter 1993
Nonfarm Payroll Employment Growth Rates (Annualized)

State	Not Berger/Phillips Unadjusted	Berger/Phillips Adjusted
Alabama	3.08	2.02
Alaska	8.04	7.67
Arizona	2.02	.18
Arkansas	3.92	2.95
California	–.98	–.98*
Colorado	2.82	1.59
Connecticut	–.87	-2.95
Delaware	2.33	-2.44
District of Columbia	.12	.12*
Florida	4.05	2.35
Georgia	4.32	1.57
Hawaii	.32	–.47
Idaho	4.27	2.38
Illinois	1.63	-1.62
Indiana	2.95	2.25
Iowa	2.64	–.11
Kansas	5.11	2.76
Kentucky	3.66	–.05
Louisiana	3.77	.50
Maine	2.61	-2.00
Maryland	1.26	–.72
Massachusetts	2.03	–.18
Michigan	4.78	2.85
Minnesota	2.85	2.44
Mississippi	4.35	2.66
Missouri	4.18	2.36
Montana	6.13	2.63
Nebraska	.11	-1.32
Nevada	5.48	4.22
New Hampshire	5.96	4.90
New Jersey	–.66	–.66*
New Mexico	2.92	2.92*
New York	1.36	–1.27
North Carolina	5.05	2.85
North Dakota	5.20	3.64
Ohio	2.55	2.32
Oklahoma	4.87	3.50
Oregon	4.10	.62
Pennsylvania	1.71	.68
Rhode Island	5.91	–.38
South Carolina	2.97	2.43
South Dakota	5.19	5.54
Tennessee	3.36	.70
Texas	5.52	2.23
Utah	6.16	6.02
Vermont	4.27	–1.01
Virginia	2.03	.60
Washington	3.11	.62
West Virginia	3.13	2.03
Wisconsin	4.44	1.18
Wyoming	1.11	1.11*
Sum-of-States	2.59	.85

*States for which test results indicated no significant seasonal differences in the UI and ES data were not adjusted.

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