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## Zvi Griliches's Contributions to Economic Measurement

Jack E. Triplett

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Zvi Griliches was without doubt the foremost economist of his day in contributions to economic measurement. In this memorial, I will of course discuss his research contributions. But his contributions went beyond his own research, formidable as it was, for perhaps what Zvi really did most for economic measurement was to exhort and preach and encourage.

A great example of his preaching (or, perhaps, the word *exhortation* is better) was his American Economic Association Presidential Address (Griliches 1994, 2): “[O]ur understanding of what is happening in our economy . . . is constrained by the extent and quality of the available data.” That obviously must be right—and rightly should have been obvious. But it was not something that ranked very high among economists’ concerns at the time.

In a similar vein, Griliches suggested that some unresolved empirical problems in economics were simply measurement problems: “I will argue that data and measurement difficulties may in fact be a major source of this failure. This point will be made not to provide us with an alibi, but rather to temper the pretentiousness of some of our pronouncements and to urge us toward the more mundane task of observation and measurement” (Griliches 1994, 10). Again, this was obviously right, but economists were not acting as if it were right, so someone needed to say it, and say it emphatically. How many economists would take the occasion of a presidential address to preach to the profession that it was neglecting, in its neglect of economic measurement issues, its own interest?

Earlier, however, he argued (in the best Chicago tradition) that neglect

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of data was actually in econometricians' own interest: "If the data were perfect, collected from well designed randomized experiments, there would be hardly room for a separate field of econometrics. Given that it is the 'badness' of the data that provides us with our living, perhaps it is not all that surprising that we have shown little interest in improving it" (Griliches 1986, 1466).

With respect to economic data, economists are still largely hunter-gatherers, working with what Zvi often called "found" data. He urged them to move toward the next stage of civilization, where they would be more like artisan farmers. "[W]e lead a somewhat remote existence from the underlying facts we are trying to explain. We did not observe them directly . . . In this we differ quite a bit from other sciences . . . such as archeology, astrophysics, biology, or even psychology where the 'facts' tend to be recorded by the professionals themselves" (Griliches 1986, 1467).

When Zvi was planning the econometrics curriculum for the Moscow New Economic School,<sup>1</sup> he set up the course sequence so that the first course segment focussed on data.<sup>2</sup> He said that he had no hope for changing the standard U.S. curriculum, but the New School gave him an opportunity to correct the imbalance in U.S. teaching. He believed that measurement was important to economics, and he acted on that belief.

### 19.1 His Motivation: Zvi's MFP Mismeasurement Hypothesis

Some economists do research in economic measurement because they believe that measurement is an important part of economics or because they want to develop information for testing economic theories and for explaining the economy. Griliches was motivated by this; there is no doubt about it. But he got into economic measurement because of a particular hypothesis.

In his early papers on agricultural productivity (see, for example, Griliches 1963), he developed the hypothesis that the growth in multifactor productivity (MFP) was just measurement error.<sup>3</sup> Recall that MFP, the "residual," had been discovered as the major source of economic growth in the mid-1950s (see Zvi's own summary of this and earlier work in Griliches 1996). This discovery led to a huge debate about what MFP was measuring—the contribution of technological change, the contribution of increases in knowledge and similar explanations were paramount. Abromovitz's (1956, 11) famous characterization of the residual as the "measure of

1. On the school, see its tenth anniversary at: <http://www.nes.ru/english/index.htm>.

2. Daniel Hamermesh taught that first course. A product was a study of hedonic indexes for computers, done jointly with the students—see Hamermesh et al. (1994).

3. Apparently he conceived this idea much earlier. Nerlove (2001) records that Griliches's teacher, Theodore Schultz, published a paper containing the same mismeasurement hypothesis in 1956, but Schultz, in a footnote, gave credit for the idea to his student Griliches.

our ignorance” was consistent with the search by economists such as Denison (1962) for missing variables or missing explanations.<sup>4</sup>

Griliches pointed in another direction: “[C]hanges in output are attributable to changes in the quantities and *qualities* of inputs, and to economies of scale. Conventionally derived residual measures of productivity growth are viewed not as measures of technical change but rather as the result of errors in the measurement” (Griliches 1963, 271).

For agriculture, Griliches corrected the data (a) for mismeasurement of output and (especially) inputs, (b) for error introduced by inappropriately using input shares as measures of output elasticities, and (c) for the failure of others to allow for economies of scale. Without these measurement corrections, measured MFP in agriculture increased 48 percent between 1940 and 1960. With the corrections, it declined 6 percent. This is a powerful role for economic measurement.

He later moved away from the strongest form of the MFP mismeasurement hypothesis, at least to a degree. After Jorgenson and Griliches's great debate with Denison,<sup>5</sup> a debate that marks a watershed in productivity research, Griliches conceded that his side might have “explained too much,” mainly because Denison showed that their capacity utilization adjustment was faulty. But he did not abandon the mismeasurement hypothesis entirely. He remarked at a still later date that “all of the issues raised in this first [published] paper . . . continued to preoccupy me in the years to come” (Griliches 1988, 6). Moreover, the hypothesis motivated part of Jorgenson's subsequent productivity research, as he has noted. Griliches was always greatly interested in evidence of bias in price indexes (and the corollary opposite bias in output and input quantity measures) because he thought that on-balance price measurement error enlarge, inappropriately, measured MFP.

Griliches did not live to take part in the debate about the sources of the MFP acceleration that began in the United States in 1995. (It began in 1995, but it was only discovered with the release of the Bureau of Economic

4. Abramovitz's full sentence reads: “Since we know little about the causes of productivity increase, the indicated importance of this element may be taken to be some sort of measure of our ignorance about the causes of economic growth in the United States and some sort of indication about where we should concentrate our attention” (Abramovitz 1956, 11). Denison, in his day, was as active in criticizing economic measurement as was Griliches. See his massive study of the sources of economic growth (Denison 1962). He was quite cognizant that the measured residual might incorporate measurement error and strove mightily to construct a residual that was stripped of measurement error, to the extent possible. However, Denison, unlike Griliches, was content to describe the reconstructed residual as the contribution of the advance in knowledge and always objected to proposed improvements in measurement that he regarded as improperly incorporating knowledge advances into the inputs, particularly into the capital input. This principle motivated, in part, Denison's famous mistrust of hedonic indexes.

5. The original article was Jorgenson and Griliches (1967). The debate includes Denison (1969), reprinted in Denison (1972), Jorgenson and Griliches (1972), and the series of exchanges published in the same issue of the *Survey of Current Business*.

Analysis's [BEA's] benchmark revision of gross domestic product [GDP] in late 1998.) Barry Bosworth and I have shown (Triplett and Bosworth 2006; Bosworth and Triplett, chap. 14 in this volume; Triplett and Bosworth 2004) that three-quarters of recent U.S. MFP growth took place in services industries and that almost all of the acceleration in MFP growth after 1995 was in services industries (because they had very low MFP growth in the years before 1995). For most of these services industries (medical care being an exception), *differential* changes in the measurement of output are not the sources of the acceleration because the BEA has extended most of the measurement improvements that it has made back to years before 1995. But have we missed crucial inputs? Or have we mismeasured them? These are the questions that Griliches's legacy suggests that we should ask. Measures of managerial input come to mind, but labor, capital, and intermediate inputs are each one suspect in one industry or another (Triplett and Bosworth 2004).

## 19.2 Impact on Productivity Research

Griliches stayed with measurement issues and measurement questions because he judged the topic important. This was characteristic of his career: he had sound judgment on what was important, and he was not distracted by fads in economics that come and go and occupy so much attention before eventually fading away without making real contributions. His penetrating judgments were displayed in formal and informal discussions, often dazzling his contemporaries. It was not uncommon to see him come into a conference, pick up a copy of a paper, thumb apparently idly through it, then stop on precisely the point of weakness, and fire a question at the astonished author. At NBER productivity workshops, he was notorious in finding a flaw in a paper very early in the author's presentation—on occasion, in the first sentence! The sound critical judgment that he showed of others' work kept him on track in his own.

The NBER Productivity Program and the NBER Summer Institute started in 1979. Under Griliches's leadership, those productivity sessions from the very beginning included papers and discussions on economic measurement issues. As time went on, they also included some of the more interesting (and, truth be told, some of the not-so-interesting) work being done within statistical agencies.

Inclusion of economic measurement within the topic of productivity is now so well accepted by productivity researchers in North America that they may not always appreciate how much of this is distinctively a contribution of Griliches, plus others, including Jorgenson in collaboration with Griliches and with others, Denison (1962, 1967, 1974), and Kuznets (see his Nobel Prize address [1971] and Milton Friedman's recollections of Kuznets's role in starting the Conference on Research in Income and

Wealth in Berndt and Triplett [1990]). Measurement is not always a part of the productivity research tradition elsewhere. I recall attending a productivity conference on another continent where all the economists used data they obtained from international agencies to study differences between, perhaps, economic growth in Indonesia and Afghanistan. They asked many penetrating questions about the econometrics of the estimates and developed many ingenious (and no doubt fanciful) explanations for the differences in international growth and productivity rates they had estimated. But they gave literally no attention at all to the possibility that the differences in their estimates across countries reflected little more than the differing and generally inadequate measures of the economic variables that those countries' statistical agencies produced. They "found," in Griliches's word, data on international agencies' Web pages, and that was all they needed to know. The Griliches-influenced North American tradition is a better one.

### 19.3 Hedonic Indexes—Labor and Product Markets

Among measurement topics to which Griliches contributed, his name is most prominently linked to hedonic indexes. Griliches (1961) was not the first to estimate hedonic price indexes.<sup>6</sup> However, his work established the topic's modern standing—see Lipsey's (1990) historical appraisal on this point. Hedonic indexes were dead before Griliches breathed life into them.

Griliches worked on two kinds of hedonic functions. He was best known for what we normally call a hedonic function and a hedonic price index, where the hedonic function looks like (using computers as an example) the following:

$$\ln p_{it} = a_0 + a_1 \ln \text{speed}_{it} + a_2 \ln \text{memory}_{it} + \dots + e_{it}$$

This hedonic function says that the price of computer  $i$  at time  $t$  ( $p_{it}$ ) depends on its speed (megahertz or MHz), amount of memory capacity, and other performance variables. An example of Zvi's work on computers is Berndt and Griliches (1993). Griliches's best known hedonic function—for automobiles—has the prices of automobile models on the left-hand-side, in logarithms and, on the right-hand side, the characteristics weight, horsepower, size, and other measures.

A human capital wage regressions is another hedonic function. In this formulation, wages are a function of the human capital variables education, experience, and so forth:

$$\ln w_{jt} = b_0 + b_1 \ln \text{education}_{jt} + b_2 \ln \text{experience}_{jt} + \dots + u_{jt}$$

6. Court (1939) and Stone (1956) preceded him. See, for additional historical discussion, Berndt (1991, chapter 4) and Triplett (2006, "Historical Note," appendix A to chapter III).

Not atypically for the computer and human capital literatures, both of the preceding hedonic functions appear in the double log-functional form, but this is mainly for illustration.<sup>7</sup> Griliches's automobile hedonic functions were semilog, which became controversial for reasons discussed in the following.

Both price and wage hedonic functions are motivated by the *hedonic hypothesis*, which holds that complex transactions are aggregations (*bundles* is the word commonly used in this literature) of quantities of lower order variables that we call *characteristics*. Computer or automobile characteristics are the true variables that enter consumers demand functions and that define the outputs of producers. Education, experience, and so forth are the variables in which workers invest and that employers find productive and for which they are willing to pay. The characteristics have their own prices, often termed *implicit prices*. The hedonic function unbundles the observed transaction into the variables on which economic agents' behaviors are based, and it is also used to estimate the implicit prices for these variables.

Actually, there are many hedonic functions in economics, and for many of them the purpose is not to estimate price indexes. Colwell and Dilmore (1999) identify Haas (1922) as estimating an early hedonic function for agricultural land, and the vegetables study by Waugh (1928) is frequently cited; both wanted to help farmers, not to measure farm prices. The hedonic literature on housing is enormous (Sheppard [1999] provides a review), and the literature on the structure of interest rates can also be thought of as hedonic (with characteristics such as liquidity and risk). Because the hedonic hypothesis covers many kinds of complex transactions, it might not be very interesting to discover who first estimated a hedonic function (without necessarily calling it that), but it was undoubtedly an agricultural economist.

Griliches's contributions to hedonic functions (using the term narrowly, as we usually do, to apply to price hedonic functions) were very different from his contributions to human capital or hedonic wage functions. For a number of reasons, some a bit obscure, these two literatures did not develop in a parallel fashion. Griliches's own work proceeded in parallel with the way the two literatures developed. Of course, the purposes of the two literatures diverged, to an extent, because product market hedonic functions have often been used to estimate hedonic price indexes; human capital wage regressions have not been used to estimate wage indexes. But divergence in purpose does not explain the divergence in research directions.

7. Triplett (2006, chapter V) contains a review of functional forms used for hedonic studies on computers and other products.

### 19.3.1 Hedonic Functions: The Variables

With respect to the wage hedonic function, Griliches's major interest was in measuring the variables in the function, particularly the education variable. Fairly early on, economists questioned the interpretation that years of education measured worker productivity. Alternative hypotheses included screening and the contention that education was merely a proxy for ability.

Griliches's response to these objections was to test the efficacy of the education measure in a production function (Griliches 1970; Griliches and Mason 1972). In his own work, he rejected the screening interpretation (though this has been readdressed by others) and the proxy interpretation. He did not deny that the schooling measure could be improved as a measure of labor quality ("such studies tend to treat years of school as the conceptually right and error-free measure of educational attainment, a position that is hardly tenable in light of the extreme diversity of the educational system in the United States" [Griliches and Mason 1972, S97]). He concluded, however, that alternative interpretations of the education variable, or contentions that education was not a measure of labor quality, were rejected by his production function analysis.

The research principle illustrated here is straightforward: just because education is associated with wage differentials, that does not mean it is necessarily a proper measure of labor quality. The measurement hypotheses needed scientific testing, and that was the approach he followed.

Zvi knew that the weight of cars, used as a characteristic in his automobile paper, is not a good measure of the transportation services they provide and discussed better measures in his paper with Ohta (Ohta and Griliches 1976). Probably he knew that megahertz (MHz) was not a very good measure of computer performance, and certainly if he didn't, Cole (1993) raised it to his attention in discussing his first computer paper (Berndt and Griliches 1993). But in contrast to his work on hedonic wage regressions, he spent minimal research effort on asking questions about the variables that appeared in hedonic functions.

There were probably two reasons for that. In the first place, there are long precedents in economics for the idea that education improves labor quality. The idea of human capital goes back to Adam Smith. When Zvi was working on this topic, labor economists were on their way to executing several hundred, if not more, human capital wage regressions. With that abundant background on the supply side, Zvi was actually one of the few to tackle the demand side of the problem. My point is that economists understood where the education and experience variables came from and how they were produced. No mystery outside of economics inhibited understanding of the forces that produced the characteristics that determined la-

bor quality nor the reasons these characteristics commanded prices in labor markets. After all, most research economists are in the business of producing human capital.

On the other hand, there was absolutely no economic precedent for analyzing the variables in product hedonic functions. We understand a great deal about the determinants of the supply of human capital. What are the determinants of the parallel decision on the part of a computer producer to supply more computer characteristics—to put more speed or memory into a computer? This is in the realm of engineering, or so it has sometimes been thought by economists, and certainly not in the traditional territory of economics—quite unlike the situation in human capital where the behavior of suppliers of it was well rooted in the field of labor economics. Another way of putting it is that analysis of the variables in hedonic functions was harder, and because understanding their supply required engineering knowledge, economists had little relative advantage.

Moreover, almost the only available work on the demand for heterogeneous products and their characteristics was the demand model of Lancaster (1971), which most economists regarded, with considerable justification, as nonoperational. Thus, the questions economists asked about hedonic functions were different from the ones they asked about hedonic wage equations. More recent work has shifted the balance, to an extent—for example, Berry, Levinsohn, and Pakes (1996) developed an operational demand for characteristics model, and Stavins (1995) looked at gaps in characteristics space among personal computer models. Significantly, these contributors included Griliches's students.

### 19.3.2 Hedonic Functions: Functional Form

There is another half to this story, which is both a consequence of the different approaches to measuring the variables that emerged in the two literatures and a contributor to their divergent developments. That half story concerns the question of functional form.

Because labor economists understood a great deal about the supply of human capital (and a little bit about the demand for it), none of them proposed that the hedonic wage equation should be derived from a production function, that is, from the employers' *demand functions* for human capital. Labor economists comprehended, even before Rosen's (1974) article on hedonic functions, that the wage hedonic function was some sort of combination of demand and supply relations (though the exact relation was not well understood). Others of them possibly did not think much about where the functional form came from; it was simply an empirical construct (which Rosen showed theoretically was the right way to think about it). Rosen showed that the hedonic function is a double envelope to *sets of* demand functions on one side and *sets of* supply functions on the other side. As with any envelope, the form of the hedonic function there-

fore depends on distributions of buyers and sellers, but not on the shapes of buyers' demand or utility functions or on sellers' supply or production functions.

In contrast to labor market hedonic functions, functional form became a big issue for product market hedonic functions. Economic critics demanded that the functional form for hedonic functions be derived from behavioral functions on the demand side. In consumer demand analysis of the 1960s and 1970s, functional form was, if not everything, nearly everything. Great ingenuity was expended on deriving sets of demand functions that could be estimated and that were also consistent with utility theory (the culmination of this work from the 1960s and 1970s is Deaton and Muellbauer 1980). Confronted with an estimated hedonic function on goods (automobiles or computers), consumer demand theorists contended that hedonic researchers should have derived the form of the hedonic function from the form of consumers' utility functions, by analogy with their own work on empirical consumer demand functions. "Measurement without theory" was a devastating epithet in its day (the phrase comes from Koopmans 1947, 161), and the epithet was hurled at Griliches' work and that of others, mostly in private conversations and in seminars and so forth.

Why was this question asked the way it was, and why was it not asked of hedonic wage equations? Probably, it was merely economists' familiarity with established paradigms and their reluctance to break out of them.

Economists were familiar with the economic paradigm that determines workers' decisions to improve labor quality and had no experience whatever with manufacturers' decisions to improve product quality.<sup>8</sup> On the other hand, consumer demand theorists were familiar with the paradigm that governs functional forms of demand equations and had no familiarity at all with a paradigm that determines the variables *in* consumer demand functions (what, after all, is the "good" for which demand is estimated?).

Into this gap, theorists stepped in with "proofs" that the semilog hedonic functional form (in Griliches's automobile hedonic functions) was not theoretically valid. Before Rosen (1974), that is, theorists thought that hedonic functions were some form of demand function, which should be derived from the utility function. Under this mistaken notion, then, it was easy to show semilog and linear hedonic functions corresponded to not very good utility function specifications.<sup>9</sup>

Zvi dismissed this. In a not very convincing defense, he contended that the hedonic index was just an attempt to improve price indexes empirically,

8. I do not imply that no literature on this existed. But mostly, it followed the comparatively unfruitful approach: "Let  $z$  be a measure of quality," which the researcher then inserted into some behavioral function, where it is manipulated for some purpose. Whether "quality" is validly represented as a scalar (rather than by a vector of characteristics) is not usually considered.

9. Some are still engaged in this exercise (Diewert 2003).

that the theorists were loading more on to the hedonic function than the empirical economists had in mind.

Despite the theoretical proofs to the contrary, the Consumer Price Index (CPI) 'exists' and is even of some use. It is thus of some value to attempt to improve it even if perfection is unattainable. . . . [The hedonic approach] did not pretend to dispose of the question of whether various observed differentials are demand or supply determined . . . and whether the resulting indexes have an unambiguous welfare interpretation. Its goals were modest. (Ohta and Griliches 1976, 326)

It was not a very compelling argument.

Possibly because he was attacked so vigorously by some theorists, he remained curiously uninterested in the theory of hedonic functions, even in the contribution of Rosen (1974). He seemed not impressed by the new theory. I never understood this. Rosen (1974) should have ended the pointless discussions about functional form that Zvi knew were pointless, and so one might have thought that he would have welcomed Rosen's contribution.<sup>10</sup> Pakes (2004) suggests that the issue lay in industrial organization: Rosen's model is a competitive one, but the world of differentiated products—to which the hedonic function applies—is a world with gaps in the product space and likely market power to producers who succeed in innovating to fill in a gap. That view must have been true in later years (Pakes was a Griliches student and colleague), but I never heard Zvi use this line of reasoning in the 1970s and early 1980s, and it does not figure in his last assessment of hedonic indexes (Griliches 1990).

It remains, nevertheless, curious that dissimilar sets of questions were asked by the profession about two research topics that are themselves quite parallel. For hedonic wage equations, the questions concerned predominantly the validity of the variables in the functions. The functional form was simply established empirically, without, so far as I am aware, the criticism that the functional form should be derived from the employer's objective function. I believe that the labor economists were right in their research priorities.

On the other hand, for hedonic functions on goods, most of the economic critics' questions concerned the derivation of the hedonic functional form, and few of them concerned the variables in the hedonic functions. In my view, that was the wrong orientation. Although Rosen's (1974) straightening out the theory of hedonic functions was extremely salutary for re-directing research, regrettably research on (product) hedonic functions

10. Somewhat later, however, he outlined the essence of Rosen's result and endorsed it as his own view: "What is being estimated is actually the locus of intersections of the demand curves of different consumers with varying tastes and the supply functions of different producers with possibly varying technologies of production . . . [T]heoretical derivations at the individual level [cannot] really provide substantive constraints on the estimation of such 'market' relations" (Griliches 1990, 189).

tailed off in the late 1970s and early 1980s, after the Rosen article was published (hedonic research accelerated in analysis of labor markets and real estate markets, where significantly these quasi-theoretic disputes over functional form were mostly ignored). It is also my view that economists who estimated hedonic functions would have benefited from following the lead of the labor economists and should have asked much more penetrating questions about the variables they inserted into those hedonic functions. With respect to the variables, many researchers took a kitchen sink approach, which no doubt had something to do with the decline of interest in hedonic research. Indeed, in that interval, hedonic function research became “not respectable” in certain quarters, as Griliches once observed in an NBER seminar.

#### 19.4 Other Topics

Griliches's contributions to economic measurement are also defined by what did not interest him. Except for his famous 1961 paper on hedonic indexes (Griliches 1961), which he himself emphasized he did not invent, he never made major contributions to measurement techniques as *we usually think of them*.

- He took little interest in index number formulas, despite the tremendous interest in that topic in the 1960s and early 1970s. Diewert (1976) put an end to that as a research question, in my view, by showing that a small number of index numbers (he called them *superlative*) not only provided good approximations to the unknown true economic indexes but also gave results that corresponded closely, numerically. Hausman (2003) remarked that index number formulas are second-order problems in measuring price indexes, which I suspect summarized Zvi's views. Once chain superlative index numbers were adopted (included among the measurement recommendations in Jorgenson and Griliches 1967), the index number formula didn't matter much.<sup>11</sup>
- Griliches also made no real contributions to national accounts, unlike Simon Kuznets, an economist whom Zvi venerated. Of the economists of his generation, Griliches was probably Kuznets's closest intellectual descendant. He wrote one paper (Griliches 1973) in which he says he is showing how research and development (R&D) can be integrated into national accounts, but I doubt that any national accountant would recognize it as such. Griliches probably felt that the accounting parts of national accounts were no longer interesting problems, ex-

11. Jorgenson and Griliches in 1967 used a Divisia index justification for chain Törnqvist indexes. This Divisia justification was superseded by Diewert's superior theoretical justification, which provided Törnqvist (and Fisher) indexes a grounding in production theory. On the relation between Divisia and economic approaches, see Hulten (1973).

cepting insofar as the national accountants' focus on the accounting side was getting in the way of making improvements to the measurement.<sup>12</sup> It is still true that national accounting conventions sometimes hold back improvements in economic measurements (an example is the measurement conventions for insurance and banking in national accounts—see Triplett and Bosworth [2004] chapters 6 and 7).

- Neither did he jump into the conceptual questions surrounding measuring the output of hard-to-measure industries, with one or two exceptions. However, his “Introduction” to Griliches (1992) is a marvelous and concise statement of the general problem of measuring services output. He pointed out that in many of these industries the transaction—what was being provided and what was being charged for—was not quite clear, and when it was, the transactions were so heterogeneous that they presented enormous quality change problems. Some substantial progress on services data has been made in the interim, but Griliches’s statement of the problem remains relevant and insightful.
- Though he contributed to econometrics and was early in his career thought of as an econometrician, he did not remain primarily a contributor to econometric techniques. Nerlove (2001, F424) judged that, “[A]lthough statistical and econometric methodology were not at the central core of his contribution, he was an empirical economist in the best sense, perhaps the best his generation of economists produced. This is econometrics in its best sense, which blends theory and application.” That does not mean that he did not keep up with advances in econometric methods or that he was unsympathetic to techniques themselves. An example is his thorough and sympathetic review of techniques for filtering signal from noisy data in his *Handbook of Econometrics* chapter (Griliches 1986), his work on unobserved variables (Griliches and Chamberlain 1975), and his contributions to panel data methods (Hausman, Hall, and Griliches 1984). This was another case where he made one of his sound judgments about what really mattered: “It is the preparation skill of the econometric chef that catches the professional eye, not the quality of the raw materials in the meal, or the effort that went into procuring them” (Griliches 1994, 14). Griliches’s strength as an empirical economist and his use of that strength in behalf of improving economic measurement is his lasting contribution to the field.
- Finally, though he must have believed in “measurement *with* theory,” he took little interest in some of the attempts to theorize about economic measurement that took place during his career. The theorists’

12. As an example of the latter, see the exchange between Griliches (1964), Jaszi (1964), and Gilbert (1961).

writing about hedonic functions provides an example, which I discussed in a previous section. There were exceptions, including the paper by Treadway (1969), which he, almost alone, recognized and promoted.

## 19.5 The Statistical Agencies

What was Griliches's influence on statistical agencies? His focus on measurement should have made him a welcome ally, but for most of his career, it was not the case.

One cannot consider this topic without also considering the climate. Attitudes within statistical agencies were for the most part not cordial toward academics. I can still recall a blistering rebuke once administered in an open meeting by one of my Bureau of Labor Statistics (BLS) superiors: "No one wants that except your academic friends!" (The issue was, incredibly, services statistics.) The BLS response to the Stigler committee report (Price Statistics Review Committee 1961) in the hearings held on the report is another example. Agency officials were polite, but dismissed as impractical both the committee's recommendations on cost-of-living indexes and on hedonic indexes (Reinsdorf and Triplett 2004). So ideas from outside seldom received any immediate hearing from inside statistical agencies, and Zvi's ideas were no more cordially received than those of other academics.

Over time, of course, the personnel changed. With changes in personnel, the intellectual climate also became more receptive, partly because the agencies hired more technically trained staff (particularly in economics), and the younger staff were closer to Zvi's tradition and were molded in part by his influence, which was enormous and extensive.<sup>13</sup> But it took a long time. Fraumeni (2000) lists the hedonic indexes that now contribute to U.S. national accounts and counts them as part of Griliches's legacy, but most of them were produced in the last decade of his life. Slow acceptance was not confined to the United States. Even as late as 1999, the year of Griliches's death, there was little interest in hedonic indexes outside North America, with the exceptions of France (Moreau 1996) and, to a lesser extent, Sweden.

By 2003, statistical agency views had changed, and interest in hedonic indexes was everywhere. In addition to the United States and Canada in North America and early adopters France (and Sweden) in Europe, hedonic

13. Iain Cockburn produced a "Tree of Zvi" showing a huge collaborative network of economists who were associated with him in some research capacity (this is downloadable from [http://www.people.business.edu/cockburn/tree\\_of\\_zvi.html](http://www.people.business.edu/cockburn/tree_of_zvi.html)). But the tree is incomplete in the sense that it was not possible to record all the economists who were touched by his legacy, in the form of fruitful suggestions on their work, providing an influential model for emulation and other professional inputs.

nic indexes have now been estimated in the United Kingdom, Australian, Dutch, and German statistical agencies, Eurostat established the European Hedonic Centre to examine the feasibility of hedonic indexes for computers and other products in Europe (Konijn, Moch, and Dalen 2003), and the Organization for Economic Cooperation and Development (OECD) commissioned a “handbook” on hedonic indexes (Triplett 2006). Strong interest has also been expressed in other countries. The state of interest in hedonic indexes today is several magnitudes greater than it was during any part of Zvi Griliches’s lifetime. Unfortunately, from a conversation with him in the last few months of his life, I think that he never expected the increased interest to happen. Timing is sometimes everything.

### 19.6 Final Remark

I want to end on a personal note. Zvi Griliches refereed my first published article (Triplett 1969). He published his referee’s comments!<sup>14</sup> Zvi’s last written professional work was his comment on my “Human Repair and Car Repair” article on medical care accounts (Griliches 2001). His influence, encouragement, and insightful suggestions on my research were constantly present throughout my career.

It is impossible to measure how much I benefited, personally and professionally, from knowing him.

## References

- Abramovitz, Moses. 1956. Resource and output trends in the United States since 1870. *American Economic Review* 46 (2): 5–23.
- Berndt, Ernst R. 1991. *The practice of econometrics: Classic and contemporary*. Reading, MA: Addison-Wesley.
- Berndt, Ernst R., and Zvi Griliches. 1993. Price indexes for microcomputers: An exploratory study. In *Price measurements and their uses*, ed. Murray F. Foss, Marilyn E. Manser, and Allan H. Young, 63–93. Studies in Income and Wealth, vol. 57. Chicago: University of Chicago Press.
- Berndt, Ernst R., and Jack E. Triplett, eds. 1990. *Fifty years of economic measurement: The jubilee of the Conference on Research in Income and Wealth*. Studies in Income and Wealth, vol. 54. Chicago: University of Chicago Press.
- Berry, Steven, James Levinsohn, and Ariel Pakes. 1996. Automobile prices in market equilibrium. *Econometrica* 63 (4): 841–90.
- Cole, Rosanne. 1993. Comment. In *Price measurements and their uses*, ed. Murray F. Foss, Marilyn E. Manser, and Allan H. Young, 93–99. Studies in Income and Wealth, vol. 57. Chicago: University of Chicago Press.

14. They make up a short section in Griliches (1971).

- Colwell, Peter, and Gene Dillmore. 1999. Who was first? An examination of an early hedonic study. *Land Economics* 75 (4): 620–26.
- Court, Andrew T. 1939. hedonic price indexes with automotive examples. In *The dynamics of automobile demand*, 99–117. New York: General Motors Corporation.
- Deaton, Angus, and John Muellbauer. 1980. *Economics and consumer behaviour*. Cambridge, UK: Cambridge University Press.
- Denison, Edward F. 1962. *The sources of economic growth in the United States and the alternative before us*. New York: Committee for Economic Development.
- . 1967. *Why growth rates differ: Postwar experience in nine western countries*. Washington, DC: Brookings Institution.
- . 1969. Some major issues in productivity analysis: An examination of estimates by Jorgenson and Griliches. *Survey of Current Business* 49 (5), pt. II: 1–27.
- . 1972. Reply to Jorgenson and Griliches. *Survey of Current Business* 52 (5, pt. II): 37–63.
- . 1974. *Accounting for United States economic growth, 1929–1969*. Washington, DC: Brookings Institution.
- Diewert, W. Erwin. 1976. Exact and superlative index numbers. *Journal of Econometrics* 4 (2): 115–45.
- . 2003. Hedonic regressions: A consumer theory approach. In *Scanner data and price indexes*, ed. Robert C. Feenstra and Matthew D. Shapiro, 317–48. *Studies in Income and Wealth*, vol. 64. Chicago: University of Chicago Press.
- Fraumeni, Barbara M. 2000. Zvi Griliches and his contributions to economic measurement. *Survey of Current Business* 80 (1): 15–17.
- Gilbert, Milton. 1961. Quality changes and index numbers. *Economic Development and Cultural Change* 9 (3): 287–94.
- Griliches, Zvi. 1961. Hedonic price indexes for automobiles: An econometric analysis of quality change. In *The price statistics of the federal government: Review, appraisal, and recommendations*, ed. Price Statistics Review Committee, National Bureau of Economic Research, 173–96. New York: National Bureau of Economic Research.
- . 1963. The sources of measured productivity growth: U.S. agriculture, 1940–1960. *Journal of Political Economy* 81 (4): 331–46.
- . 1964. Notes on the measurement of price and quality changes. In *Models of income determination*, 381–418. *Studies in Income and Wealth*, vol. 28. Princeton, NJ: Princeton University Press.
- . 1970. Notes on the role of education in production functions and growth accounting. In *Education, income and human capital*, ed. L. Lee Hanson, 71–115. *Studies in Income and Wealth*, vol. 35. New York: Columbia University Press.
- . 1971. Introduction: hedonic price indexes revisited. In *Price indexes and quality change: Studies in new methods of measurement*, ed. Zvi Griliches, 3–15. Cambridge, MA: Harvard University Press.
- . 1973. Research expenditures and growth accounting. In *Science and technology in economic growth*, ed. Bruce R. Williams, 59–83. New York: Wiley.
- . 1986. Economic data issues. In *Handbook of econometrics*. Vol. 3, ed. Zvi Griliches and Michael D. Intriligator, 1465–1514. Amsterdam: Elsevier Science.
- . 1988. Introduction. In *Technology, education, and productivity*, ed. Zvi Griliches, 1–24. Oxford, UK: Basil Blackwell.
- . 1990. Hedonic price indexes and the measurement of capital and productivity: Some historical references. In *Fifty years of economic measurement: The jubilee of the Conference on Research in Income and Wealth*, ed. Ernst R. Berndt

- and Jack E. Triplett, 185–202. *Studies in Income and Wealth*, vol. 54. Chicago: University of Chicago Press.
- . 1992. Introduction. In *Output measurement in the service sectors*, ed. Zvi Griliches, 1–22. *Studies in Income and Wealth*, vol. 56. Chicago: University of Chicago Press.
- . 1994. Productivity, R&D, and the data constraint. *American Economic Review* 84 (1): 1–23.
- . 1996. The discovery of the residual: A historical note. *Journal of Economic Literature*, 34 (September): 1324–30.
- . 2001. Comment on “What’s different about health? Human repair and car repair in national accounts and in national health accounts.” In *Medical care output and productivity*, ed. David N. Cutler and Ernst R. Berndt, 94–95. *Studies in Income and Wealth*, vol. 62. Chicago: University of Chicago Press.
- Griliches, Zvi, and Gary Chamberlain. 1975. Unobservables with a variance-components structure: Ability, schooling and the economic success of brothers. *International Economic Review* 16 (2): 422–49.
- Griliches, Zvi, and William Mason. 1972. Education, income, and ability. *Journal of Political Economy* 80 (3, pt. II): S74–S103.
- Haas, G. C. 1922. Sale prices as a basis for farm land appraisal. Technical Bulletin no. 9. St. Paul: University of Minnesota Agricultural Experiment Station.
- Hamermesh, Daniel, Zvi Griliches, with students of the New Economic School. 1994. Hedonic price indexes for personal computers: Intertemporal and inter-spatial comparisons. *Economic Letters* 44 (4): 353–57.
- Hausman, Jerry A. 2003. Sources of bias and solutions to bias in the Consumer Price Index. *Journal of Economic Perspectives* 17 (1): 23–44.
- Hausman, Jerry A., Bronwyn Hall, and Zvi Griliches. 1984. Econometric models for count data with application to the patents-R&D relationship. *Econometrica* 52 (4): 909–38.
- Hulten, Charles R. 1973. Divisia index numbers. *Econometrica* 41:1017–25.
- Jaszi, George. 1964. Comment. In *Models of income determination*, 404–9. *Studies in Income and Wealth*, vol. 28. Princeton, NJ: Princeton University Press.
- Jorgenson, Dale W., and Zvi Griliches. 1967. The explanation of productivity change. *Review of Economic Studies* 34 (3): 249–83.
- . 1972. Issues in growth accounting: A reply to Edward F. Denison. *Survey of Current Business* 52 (5, pt. II): 65–94.
- Konijn, Paul, Dietmar Moch, and Jorgen Dalen. 2003. Comparison of hedonic functions for PCs across EU countries. Eurostat discussion paper presented at 54th session of the International Statistics Institute, Berlin. August.
- Koopmans, Tjalling. 1947. Measurement without theory. *Review of Economics and Statistics* 29 (3): 161–27.
- Kuznets, Simon. 1971. Modern economic growth: Findings and reflections. *Nobel lectures: Economic sciences, 1969–1980*, ed. Assar Lindbeck, 87–102. Singapore: World Scientific, 1992.
- Lancaster, Kelvin. 1971. *Consumer demand: A new approach*. New York: Columbia University Press.
- Lipsey, Robert E. 1990. Comment. In *Fifty years of economic measurement: The jubilee of the Conference on Research in Income and Wealth*, ed. Ernst R. Berndt and Jack E. Triplett, 202–9. *Studies in Income and Wealth*, vol. 54. Chicago: University of Chicago Press.
- Moreau, Antoine. 1996. Methodology of the price index for microcomputers and printers in France. *Industry productivity: International comparison and measurement issues*, 99–118. Paris: Organization for Economic Cooperation and Development.

- opment.
- Nerlove, Marc. 2001. Zvi Griliches, 1930–1999: A critical appreciation. *Economic Journal* 111 (June): F422–F448.
- Ohta, Makoto, and Zvi Griliches. 1976. Automobile prices revisited: Extensions of the hedonic hypothesis. In *Household production and consumption*, ed. Nestor E. Terleckyj, 325–90. Studies in Income and Wealth, vol. 40. New York: National Bureau of Economic Research.
- Pakes, Ariel. 2004. Hedonics and the Consumer Price Index. Paper presented at international conference in memory of Zvi Griliches (1930–1999), R&D, Education, and Productivity, Paris.
- Price Statistics Review Committee, National Bureau of Economic Research. 1961. *The price statistics of the federal government: Review, appraisal, and recommendations*. Report to the Office of Statistical Standards, Bureau of the Budget, NBER General Series no. 73. New York: National Bureau of Economic Research.
- Reinsdorf, Marshall, and Jack E. Triplett. 2004. A review of reviews: Sixty years of professional thinking about the CPI. Paper presented at the NBER Conference on Research in Income and Wealth on price indexes, Vancouver.
- Rosen, Sherwin. 1974. Hedonic prices and implicit markets: Product differentiation in pure competition. *Journal of Political Economy* 82 (1): 34–55.
- Sheppard, Stephen. 1999. Hedonic analysis of housing markets. In *Handbook of regional and urban economics*, ed. P. Cheshire and E. S. Mills, 1595–1635. Amsterdam: Elsevier Science.
- Stavins, Joanna. 1995. Model entry and exit in a differentiated product industry: The personal computer market. *Review of Economics and Statistics* 77 (4): 571–84.
- Stone, Richard. 1956. *Quantity and price indexes in national accounts*. Paris: Organization for European Economic Cooperation.
- Treadway, Arthur B. 1969. What is output? Problems of concept and measurement. In *Production and productivity in the service industries*, ed. Victor R. Fuchs, 53–84. Studies in Income and Wealth, vol. 34. New York: Columbia University Press.
- Triplett, Jack E. 1969. Automobiles and hedonic quality measurement. *Journal of Political Economy* 77 (3): 408–17.
- . 2006. *Handbook on hedonic indexes and quality adjustments in price indexes*. Paris: Organization for Economic Cooperation and Development.
- Triplett, Jack E., and Barry P. Bosworth. 2004. *Services productivity in the United States: New sources of economic growth*. Washington, DC: Brookings Institution.
- . 2006. “Baumol’s disease” has been cured: IT and multifactor productivity in U.S. services industries. In *The new economy and beyond: Past, present, and future*, ed. Dennis W. Jansen, 34–71. Cheltenham, UK: Edward Elgar.
- Waugh, Frederick V. 1928. Quality factors influencing vegetable prices. *Journal of Farm Economics* 10:185–96.