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OF ECONOMICS AND STATISTICS: THE “GERSCHENKRON EFFECT”

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ABSTRACT

The “Gerschenkron effect” refers to the purported biases of early-weighted and late-weighted indices of production. If production is properly measured in what economists mean by “real” terms, the “Gerschenkron effect” does not exist at all.

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The "Gerschenkron effect" is the recognition that when intertemporal price and quantity relatives are negatively correlated an "early-weighted" aggregate will grow faster than a "late-weighted" aggregate (Gerschenkron, 1947). Empirically, that negative correlation is the norm, as the industries characterized by relatively rapid (slow) technical progress and a falling (rising) relative price benefit (suffer) from cost-reducing substitution.

The "Gerschenkron effect" is accordingly a staple of the index-number literature. At times, it is used to examine relative rates of technical change; most often, it is simply recalled to categorize "early-weighted" indices of production as "biased upward" (in the sense that they overstate the true growth rate) and "late-weighted" indices as symmetrically "biased downward" (e.g., Ames and Carlson, 1968, Jonas and Sardy, 1970, Crafts, 1985, Baffigi, 2013, and references therein). Like other parts of our now customary intellectual baggage, it is taken as a given, and rarely, if at all, considered on its merits.

On its merits, the "Gerschenkron effect" would seem to be a statistical truism, indeed an arithmetic one. But not all arithmetic is "political arithmetick," not all statistics are *economic* statistics (which is why we had a *Review of economic statistics*, the renaming of which is rich in sinister significance). As a matter of economics, the "Gerschenkron effect" does not stand up to scrutiny: it is the manifestation not of an aggregation or "index-number" problem, but simply of bad measurement.

I

We hold these truths to be self-evident: that if $A = B$, $B = C$, and $C = D$, then $A = D$; and that the self-same glass of water may be worth anything from nothing at all to more than its weight in diamonds, depending on its relative scarcity. That the "Gerschenkron effect" is a snare and delusion follows directly; but let us proceed by easy steps.

Consider first the measurement of industries producing different goods, and of their joint product, at a single point in time. We measure the industries, and their products, in *value* terms (strictly speaking value *added*, but to avoid burdening the exposition let us assume that all raw materials are free). Specific considerations may warrant measuring the products along other dimensions (weight, for example, if these are supplies to be transported, or individual pieces, if these are animals to be housed in separate cages), but for general economic measurement we use price-weighted quantities; and we do this because prices (tend to) correspond at once to the cost of the goods (the primary resources they absorb, which *are* the producing industries), and to the benefit they yield, in short to everything of interest to an economist. Quantities alone are of no concern: if one industry produces 2n cats and another n dogs, and each dog is worth two cats, we consider the two industries' products equal, and the two industries themselves equal in size. Nothing changes, obviously, if we consider not two industries but four.

Imagine now, to reduce the problem to its barest essentials, that our four industries are actually two, i.e., those producing the same two goods, in two different time periods; that these two industries are "small," in the usual technical sense that whatever they may do or not do the economy-wide averages are unaffected; and that they are embedded in a "large" world with homogeneous labor, a stable wage and price level, and, in the large, a stable technology. As simplifications go, this assumption of overall stability is particularly powerful. It rids us not least of the problem of deflation: nominal values are *ipso facto* "real," the intertemporal aspect is trivialized, and two industries in two periods are to all intents and purposes the equivalent of four industries in a single period. Let us set that aside, however, and carry on in the intertemporal context of the "Gerschenkron effect."

Imagine finally that the two industries at hand are the deer-catching and beaver-catching industries; and assume that both of these employ only labor. We have it on good authority that if it usually costs twice the labor to kill a beaver which it does to kill a deer, one beaver should naturally exchange for or be worth two deer.

Assume that in the "early" period these two industries employ the same number of workers, at identical wages, and therefore have an identical value product: say 100 beaver at $2 each, and 200 deer at $1 each. Call the "early" beaver value product *A*, and the "early" deer value product *B*: by assumption, *A* = *B*. Imagine that the deer-catching industry remains totally unchanged, so that in the "late" period it is still producing 200 deer at $1 each, with (obviously, given the stable wage rate) the same number of workers as before. Call the "late" deer value product *C*: by assumption, *B* = *C*. Imagine that in the "late" period the beaver industry's value product is again identical to that of the deer industry. Call the "late" beaver value product *D*: by assumption, *C* = *D*. It follows, self-evidently, that *A* = *D*: that the beaver-catching industry too has retained its original labor force, that, like the deer-catching industry, it has not grown at all.

It bears notice that this conclusion is reached without so much as mentioning the "late"-period beaver catch, or beaver-catching technology. Assume now that in the interval between our two periods workers have learned to imitate the beaver's mating call, halving the (time) cost of catching them. In the "late" period a beaver is worth half as much as before in terms of deer, of all other goods, and of paper money too. Beaver too are now worth $1 each: the industry's work force and value product (at the unchanged price level) are by assumption unchanged, its physical product has doubled to 200 beaver.

Enter the "Gerschenkron effect." At "early" prices, the product of the two industries together grows from $200 of beaver and $200 of deer to $400 of beaver and $200 of deer, or, overall, by one-half; at "late" prices, from $100 of beaver and $200 of deer to $200 of beaver and $200 of deer, or, overall, by one-third. Given the negative correlation of relative-quantity and relative-price movements, the faster growth of the "early" price-weighted aggregate is as inevitable as death and taxes -- and as illuminating. The growth of these industries' aggregate real product -- their aggregate value product at an unchanging price *level* -- is by construction zero: both the base-year-price-weighted quantity indices overstate it; both display an *upward* bias, the "late-weighted" index as well as (though not as much as) the "early-weighted" one.

Obviously, too, the root problem is not an "index-number" problem at all, for the mismeasurement is logically prior to the combination of the two product series into a single aggregate. The error is entirely internal to the measurement of the product of the technologically progressive industry, in this case the beaver-catching industry; and it is specifically in the measurement of the growth of its real (value) product by that of its physical product. Its real product did not increase at all; its physical product doubled, but the mere number of beaver caught is as intrinsically irrelevant to our measure in this (ostensibly) intertemporal context as the mere numbers of cats and dogs in the (explicitly) intratemporal example above. To assume productivity growth only in the beaver-catching industry is to assume a reduction in the beavers' relative scarcity, in their cost, in their benefits, in short in their real value: productivity growth in that one industry means that the increase in its physical output overstates the increase in production, in the size of the industry itself. The problem is in that *one* series, the games one can play when adding it to another merely confuse the issue.

Technical progress transforms water-in-the-desert, worth its weight in diamonds, into tap-water worth nothing at all: the two may have the same chemistry, but their relative scarcities are very different. It follows, self-evidently, that they are not the same *economic* thing: like cats and dogs, they must be counted using appropriately different price weights.

II

To an economist, all this is obvious, and intuitively appealing: or perhaps it should be, but is not. If it is not, one suspects, it is because the specialized understanding of the import of the water-diamonds paradox clashes with the general understanding that physical things are indeed real: on the basis of the latter, surely, one is not inclined to accept the above distinction between the industry's real product and its physical product, or the above claim that in the presence of (industry-specific) technical progress the growth of the latter exceeds that of the former.

The attendant difficulty seems itself to have very deep roots, in the very nature of the social sciences, and of language. The "hard" (real?) sciences deal with concepts beyond our general understanding: to the rest of us a boson may conjure up some extinct herbivore, but to a physicist the term is presumably unambiguous, uncontaminated by a different meaning in ordinary discourse. Not so the social sciences in general, and economics in particular: because we deal with the stuff of ordinary life we use ordinary words, but as we refine our concepts those words acquire technical meanings that often differ from their ordinary ones (thus for example "rent," or more dramatically "marginal," which conveys to an economist the opposite of what it conveys to the ordinary copy-editor).

In ordinary discourse "real" means "thing-like," things are real by definition. But as a part of economics' technical language "real" is used metaphorically rather than literally, it means "thing-like" only in specific circumstances. The proof is in the antonym, which is not "unreal," but "nominal."

The distinction between "real" and "nominal" emerged of course in the context of inflation, where the first-order change was the rise in the price *level*, and all other changes were altogether secondary: in economics "real" means not generally "like things" but specifically "like things when the currency loses its value in exchange, and things do not." In that context things are "real," in the technical sense, not because they are things but because they can be converted into a constant quantity of goods in general, and for that matter of labor.

Set labor aside, for now, and consider only the conversion into goods in general. In the case of inflation, everything -- every thing -- is "real" (maintains its value in exchange), save paper money; with no inflation, and technical progress only in our "small" beaver-catching industry, paper money is "real," and all things are "real" *except beaver*. We know this: one would have been better advised, ten years ago, to hoard cash than to hoard computer memory cards. As a general proposition, in the presence of technical progress things are obviously real in the colloquial sense, and as obviously *not* "real" in the technical sense of the term. "Strawberry fields," with a perception perhaps artificially enhanced, got it right; Alexander Gerschenkron got it wrong.

And so, in fact, did the general literature on "real" value added, lead astray by the non-technical meaning of the word, by the sense that "real" meant somehow directly in industry-specific things rather than in goods-in-general. In this case (and in contrast, say, to that of "rent"), the metaphorical meaning failed to acquire an adequate psychological distance from the literal one, and in the event the weight of the latter proved overwhelming. Solomon Fabricant and Robert Geary measured "real" value added as a difference between base-year-price weighted physical quantities, perplexingly producing sometimes negative results; Paul David reacted by suggesting own-output-price deflation, which avoids negative results at the cost of violating the first condition required of any measure of value added, that it be invariant to (vertical) disaggregation; Kenneth Arrow and Christopher Sims went so far as to argue that "real value added" does not even exist unless the production function is suitably separable (Fabricant, 1940, Geary, 1944, David, 1966, Sims, 1969, Arrow, 1974) . These names include something of a pantheon: that even such minds may have been misled is a testimony to the power of words, to their capacity to constrain thought, to give the irrelevant the appearance of relevance -- but of that, Deirdre McCloskey warned us long ago (McCloskey, 1985).

III

Some concluding remarks may be in order.

One concerns the links between products and resources. In equilibrium, value added in the production of a good equals the value of the primary resources it consumes. The fable above tells the story of physical goods that are not real because they happen to depreciate, relative to goods in general. An alternative fable about a "small" industry in a stable "large" economy would eliminate technical change altogether, and tell of a change in fashion that increases the demand for beaver. Assume that beaver-hunters are a specialized resource, that their number is given, that the supply of beaver is perfectly inelastic: physical product (the number of beaver caught) is unchanged, but the relative price of beaver rises, and so does the relative wage of beaver-hunters. The industry's real product grows because its unchanged physical product is now more scarce than before, the industry becomes larger because the unchanged physical resources it consumes have similarly become more scarce. Technical progress turns water-in-the-desert into tap-water, demand growth does the opposite: physical resources are no more "real" than physical goods.

Another concerns industry-specific technical progress. Normally, it would seem, technical progress saves primary resources, as in our beaver-catching fable above: it reduces value added (at given unit resource costs) per unit of physical product, so that the growth of the latter exceeds the growth of the industry's real value product and of the industry itself. In this case, the above fable stands as told. If technical progress merely saves raw materials, value added per unit of output is unchanged, and the growth of the industry's physical product can double as a measure of its real growth. If technical progress saves raw materials at the cost of a greater consumption of primary resources (all per unit of output) the point of the fable is made *a contrario*: the growth of physical product *under*states the growth of the industry, and of its value added (at given unit resource costs). But the point of the fable is that physical product movements are a poor measure of real production movements, the way the price of Maine potatoes is a poor index of consumer prices even if under certain conditions it produces the appropriate number; and that point stands.

A third considers economy-wide technical progress. The above fable assumes it away: beaver depreciate (relative to goods in general) because industry-specific productivity growth exceeds zero. But if "real" means "converted to goods in general" the relative price of the product falls only if industry-specific productivity growth exceeds the average (and *increases* in the opposite case); and in our own fortunate era that average is well above zero. Amend the above fable to assume that productivity, on average, doubled; assume again a constant price level, and have the wage (therefore) also double. The (nominal and real) value of beaver therefore remains constant, at $2: the "late" period catch is 200 beaver, for a total of $400. Deer, produced by the "small" exceptional industry with stagnant productivity, double in value to $2, for a total of, again, $400. The combined real product doubles, from $400 to $800. The base-year-price-weighted quantity indices grow from $400 to $600 at "early" prices and from $600 to $800 at "late" prices: both understate aggregate real product growth, both display a *downward* bias, the "early-weighted" index as well as (though not as much as) the "late-weighted" one. If the assumptions built into the initial fable are reversed, so too, symmetrically, are its conclusions.

A fourth considers the "real" value of labor; to avoid clutter, let us again think of it as homogeneous. Historically, of course, the primary social concern that motivated the distinction between "real" and "nominal" values was that with the "real wage," that is, the value of labor in terms of goods-in-general: the concern that inflation might hurt the poorer members of society, that in the short run sticky wages might lag behind prices. In the long run, of course, wages are no more sticky than prices are; and that social concern is replaced by a theoretical one, in the context not of inflation but of the *diffuse* technical progress considered above. As noted, the latter means that the "real wage" tends to rise, that labor becomes ever more valuable in terms of goods, or, if we prefer, that goods become ever *less* valuable in terms of labor.

Our concern with the social effects of inflation has assigned to "real" the meaning of "converted into goods in general": the implication is that goods-in-general conserve their "real value," as labor and individual goods do not. But two comments are here in order. First, we have it again on good authority that as *all* goods become more abundant they are collectively, as well as individually, worth less. Diminishing marginal utility is here enough; catastrophically diminishing utility is implied if goods become increasingly positional goods, a matter of keeping up with the Joneses, or, for what it may be worth, by the "Easterlin Paradox" (Easterlin, 1974: its empirical content is moot, for asking people if they are happy is like asking them if they are tall or healthy; the response is inevitably a distribution around what is perceived as average, simply because words serve to draw distinctions, and their "real" content changes to maintain their usefulness). Second, we have it again on good authority that the real value of a good is the quantity not of other goods, but of labor, that it can purchase or command; and all authority aside the strength of that intuition is obvious from the historical literature, as authors uniformly convey a sense of the period's monetary values by indicating not the prices of goods but the typical wage rate.

The bottom line is that over time, as across space, labor and goods-in-general cannot both be "real." Measurement in the one and measurement in the other differ, over time, by the increase in the real wage. The choice is arbitrary, the inevitable ambiguity irritating but not debilitating; in terms of the above parables it simply means that our measures are identified up to a limited rotation of the axes.

APPENDIX

At current prices, production is $VA_1 = va_{11}Q_{11} + va_{12}Q_{12}$ in period *1* and $VA_2 = va_{21}Q_{21} + va_{22}Q_{22}$ in period *2*, where va_{ij} and Q_{ij} refer respectively to unit value added, and physical product, in period *i* by industry *j*.

The "early"-price-weighted quantity measure of total product is $VA_{11} = va_{11}Q_{11} + va_{12}Q_{12}$ (= VA_1) in period *1*and $VA_{12} = va_{11}Q_{21} + va_{12}Q_{22}$ in period *2*.

The "late"-price-weighted quantity measure of total product is $VA_{21} = va_{21}Q_{11} + va_{22}Q_{12}$ in period *1*and $VA_{22} = va_{21}Q_{21} + va_{22}Q_{22}$ (= VA_2) in period *2*.

The measure of total product converted into goods in general is VA_1/p_1 in period *1*and VA_2/p_2 in period *2*, where *p* is the overall price index.

The measure of total product converted into labor is VA_1/w_1 in period *1*and VA_2/w_2 in period *2*, where *w* is the wage index.

The alternative product indices are the ratios of the various period-*2* measures to the corresponding period-*1*measures, normalized to 100 in period *1*.

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