Senior's 'last hour': suggested explanation of a famous blunder

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I

In 1837 Nassau Senior—Drummond Professor of Political Economy at Oxford—published his *Letters on the Factory Act*. These were an exercise in applied economics: Senior tried to show that the effects of the then-existing Child Labour Law were bad and that the effects of the proposed Ten Hours Act would be worse.[1] Not only would the regulation of working hours interfere with the workers' freedom to make whatever contracts they wished with employers, but the regulation of working hours would also destroy substantial parts of the British cotton textile industry.

In his analysis Senior commits an analytical blunder. By failing to recognize that a reduction in total labor input (hours worked) will in general entail a reduction in the total amount of working capital, he concludes that all of the profits of British cotton mills are produced "in the last hour" of the workday. Therefore, according to Senior, a reduction in the length of the working day from the then-current 11½ hours to 10 hours would either bankrupt the industry or else reduce the wages of workers to "the Irish standard."[2]

A decade later the Ten Hours Act passed. The British cotton textile industry did not go bankrupt. Senior's pamphlet, written for the particular occasion, dropped into obscurity—although not without providing Marx an opportunity to rage against the Vulgar Economist Senior.[3] But Senior's *Letters on the Factory Act* remain interesting for the magnitude and apparent obviousness of the analytical blunder committed. It seems that anyone should be able, with a moment's thought, to put his finger on Senior's mistake. How, then, could a serious scholar and respected professor so err?

Karl Marx has a simple answer: Senior is not a 'scientific' but a 'vulgar' economist. The manufacturers were determined to fight the factory acts,

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1. Nassau Senior, *Letters on the Factory Act* (London, 1837).
2. Ibid. 15.
3. Karl Marx, *Capital* I (New York, 1977).

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and so they summoned Senior "from Oxford to Manchester, to learn in the latter place the political economy he taught in the former. The manufacturers chose him to be their prize-fighter." Senior is one of those "vulgar economists who . . . ceaselessly ruminate on the materials . . . provided by scientific political economy, and seek there plausible explanations of the crudest phenomena for the domestic purposes of the bourgeoisie."[4] According to Marx, Senior is not a scientific analyst but a partisan advocate, so it is not surprising that the logic of his arguments is defective.

Marian Bowley also has a simple answer, put forward in her *Nassau Senior and classical economics:* "The logic of . . .[Senior's] calculation was sound enough, that the value of the product is only sufficient to yield profits if there is a balance after all current costs of production have been covered. But the values . . . of costs and output were taken from a completely inadequate survey." She also sees problems because Senior's assumption of "unchanged productivity per man-hour . . . might not be valid."[5] According to Bowley, Senior is an honest and competent analyst who just used faulty empirical data.

Orace Johnson[6] believes that Senior fails to make the proper distinction between stocks and flows; he errs "by including stock figures . . . in his flow numerator," possibly because of his eagerness to make the moral point that excessive government regulation is harmful. According to Johnson, Senior tried to make a serious analysis—he just made a conceptual error along the way.

None of these previously advanced explanations takes Nassau Senior seriously. For Marx, Senior's claim to be a serious economist is a bad joke. For Johnson, Senior makes substantial and inexplicable conceptual confusions. For Bowley, Senior is just careless in his application of economic theory to the world. Whichever explanation is adopted, Senior appears a knave, a fool, or sloppy.

Yet Senior's contemporaries took him very seriously. They did not challenge his honesty, his intelligence, or his industry. Should not we do the same? Because of Senior's substantial reputation in nineteenth-century England, any attempt to account for his blunder which paints him as less than a serious and capable economist is not satisfactory.

In constrast to Marx, Johnson, and Bowley, I argue that Senior's blunder is comprehensible and—while not excusable—a natural consequence of his 'advances' view of the role of 'capital' in production. Senior liked to think of 'capital' as nothing more than advances, as wage payments and purchases of materials made in advance of the sale of the final product.

4. Ibid. 333, 175.
5. Marian Bowley, *Nassau Senior and classical economics* (London, 1937).
6. Orace Johnson, 'The "last hour" of Senior and Marx,' *History of Political Economy* 1.2 (1969).

According to Senior's implicit model of the economic organization of production, the essential function of the capitalist is to advance means of subsistence to the workers, so that they do not starve before they create a finished product. The amount of 'advances' has no necessary connection with the amount of final product produced: that depends on the effort made by the workforce. This is not to say that Senior did not recognize that 'capital' played other roles in production than merely as 'advances.' But he regarded the role of 'advances'—primarily of wages—as the ideal typical, the characteristic, the primary role.

Given Senior's implicit model, the 'turnover' period of capital becomes a key parameter. The period of time for which advances have to be made is a major determinant of profitability. Senior regarded the 'turnover' period as fixed either by technology or by organization; he failed to note that in general a change in the length of the working day will change the 'turnover' period. And this failure of observation is understandable when the implicit conception of capital underlying Senior's argument is taken into account.

The next two sections of this note expand on the above argument. Section II attempts to show that there is something interesting in Senior's blunder to be analyzed—that Senior was a highly respected economist whose mistakes should be attributed not to pure irrational error but to an inadequate set of theoretical concepts. And Section III examines the crucial steps of Senior's argument and points out how they make sense only in the context of an 'advances' conception of capital.

II

Nassau William Senior, lawyer and economist, was born in 1790 and died in 1864.[7] He was among the most prominent of the British economists of the generation that fell between David Ricardo and John Stuart Mill. Of all the members of the Political Economy Club, only John Ramsey Mc-Culloch could rival the influence and prominence of Nassau Senior in his prime. His judgments were taken seriously both by the small community of political economists and by the educated public at large.

This can readily be seen from the tracks that he left. When Oxford established its first chair in Economics, the Drummond Professorship of Political Economy, it called on Nassau Senior to be the first holder of the office. When his five-year term expired, he was immediately offered the newly created chair in Political Economy at King's College, London. Toward the end of his life, in 1860, he was elected President of Section F (the Social Science Section) of the British Association for the Advancement of

7. The information in this section is drawn from Marian Bowley, *Nassau Senior and classical economics*, and from the *Dictionary of national biography.*

Science and of the Education Department of the National Association for the Promotion of Social Science.

Senior wrote (in addition to his articles on "historical and philosophical subjects," his journals, and his records of conversations with eminent people) close to twenty articles and pamphlets on economic subjects. He was appointed to the commissions on the Poor Laws and on the Unemployed Hand-Loom Weavers—he played the role of chief economic advisor to the Whigs throughout the 1830s—and he appears to have been the principal author of the reports to Parliament of both commissions. When the *Edinburgh Review,* one of the half-dozen or so most noted political journals of the day, published a review of John Stuart Mill's then newly written *Principles of political economy,* Nassau Senior was the reviewer. Senior was a close friend of the French politician and political scientist Alexis de Tocqueville. Count Cavour, the first prime minister of united Italy, called him "l'esprit le plus éclairé de la Grande Bretagne." According to some, he deserved "first place among the English economists between Ricardo and J. S. Mill."[8] Rather than dismiss a man who so impressed his contemporaries either as the maker of inexplicable blunders or as the prisoner of ideological bias, we should look for some coherent pattern behind the gaps in his arguments.

III

The crucial portion of Senior's argument begins as follows:

> I find that the usual computation to be that the fixed capital is in the proportion of four to one in the circulating. . . . I find also that the whole capital is supposed in general to be turned over (or, in other words, that goods are produced and sold representing the value of the whole capital, together with the manufacturer's profit) in about a year. . . . I also find that the net profit annually derived may be estimated at ten per cent. . . . But in order to realize this net profit, a gross profit of rather more than fifteen per cent is necessary.[9]

Senior recounts some stylized facts: 80 percent of capital invested is fixed, 20 percent circulating; depreciation is approximately 5 percent per year on total capital; and net profit runs at 10 percent per year. But why is there this observation that the whole capital is "turned over . . . in about a year"? It appears to be a roundabout way of stating that the cost of purchased inputs (raw materials and labor) in a year is approximately equal to the total capital invested. But rather than work with the two magnitudes of the capital stock and the annual flow of inputs, Senior works with the

8. Quoted in the *Dictionary of national biography.*
9. *Letters,* 11–12.

capital stock and the turnover time. The two sets of concepts convey the same information, true, but the emphasis is different.

Senior continues:

> Now, the following analysis will show that in a mill so worked, the whole net profit is derived *from the last hour.* I will suppose a manufacturer to invest £100,000–£80,000 in his mill and machinery, and £20,000 in raw material and wages; the annual return of that mill, supposing the capital to be turned over once a year, and gross profit to be fifteen percent, ought to be goods worth £115,000, produced by the constant conversion and reconversion of the £20,000 circulating capital, from money into goods and from goods into money, in periods of rather more than two months. Of this £115,000 each of the twenty-three half hours of work produces . . . one twenty-third. Of these 23-23ds, (constituting the whole £115,000) twenty, that is to say £100,000 of the whole £115,000, simply replace the capital— one twenty-third (or 5,000 out of the £115,000) makes up for the deterioration of the mill and machinery. The remaining 2-23ds, that is, the last two of the twenty-three half hours of every [work] day, produce the net profit of ten percent.[10]

This section is distinctly odd. Senior carefully takes account of capital depreciation, he assumes a standard workday of 11½ hours, and he proceeds to assign each half-hour of the workday a share of the final product. The first 10 hours of every workday—20/23 of the total labor input— simply produce enough final product to replace the raw materials and wages advanced. Today, economists talk of the value added in the factory, not of the amount of time it takes to "replace the value" of the working capital advanced.

The two passages quoted above are followed directly by the punchline of Senior's analysis:

> If, therefore, (prices remaining the same,) the factory could be kept at work thirteen hours instead of eleven and a half, by the addition of about £2,600 to the circulating capital, the net profit would be more than doubled. On the other hand, if the hours of working were reduced by one hour per day (prices remaining the same), net profit would be destroyed—if they were reduced by an hour and a half, even gross profit would be destroyed.[11]

This is startling. Consider, first, Senior's claim about the consequences of an increase in the working day. Fixed capital would remain at £80,000.

10. Ibid. 12–13.
11. Ibid. 13.

Working capital would be raised to £22,600 because now the manufacturer must hire labor and materials to work for 13 hours per day rather than 11½. With 26 half-hours in the day instead of 23, and with each half-hour worked producing goods worth £5,000 over the year, the total output of goods would be worth £130,000. Senior appears to subtract £5,000 (for depreciation) and £102,600 (for cost of labor and raw materials equal to the value of capital invested, which is turned over once a year) from £130,000 to obtain a net profit of £22,400—"more than double" the initial profits of £10,000 achieved at the 11½-hour workday. His second claim—about the effects of the reduction in the working day—is simply the same argument run in reverse.

These claims are simply wrong. Gross (operating) profit is only 15 percent of raw material and labor costs. If £115,000 worth of finished goods required an input of £100,000 worth of raw materials and labor, then £130,000 worth of finished goods should require an input of approximately £113,000 worth of raw materials and labor. Gross profits would rise from £15,000 to £17,000, and net profits from £10,000 to £12,000— a far cry from the "more than doubled" claimed by Senior. Similarly, a reduction in the workday to ten hours would reduce net profits from £10,000 to £8,000; rather than eliminating them altogether, it would only reduce them from 10 percent per year on invested capital to a bit more than 8 percent.

Where did Senior make his mistake? Recall the statement "I find also that the whole capital is . . . turned over . . . in about a year." This is, in our minds, a roundabout way of stating the value of purchased inputs— raw materials and labor—in a year. If existing capital is used for more hours per day, then the turnover period will shorten: there will be more purchased inputs flowing by the same stock of capital, and so the time it takes for the value of purchased inputs to cumulate to the value of the capital stock will be reduced.

But when Senior does his calculations of how profit varies with the length of the working day, he assumes that the period of turnover is invariant, that the whole of invested capital is and continues to be turned over "in about a year" no matter how long the working day. In Senior's mind, all capital is invested at the beginning of the year. Count up the value of all goods sold during the year, deduct depreciation, and also deduct the value of capital invested—because capital turns over once a year—and what is left is profit. This is the implicit structure of Senior's analysis: (cost of raw materials and labor) = (capital invested) × (frequency of turnover), where the frequency of turnover is given, fixed by some technological or organizational considerations.

Senior's analysis is false. The period of turnover is not invariant with respect to changes in the length of the working day. If the mill is working

13 hours a day, then capital turns over more than once a year; if the mill is working 10 hours a day, then capital turns over less. As Marx put it:

> Gentlemen! If you work your mills for 10 hours instead of 11½, then, other things being equal, the daily consumption of cotton, machinery, etc. will decrease in proportion. . . . Your workpeople will in the future spend one hour and a half less time in reproducing or replacing the capital advanced.[12]

Senior's assumption, made early in his analysis, that the most important thing to know about variable costs is that capital turns over once a year is the assumption that leads him astray.

So the problem of why Senior made his blunder can be reduced to the problem of why he made this initial assumption about the time of turnover and did not consider that changes in the working day might change the time of turnover. What kind of view did Senior have of production in order for this assumption—the identification of a constant turnover time—that seems so bizarre to become an important and natural step in his argument?

The calculation of a turnover time is a natural step to take if one is working within the framework of an 'advances' theory of capital.[13] The assumption of a constant, technically determined turnover time is not inevitable once an advances theory of capital has been adopted. But there is a definite affinity between the advances conception and Senior's blunder. If one holds an advances theory, then questions of profitability can be broken into three simple steps: First, what is the total investment required to pay for raw materials and to support the workers while the product is being made? Second, how long does the process of production take? And, third, what is the value of the final product?

This breakdown is a natural one to make if the typical capitalist is one

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12. *Capital* I, 334.
13. The idea that 'advances of wages' played an important role in classical theories of capital is a commonplace among historians of economic thought. Witness Mark Blaug's masterly exposition, from his *Economic theory in retrospect,* 3d ed. (Cambridge, 1978), 194: "if we lift the 'veil' of money, what are the characteristics of the real capital stock that the sum of money represents? Production is time-consuming but workers must be hired and equipment installed before there are final products ready for sale. The capital fund of a firm, therefore, is nothing but the power to purchase labor and the products of other firms over the period during which the firm has no output to sell. . . . The real meaning of capital emerges even more clearly if we think of the whole economy as a giant firm. This giant firm, like any other firm, must pay workers for their services as they are rendered, before the services have ripened into consumers' goods. To tide itself over this period, the firm must be in possession of a stock of finished consumer goods as well as semifinished goods capable of being added to inventories as they are depleted. . . . In other words, the real capital fund of a society can be defined as the sum total of all produced goods in process in the hands of producers, wholesalers, and retailers; in practice, this amounts to an inventory of consumer goods and raw materials as well as plant and equipment. What the classical economists did was to seize on a part of the whole stock of produced inputs, namely, wage goods consumed by workers, identifying that part with the whole."

who makes individual ventures, who commits his capital either to sup-
porting craft workers for the time it takes them to finish some task or to
some mercantile venture which will naturally wind itself up. For then the
amount of advances bears no direct relation to the amount finally pro-
duced—that depends on the skill and effort of the workforce. At the end
of the venture, all of the capital invested is embodied in the finished prod-
uct. In order to determine his annual rate of profit, the capitalist has only
to take the value of the finished product, subtract off the capital invested,
divide by the capital invested, and then divide by the fraction of a year the
venture took. If this advances model of capitalist production were a rea-
sonable description of the situation (as it is in many agricultural and mer-
cantile enterprises, where the period of turnover is either the crop year or
the duration of a voyage), then Senior's analysis would be unexceptiona-
ble. If a decrease in the workday translated into an equivalent proportional
decrease in the product produced for a fixed total expenditure (rather than
simply into a proportional decrease in value added), then the Ten Hours
Act might have indeed bankrupted the industry.

But English cotton mills were not well-modeled by the advances theory
of capital. Clearly, fixed capital plays a major role; more important than
the role of the manufacturer as provider of advances to the workforce is
his role as contributor of the machines. Senior recognized this. And so
when he calculated the period of turnover, he calculated not the period of
turnover on *working* capital but the period of turnover of *total* capital.
Even though he knew that working capital really did turn over five times
a year, he conducted his analysis as if all of the capital were working
capital and it turned over once a year. He believed he could use the ana-
lytical device of turnover to translate the situation of the English cotton
mills into the analytical scheme of the theory. If Senior had subtracted the
product of the *working* capital and the frequency of turnover of the *working*
capital from annual sales, then he would have obtained an accurate mea-
sure of gross profit. But he thought he could handle fixed capital—capital
that was not functioning as advances and so did not have a technologically
determined period of turnover—as if it were advances.[14]

14. The advances theory can serve as the foundation for a profound and insightful theory
of capital, as in Eugen von Böhm-Bawerk, *Capital and interest,* 3 vols. (South Holland,
Ill., 1959). There is no necessary connection between the advances conception of capital
and Senior's blunder, but there is a definite affinity. The form the advances theory took in
Senior's mind is considerably less flexible, as F. W. Taussig notes in his *Wages and capital*
(New York, 1896). On page 262 he criticizes Senior for identifying "wage goods con-
sumed" with "capital": "Almost imperceptibly, Senior drifts back into the familiar mode of
approaching the question. Capital is stated in terms of so much food. . . . It is true that he
professes to examine only the simplest state of society, in which all capital may be food;
but he examines no other; and he does not introduce at the close those qualifications . . .
which he clearly had in mind when he began." Taussig blames Senior's failure to proceed
further on "intellectual indolence." In my view, this does not take proper account of Senior's

In Senior's somewhat simplistic advances framework, the period of turnover is constant: it is a crop year, the duration of a single voyage, or something similar. The idea that the period of turnover might be systematically variable never enters the mind. The period of turnover is a given constant. To Senior, working within the advances framework, the thought that a change in the length of the workday would invalidate his initial "supposing the capital to be turned over once a year" never crossed his mind.

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mind set; for Senior, the assumption of constant turnover time—that, effectively, all capital is advances of wages—plays about the same role as the aggregation into the two grand factors of 'labor' and 'capital' does in modern economics: it is an approximation, but one that is thought to be justified and to not bias the results.