Economica, **54**, 417–428

Turgot: Founder of Classical Economics

By Anthony Brewer

University of Bristol

Final version received 27 January 1987. Accepted 6 March 1987.

Turgot's capital theory is rightly famous. This paper argues that his contribution to distribution theory should also be recognized as a major achievement. The interest rate (or profit rate) is equalized between different activities and governed by returns at the agricultural margin (intensive and extensive). Returns decrease as the margin moves out with capital accumulation. This implies a rent theory and a theory of accumulation substantially equivalent to that of Ricardo, and makes Turgot, who wrote before Smith, the original inventor of the main lines of classical economics.

A. R. J. Turgot (1727–81) was a major political and intellectual figure in pre-revolutionary France. His economic writings are few and scattered,[1] but they mark a watershed in the history of economics; his contributions to capital theory, in particular, are recognized as a major achievement.[2] There has been some discussion of his relation to classical economics, focusing mainly on the extent of his influence on Adam Smith.[3]

I will argue that Turgot substantially anticipated Ricardo's theory of rent, profit and capital accumulation, so that the appropriate comparison is with Ricardo, not Smith. In Section I, I present a simple model embodying Turgot's arguments, and in Section II I discuss some extensions of the model. Turgot's style was strikingly modern, considering its date, but he stopped far short of presenting a formal model. The 'rational reconstruction' presented here is intended to reveal the logical structure of his system, and does involve making some additional assumptions, for the sake of completeness and tractability. The main elements of the model will be justified by citations from Turgot's writings. Section III examines some possible discrepancies between Turgot's writings and the interpretation presented here. It can be regarded as a test of the 'rational reconstruction' put forward in Sections I and II. It will be argued that these discrepancies are, in the main, apparent rather than real. Finally, Section IV deals with the argument that Turgot anticipated the 'Ricardian' theory of distribution, and argues specifically that the zero-rent margin, the key component of the Malthus–West–Ricardo theory of rent and profit, is implicit in Turgot's theory.

I. The Basic Model

(a) *Prices*

Turgot distinguished 'exchange value', or current market price, from 'fundamental value', which corresponds to 'natural price' in the terminology of later classical writers. Fundamental value is 'what the thing costs to him who sells it, that is, the raw material cost, the interest of advances, the wages of labour . . .' (1767a, p. 120, n. 16).[4] Price (exchange value) tends towards fundamental

value, because production will be expanded when price is above cost, and contracted, or (in the end) shut down altogether, when price is below cost. In the model presented here, all prices are fundamental values unless otherwise stated.

For simplicity, I assume that there are only two goods, one agricultural (good 1), and one manufactured (good 2). This is the minimum required to reproduce Turgot's main arguments; the consequences of introducing more goods will be discussed in Section II. Good 1, the agricultural good, will be taken as numeraire. Turgot normally worked with money prices, but nothing of substance turns on the choice of numeraire except, perhaps, the measurement of changes in the capital stock, which will be discussed in due course.

Consider production of the manufactured good. Turgot did not discuss returns to scale or the possibility of substitution, so it seems reasonable to assume fixed coefficients and constant returns to scale. 'Advances' (capital) are needed because production takes time, so the worker has to subsist and be provided with tools and materials before the product is available for sale (1766, pp. 66, 70). I assume that production takes one period of time, in which all tools and materials are used up. Inputs are paid for at the beginning of the period, and revenue is received at the end. The condition that price must equal cost, including interest on advances, can then be stated as

$$p = (1+r)(a+pb+wl)$$

where p is the price of good 2 in terms of good 1, r is the interest rate, w the wage rate, and a, b and l represent the amounts of goods 1 and 2 and of labour required per unit of good 1 produced.

(b) *Wages and profits*

Wages, in the long run, are fixed at subsistence level; 'the wages of the workman are limited to what is necessary to procure him a subsistence' (1766, p. 46; see also 1767b, pp. 126–7, 1767c, pp. 211–12, and 1770b, pp. 166–8, 177). 'High wages . . . encourage population . . . and the increase of people in turn lowers wages through competition' (1767b, p. 127), while if workers do not get enough for subsistence, 'someone must starve' (1770b, p. 175). This bleak message is qualified at various points: wages must cover subsistence in bad years, so on average they are above (biological) survival levels; and there is a scale of wages for different skills, with only the bottom of the scale anchored at subsistence.

The relevant point is that wages are fixed in real terms. Turgot treated subsistence as consisting mainly of food, hence of agricultural products, but argued that they are consumed in manufactured forms (e.g. 1766, pp. 44, 46). Whatever the composition of subsistence, it can most conveniently be incorporated into the model by treating the subsistence needs of workers on a par with inputs of materials and so on, and rewriting the price equation as

$$(1) \qquad p = (1+r)(a+pb)$$

where a and b incorporate wage goods. Given the technical conditions of production and the real wage, the price of manufactures is an increasing

function of the interest rate, since (1) can be written as

$$p = \frac{(1+r)a}{1-(1+r)b}.$$

The determinants of the interest rate are more complicated, and will be discussed later; for the moment, the interest rate is treated as parametric. Turgot repeatedly emphasized (e.g. 1766, p. 87) that rates of return on different uses of wealth are equalized by mobility of capital between different uses (making due allowance for risk and wages of management; this adjustment will be ignored for simplicity, though it could be included without altering the results in any important way). In particular, the rate of profit in industry and in agriculture must be equal to the interest rate; this is already built into (1) above.

(c) *The margin of cultivation in agriculture*

Now consider agriculture. Turgot treated the range of alternative uses for a given piece of land rather differently in different contexts. For theoretical purposes, the main choice, and the one he stressed repeatedly, is between cultivating the land and leaving it idle. He also discussed the choice between different degrees of intensity of cultivation (1767a, pp. 111–13; this choice is discussed in Section II(a) below), while for many practical purposes in France in his time, the alternative to large-scale capitalist farming was sharecropping. Where modern methods were not used, 'the proprietors . . . hire *Colons* or *Métayers* who are unable to make any advances or to cultivate properly' (1766, p. 72; see also Section II(b) below). To bring out the issues involved, it is enough to consider only whether a given piece of land is cultivated or not.

Let there be n different types of land, indexed $1, \ldots, n$. If type k land is cultivated at all, it yields an output Q^k of goods (in total, from all land of that type), using inputs of goods 1 and 2 given by A^k and B^k, respectively. As before, A^k and B^k include wage goods corresponding to the subsistence needs of the workers employed, and a one-period cycle of production is assumed. The surplus of output over cost is given by

$$S^k = Q^k - (1+r)(A^k + pB^k) \tag{2}$$

where interest on advances is counted as a cost. S^k is a decreasing function of r, since Q^k, A^k and B^k are taken as given, while p is an increasing function of r.

If the surplus is positive, the land will be cultivated, and surplus will accrue to the landowner as rent, because competition between entrepreneurs for land to rent reduces their profit to equality with the interest rate (1766, p. 72). If the surplus is negative, that is, if the product is not sufficient to cover all costs including interest, the land will not be cultivated (1766, p. 88). Turgot did not discuss the case where surplus is zero; presumably it is a matter of indifference whether the land is cultivated or not. Formally, I assume that land of type k is cultivated if $S^k \geq 0$.

Total agricultural output, Q_1, is given by

$$Q_1 = \sum Q^k \tag{3}$$

where the summation is taken over all k for which $S^k \geq 0$. Similarly, total rent, S, total demand for inputs into agriculture of goods 1 and 2, A_1 and B_1, and total capital investment (advances) in agriculture, K_1, are given by:

$$S = \sum S^k \tag{4}$$

$$A_1 = \sum A^k \tag{5}$$

$$B_1 = \sum B^k \tag{6}$$

$$K_1 = A_1 + pB_1 \tag{7}$$

where the summations, again, are taken over all k for which $S^k \geq 0$. Since S^k is a function of r, all of the variables determined above (Q_1, S, A_1, B_1 and K_1) are also functions of r.

Output of good 2, the manufactured good, must now be determined. Turgot did not discuss the composition of output in any detail, but he did insist that supply adjusts to demand so as to ensure price equal to cost (see Section I(a) above). Output in agriculture is constrained by the availability of land that can be cultivated profitably at any given interest rate, as discussed above, but non-agricultural output is not constrained in the same way. (This will be discussed further in Section II(b).) To close the formal model, I assume that consumption demand for good 2 from non-wage-earners is given by a demand function $D(p, Y)$, where $Y = r(K_1 + K_2) + S$ is total non-wage income, and K_2 is capital employed in manufacturing. To this must be added the demand for good 2 as an input in both sectors, including demand from workers. The condition that demand should equal supply (production) can be written as

$$Q_2 = D\{p, r(K_1 + K_2) + S\} + B_1 + bQ_2 \tag{8}$$

and the capital employed in manufacturing, equal to costs in manufacturing, is given by

$$K_2 = (a + pb)Q_2. \tag{9}$$

The basic idea of the model is quite simple. Agricultural output is governed by the interest rate, since only those types of land that yield a profit rate at least equal to the interest rate will be cultivated. Manufactured output is governed by agricultural output, because of the conditions for balance between the two sectors. Formally , (1) and (3)–(9) determine the eight variables Q_1, Q_2, K_1, K_2, S, p, A_1 and B_1.

(d) *Accumulation and the interest rate*

Consider now the effect of a reduction in the interest rate. Surplus rises on each type of land, because interest is a cost, and because the relative price of non-agricultural inputs falls (p has been shown to be an increasing function of r; Turgot did not make this point, but it is needed for formal completeness.) As the interest rate falls, some land that was previously extra-marginal and uncultivated will become worth cultivating. The summations in (3)–(6) above will be taken over a greater range of types of land, and agricultural output will increase.

This is the central point of Turgot's theory. In his words:

> The price of interest may be looked on as a kind of level, beneath which all labour, industry, agriculture and commerce come to an end. It is like the sea spread over

> a vast area; the summits of the mounts rise above the waters and form fertile and cultivated islands. If the sea happens to flow back . . . the plains and valleys appear, and are covered with productions of every kind. It is enough that the water rises or falls a foot to inundate immense tracts, or throw them open to cultivation. [1766, p. 88]

In terms of the model as it is presented here, a reduction in the interest rate is certainly associated with an increased agricultural output. Turgot assumed that it would involve an increase in total output and in total capital required (1767a, p. 116). Perverse results are just possible, for example if good 2 is an inferior good, or if the reduction in p_2 lowers capital required in terms of good 1 as numeraire. The first of these is unlikely to occur in practice, and the second is an artificial result of the choice of numeraire, and would be offset by corresponding capital losses. Both will be ignored. The total demand for capital is then a decreasing function of the interest rate.

The interest rate is not exogenous. It is 'a kind of thermometer of the abundance or scarcity of capitals in a nation' (1766, p. 87). Like any other price, the interest rate is determined by supply and demand (1766, p. 77). However, since returns in all the different uses of capital are equalized, the interest rate, as a proxy for the general profit rate, is determined by supply and demand for capital. It depends on 'the quantity of movable wealth accumulated to form capitals' (1766, p. 84).

At any date, the existing quantity of capital can be taken as given. The demand for capital has been shown to be a decreasing function of the interest rate. Together, the supply and demand for capital close the model; formally,

$$K_1 + K_2 = \bar{K} \tag{10}$$

where $\bar{K}$ is the existing stock of capital.[5] The system (1), (3)–(10) determines the nine variables Q_1, Q_2, K_1, K_2, S, p, A_1, B_1 and r.

Over time, capital is accumulated by saving out of rent and profits. As the supply of capital increases, the interest rate falls as the system moves down the demand curve for capital, and production expands, absorbing the additional capital. In Turgot's words,

> The effect of this accumulation is to lower the interest of loan money; . . . to diminish the necessary returns of the entrepreneurs in all industries; to make profitable, and consequently possible, enterprises which were not so previously; to increase proportionately the total number of enterprises and the total output. [1767a, p. 116]

II. Extensions

(a) *Choice of techniques*

Although Turgot's main stress was on the division between cultivated and uncultivated land, he also allowed for differing degrees of intensity of cultivation. 'While . . . in the case of ordinary good cultivation, the annual advances return 250 for 100, . . . as the advances are increased gradually . . . each increase would be less and less productive' (1767a, p. 112; the whole passage is an outstandingly clear discussion of diminishing returns).

There is no difficulty in incorporating a choice of intensity of cultivation into the model; indeed, it would be quite possible to assume that all land is

cultivated to some degree, so that the intensive margin wholly replaces the extensive margin. Let there be a choice of methods of production on each type of land. Corresponding to each method, a value of S^k can be calculated, as in (2) above. The method that maximizes the surplus (given the interest rate) will be chosen, and the maximum surplus will accrue to the landowner as rent (1766, p. 72; 1767a, p. 112). As before, if $S^k < 0$, the land is not cultivated at all.

Turgot insisted that the return to a marginal increment of investment on a given piece of land falls beyond some point, though there are increasing returns initially. Investment is carried to the point where the return at the margin is equal to the interest rate. This is equivalent to a marginal (net) product theory of the profit rate, though Turgot did not phrase it in those terms. Indeed, he stated explicitly that 'advances are not in themselves productive' (1767a, p. 111): rather, they are necessary to finance the employment of labour and of other productive inputs.

With a choice of techniques in agriculture, output and capital employed on each type of land considered separately are functions of the interest rate. As capital is accumulated and the interest rate falls, output on a given type of land will jump from zero to some positive level (because of initial increasing returns), and will continue to increase as the interest rate falls further. For the system as a whole, an increase in the capital stock is absorbed at both the intensive and extensive margins.

It would also be possible to incorporate a choice of techniques in non-agricultural production. Turgot had little to say about this possibility, but he did phrase his discussion of accumulation so as to cover the possibility that capital may be absorbed in both sectors as the interest rate falls. In particular cases, he discussed cost-minimizing choices, for example choice between storage and interregional transport of grain to meet local shortages (1770b, p. 176), and choice of location in the production of iron (1773, pp. 186–7).

(b) *Many goods*

There is no difficulty in incorporating many non-agricultural goods in the model. Turgot clearly had a many-good world in mind, but gave no formal analysis of changes in relative prices as accumulation proceeds. The condition that price be equal to costs is sufficient. Formally, with more than one non-agricultural good, there is a price equation for each, corresponding to (1), and the price equations must in general be solved simultaneously if one good serves as an input in the production of others, or as part of the wage bundle. A demand equation for each non-agricultural good is needed to complete the system. Such a ('Sraffian') system is implicit in Turgot's discussion of reproduction (e.g. 1766, pp. 75–6).

Introducing a multiplicity of agricultural goods raises more serious problems. Turgot pointed the way, first by insisting that all prices are determined by demand and supply, and second by arguing that 'the cultivator can choose' from among a variety of crops 'those whose sale yields the highest profits' (1767a, pp. 120–1). For any given interest rate and set of prices, the profit maximization condition would determine the quantity supplied of each good, and the resultant supply functions would have to be equated with appropriate demand functions. Done thoroughly, this would generate a full Walrasian

general equilibrium system; it would of course, be quite anachronistic to look for such a system in Turgot.

III. Problems

The model presented above is based on Turgot's assumptions and the main arguments are taken directly from his writings. It supports his main conclusion, that capital accumulation drives down the interest rate, allowing expansion of the economy by pushing out both the intensive and extensive margins in agriculture, with a consequent increase in output and rent ('net product'). There remain, however, aspects of his work which do not, at first sight, fit very comfortably into the rational reconstruction presented here, and which therefore need further discussion.

(a) *Non-agricultural prices and outputs*

In the model of Section I, non-agricultural output adjusts passively to changes in demand stemming from changes in the scale of agricultural activity and to changes in relative prices induced by interest rate changes. Turgot, however, treated agricultural and non-agricultural activities in a much more symmetrical way, arguing that a lower interest rate makes previously extra marginal activities in both sectors 'profitable, and consequently possible' (1767a, p. 116). His phrasing is not incompatible with the model presented above, but it might be thought to cast some doubt on it.

This difficulty can be overcome by noting that Turgot's analysis implicitly relates to an open economy,[6] whereas the model presented here is restricted, for the sake of simplicity, to a closed economy. In the main discussion of the role of the interest rate as a 'thermometer' of the abundance of capital in the *Reflections*, for example, Turgot argued that a nation where the interest rate is relatively low has a competitive advantage, because interest is a cost; so,

> as its manufacturers and merchants can content themselves with a lower profit, they will place their goods on all markets at a much lower price, and will draw to themselves the almost exclusive trade in all those commodities of which the trade is not retained (by exceptional circumstances or by the excessive cost of carriage), for the commerce of the [high interest] nation. [1766, p. 88; see also 1759, p. 29]

Each time Turgot dealt with the effect of interest rates on non-agricultural outputs, he did so explicitly in terms of external competitiveness.

In an extreme case, with goods freely tradable and zero transport costs, outputs in the agricultural and non-agricultural sectors would be independent of each other (for a given interest rate), depending only on profitability at given world prices. It is clear that Turgot did not consider such an extreme case, but it is equally clear that he did not assume a closed economy. He did not assume perfect interregional mobility of capital either (1770a discusses reasons why the interest rate should be relatively high in Angoulême), so a reduced interest rate in one region would give producers in that region a competitive advantage.

(b) *Expansion without diminishing returns*

An essential feature of the interpretation of Turgot's theory presented here is that the most fertile land (strictly, the land most productive of surplus) is

cultivated at high interest rates, with cultivation shifting to less and less fertile areas as the interest rate falls. At the margin, the return on investment equals the interest rate (plus compensation for risk, etc.). Turgot repeatedly emphasized these arguments. (See references cited in Section I(c) and (d), and the discussion of the zero-rent margin in Section IV below.) At the same time, one can find statements that appear directly to contradict the analysis. The scale of investment at which diminishing returns set in has not been reached (1767b, pp. 125–6). The use of additional capital must 'increase the produce in a much greater proportion than the interest' (1770b, p. 172).

Was Turgot simply inconsistent? I think this conclusion can be avoided, at least to some extent, by recognizing that he had two different models for use in different circumstances. One is a theory of economic development in which capitalist agriculture supplants more primitive forms of organization (slavery, sharecropping, etc.), while the second is a theory of the effects of capital accumulation in a fully capitalist system, the theory set out in Sections I and II above.

Turgot's account of economic development is most fully set out in the early part of his *Reflections* (1766, pp. 47–56). He discussed the settling of a hypothetical empty country (starting with the most fertile land), the institution of private owernership of land, and the emergence of a class division between the owners and cultivators of the land. He then discussed five different ways for the owner to get a revenue from their lands. The fifth, and 'most advantageous', is 'renting, or the letting out of land' (1766, p. 55), but this 'assumes an already wealthy country', since the tenants must be in a position to invest on the necessary scale. The northern provinces of France had reached this stage of development, and were 'incomparably richer and better cultivated' than the southern provinces, which had not (1766, p. 55). This line of argument was taken almost direct from Quesnay.

Turgot's theory of interest and profit clearly assumes the renting of land; when he introduced agricultural investment as a use of capital, he described it specifically in terms of 'owners of large capitals' who take leases of land and pay rent (1766, p. 71). When he described agricultural expansion without diminishing returns, on the other hand, it was typically in the context of the contrast between the wealthy northern provinces and the poor southern provinces, that is, in the context of a contrast between two different systems of tenure. Thus, where Turgot argued that 'the point where augmentation of the advances would not increase the output in proportion to the increase of expenses' has not been reached (1767b, pp. 125–6), this is supported by the claim that the highest rents are found where the cultivators are most wealthy, echoing the language of his north–south contrast, while the parallel argument that additional capital increases the produce in greater proportion than interest (1770b, p. 172) is also followed almost immediately by a specific comparison between north and south (1770b, p. 173).

One might reasonably ask, of course, why capital does not flow from north to south to equalize marginal returns in agriculture, as Turgot's own account of profit rate equalization might lead one to expect. Part of the answer is that he clearly did not regard capital as freely mobile between different regions of France, as is shown by his explanation of the relatively high interest rate in Angoulême (1770a). In any case, he explains the interregional differences in

terms of the absence of rich farmers locally rather than in terms of a general lack of capital (see for example 1766, pp. 55, 72); poor farmers, presumably, cannot borrow because they are not creditworthy, and agricultural entrepreneurship is immobile.

(c) *Effects of taxation*

Turgot's treatment of taxation was firmly in the physiocratic tradition. Only agriculture could produce a surplus over cost (the 'net product'), in the form of rent. Hence, only rent could be taxed; any other form of taxation either must be passed on in higher prices, falling eventually on landowners, or must result in the abandonment of the activity concerned. The definition of 'net product' is not worth arguing about; if Turgot chose to define it as consisting only of rent, then that definition is as good as any other. That he used a particular phrase in the same way as the physiocrats does not mean that his theory was the same as theirs. The analysis of tax incidence is another matter.

He argued, in particular, that if interest or profit is taxed, it causes 'an augmentation in the price of advances', which diminishes economic activity (1766, p. 92; see also 1767a, pp. 113–14). The argument is straightforward in the case where the tax falls only on profits in a particular activity. Capital mobility equalizes after tax returns on investment, so either the price of the product must rise to cover the tax, or the activity will be curtailed. (Normally, of course, there will be a combination of the two, in proportions determined by the slope of the demand curve.) Similarly, a tax on interest, but not on other kinds of profit, will impede the working of financial markets by making it more attractive to invest directly than to lend (cf. Turgot's discussion of legal restrictions on interest, for example, in 1770a, pp. 150–1, 162). So far, so good; Turgot's analysis poses no problems, though it is true that he did not discuss any consequential effects on the profit rate, especially of taxes on marginal agricultural investments.

Consider, however, the effect of a tax on all forms of profit. If the total accumulated capital is taken as given, the (pretax) rate of return must settle at the level at which the capital can all be employed, as set out in Section I above. The tax must fall on the recipients of profit incomes, since there is, by assumption, no alternative income-producing form of investment open to them. If Turgot's conclusion is to be saved, it must be because capital is withdrawn from productive use altogether, either by dissaving or by hoarding of money. Turgot did consider this possibility, though only as an illustration, and in a different context (1766, p. 83); but it could hardly be considered a likely response to a (small) reduction in the after-tax rate of return, particularly as Turgot claimed that the interest rate had been falling over time without seriously impairing accumulation.

It is not entirely clear which cases Turgot was referring to, since he did not always spell out the exact kind of tax involved. At best, his treatment of taxes was unclear; at worst it was incompatible with the analysis of the demand for capital that he presented so clearly at other points in his writings; no doubt he was led to overstate his case by his fierce opposition to the irrational and archaic system of taxation in France at the time (a system that he tried, but failed, to reform). It is worth noting that he did recognize (in a discussion of Holland) that profits could be taxed successfully if they were, in some sense,

above the minimum needed to induce investment (1767b, pp. 128–32), and also that profits were 'dispensable' in the sense that part of profit could be, and was, saved.

IV. Turgot and Classical Economics

The classical economics of the early nineteenth century was the product of a long tradition, stretching back to Petty and Cantillon. Turgot was the first to gather together all of the main elements of the mature classical model, and should therefore be regarded as the founder of classical economics.[7] In particular, I argue that he substantially anticipated the theory of rent and profit rediscovered and popularized by Malthus, West and Ricardo in the early nineteenth century.

Many elements of the classical model were already well known in Turgot's time. The theory of subsistence wages and the 'Malthusian' population theory on which it rested were already well established, as was the analysis of prices in terms of supply- and demand-determined market prices (exchange values, in Turgot's terminology), which tend towards cost-determined natural prices (fundamental values). Turgot's explicit introduction of interest as an element in cost was a step forward. Quesnay had argued thet capital scarcity was an important constraint on output, but he continued to treat the return on capital as a kind of wage, analogous to the wage of skilled labour. In Turgot's analysis, as in that of Smith and Ricardo, profit (interest) took its place alongside wages and rent as a distinct component of income, so it was necessary to explain how the surplus of output over (subsistence) wages was divided between profit and rent. As is well known, Smith's account of the determinants of profit was distinctly vague. It has been the subject of much debate, which cannot be reviewed here; in any case, Turgot's work preceded the *Wealth of Nations*, so the only question is how much Smith learned from Turgot (not enough, might be a reasonable answer).[8]

In the mature classical theory of Malthus, West and Ricardo, profit and rent are determined by the condition that marginal land yields no rent, so the profit rate is determined by returns on marginal land, while the additional returns on intra-marginal land accrue to the landowner as rent. Turgot's theory was essentially the same. This conclusion follows from the reconstruction presented above, and can be reinforced by considering some relevant extracts from his writings.

Referring specifically to the extensive margin, Turgot wrote:

> If the interest is at five per cent, all uncleared land whose produce would not yield five per cent over and above the replacement of the advances and the recompense of the care of the Cultivator, would remain uncultivated. [1766, p. 88]

Land that yields more than 5 per cent (in the example) is cultivated, and the excess over 5 per cent goes to the owner as rent (cf. 1766, p. 71). Land that yields less is not used. Clearly, land that yields exactly 5 per cent is the marginal land, and yields no rent. Turgot did not say this in so many words, but the implication is so obvious and so direct that there was no need to. In terms of the famous metaphor likening the interest rate to the sea, with 'cultivated islands' above water level (1766, p. 88), the zero rent margin is represented by the tidemark.

Now consider Turgot's treatment of the intensive margin. In a numerical example (1767a, pp. 112–13), the first 'dose' of investment yields 150 per cent, the second 125 per cent, and so on. Investment should be increased as long as it increases the net product, i.e. the return over and above interest (1767a, p. 112). Since the return declines eventually to zero (1767a, pp. 111–12), there is an optimal level of investment at which the net product is maximized, that is, at which the marginal contribution to the net product (rent) is zero. Again, a zero rent margin is implicit.

Turgot also considered the effect of taxation on returns, and hence rents, and explicitly described a zero rent margin:

> if the exchange value [net of tax] is diminished, the revenue would diminish gradually to the point where finally the soil would produce nothing beyond the reproduction of advances and the profit of the cultivator; ... from then on, there would be no more letting out of land. [1763, p. 103]

Turgot credited Quesnay with this argument, but in Quesnay's account it was not coupled to the determination of the interest rate or to the equalization of profits between different activities, so it did not play the same role as it did in Turgot's model.

Nothing said above should be taken as a claim that Malthus, West or Ricardo was influenced by Turgot. It is true that Ricardo, for example, knew the *Reflections* (1766), since he referred to it, though only in passing, and only on relatively tangential issues.[9] Direct influence seems unlikely, since there are such striking differences in presentation and emphasis, which have caused the underlying similarity to go unnoticed. Unconscious influence is possible, but hardly seems worth discussing, since it can be neither proved nor disproved. I confine myself to the more measurable issue of priority, where there can be no doubt: Turgot came first, by half a century.

ACKNOWLEDGMENTS

Peter Groenewegen, Ian Steedman and an anonymous referee made helpful suggestions, but should not be blamed for the outcome.

NOTES

1. The main source for Turgot's economic writings in English translation is Groenewegen (1977). Meek (1973) contains a brief biography and some of Turgot's non-economic as well as economic writings. For an alternative treatment of Turgot's theory (mainly complementary to that presented here), see Groenewegen, (1970, 1971, 1983).
2. See Schumpeter (1954, pp. 243–9, 323–4, 332–3) and Walsh and Gram (1980, pp. 40–4).
3. See Groenewegen (1969, 1983) and Walsh and Gram (1980, p. 71).
4. References cited by date with no author's name are by Turgot; page references are to Groenewegen (1977). It should be noted that the main writings cited here date from a relatively short period, within which Turgot's views seem very consistent. I treat all of these writings as alternative sources of a single theory.
5. Strictly, K_1 is not a continuous function of r, since each type of land switches into use at a critical interest rate; this objection is easily dealt with, for example by assuming a continuum of types of land.
6. Smith (1766) similarly assumed an open economy; see Brewer (1986b).
7. Various authors, following Marx, identify classical economics with the idea of a surplus over (necessary) cost (Garegnani, 1984), and trace this idea back to Petty and Cantillon (Walsh and Gram, 1980, p. 3, cf. Roncaglia, 1977, pp. 62–4). Eltis (1984), like Garegnani, starts the story with Quesnay. I take the division of surplus between profit and rent, together with the equalization of profit rates, to be an essential component of classical economics. Samuelson (1978) has a rather different implicit definition, involving diminishing returns in agriculture

coupled with a relation between the wage rate and the rate of population growth. In Samuelson's terms, I argue that Turgot's model is a variant of the 'canonical classical model' which is at least as developed as Smith's.

8. For discussion of the relation between Turgot and Smith, see Groenewegen (1969). Walsh and Gram (1980, pp. 41, 71) suggest that Smith may have influenced Turgot, when they met in 1765–6, at the time when Turgot was writing the *Reflections* (1766). They provide no evidence for this implausible conjecture, however, and in any case the main points of Turgot's theory are found in his early writings, before the meeting with Smith. I have argued elsewhere (Brewer, 1986a, 1986b) that Smith's work also contains more elements of the Malthus–West–Ricardo theory than has been generally recognized, but there can be no doubt that Smith's treatment was considerably less well developed than Turgot's.
9. In the preface to his *Principles*, Ricardo implicitly denied any close similarity with Turgot's theory, since he wrote that Turgot (and others) 'afford very little satisfactory information respecting the natural course of rent, profit, and wages' (Ricardo, 1817, p. 5). See also Groenewegen (1983).

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