

Impact Studies without Multipliers:
Lessons from Quesnay's Tableau Economique

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Preliminary version, comments invited.

This paper is a revised and shortened version of an earlier papers of ours,¹ focusing on the implications for input-output methodology of Quesnaysian argument. The present paper reports on work in progress, and has not yet reached its final form.

¹ A.E. Steenge and R. van den Berg, "Transcribing the Tableau Economique: Input-Output Analysis à la Quesnay", *Journal of the History of Economic Thought*, Vol 29, pp. 331-358 (2007).

Abstract:

The Tableau économique, first presented by Francois Quesnay in 1758, is traditionally seen as a direct forerunner of circular flow and input-output types of studies. Over the centuries it has inspired many scholars including Karl Marx in his studies of capitalism. The Tableau, however, was presented in a format (the zigzag) that has not become a part of the toolkit of modern economics.

Several attempts to transcribe the Tableau into a modern input-output table have been made of which Almarin Phillips' 1955 formulation of the Tableau's equilibrium state (the "state of bliss") has been very influential. Yet, Phillips' input-output table has invoked much debate and controversy. A major issue was his handling of the many interactions of technological, institutional and behavioral rules and practices that characterize the Tableau. For Phillips' table this basically means that the individual researcher has to judge for him/herself which manipulations of the table are consistent with Quesnay's views. Very little is known here.

A recent reconstruction of the Tableau from basic XVIIIth Century texts and data shows that special methods were employed by Quesnay (and to a lesser extent his contemporaries) to calculate the impact of *changes* in (what we now would call) final demand (Steenge and van den Berg, 2007). In the paper we discuss the methods used, and the way in which these differ from methods in use in input-output practice today. We also list manipulations that are allowed (i.e. consistent with Quesnay's views), and which not. Our conclusion is that Quesnay's methodology is different from Leontief's on a number of key points. However, we can perform impact studies which are relevant for dealing with many of today's policy issues, in particular when broader societal themes such as cultural, environmental and sustainability issues are involved.

1. Introduction

Since its publication in 1955, Almarin Phillips' article 'The Tableau Économique as a Simple Leontief Model' has inspired an interesting line of interpretation of the arithmetical schemes presented two centuries earlier by François Quesnay. Subsequent attempts to represent the *Tableaux économiques* in the form of Input-Output transcriptions by amongst others Shlomo Maital (1972), Bernhard Korte (1972), Tibor Barna (1975) and Paul Samuelson (1986) have underlined the brilliance of the French doctor's formal conception of the economy as a reproductive system.

At the same time, however, these modern 'translations' have not been wholly satisfactory. Most fundamental is a perceived discrepancy between the purpose of the *Tableaux* and that of traditional Input-Output (I-O) analysis. One of the primary purposes of the *Tableaux* was to study the conditions for economic growth and decline. Quesnay's well-known recipe for growth was the creation of conditions that were favourable to income generation in those sectors of the economy that were deemed by him to be capable of generating a large surplus. Some modern commentators, in particular Walter Eltis (1975ab, 1984) have emphasised the primary importance of Quesnay's conception of the phenomena of growth or decline, without however attempting a restatement using I-O methodology.

The I-O transcriptions of the *Tableaux* presented up to date have contributed little to a modern interpretation of Quesnay's understanding of economic development, its preconditions and its impediments. Tellingly, Quesnay's basic conviction that money income needs to end up 'in the right hands' in order to allow a continued productive use and guarantee the existing level of prosperity in the economy, is routinely disproved in I-O interpretations of the *Tableaux*.

In Steenge and van den Berg (2007) we provided an alternative interpretation of the Quesnaysian insight. That is, we proposed an I-O model that allows for a specification of differing productive capacities of sectors and for disequilibrium approaches. Not only does such an I-O model do more justice to Quesnay's intentions and is it capable of reproducing some results that existing I-O transcriptions cannot. More importantly, the model may also be a useful tool for the understanding of the favourable and unfavourable directions of growth of modern economies. However, it also may be interpreted as an example of what may be called a "non-multiplier based" input-output model. That is, the consequences of a shift in final demand are determined within a set of theoretical concepts not based on fixed coefficients types of production functions. Particularly when economic decision making is influenced by political, sociological or psychological motivations, this way of looking at intersectoral relationships may offer tools that increase our understanding of real world developments.

Below we shall first present the basic argument of our 2007-paper, and after that focus on the research topics that are involved.

2. Which *Tableau*?

The interpretation of the *Tableau économique* has always been complicated by the fact that it did not spring fully formed from Quesnay's mind, but was amended in various ways over a period of eight years.¹ The earliest version, used by Quesnay and Mirabeau up to 1763, is most immediately recognisable by its striking symmetrical multiple line pattern, already referred to by Quesnay himself as 'the zigzag' (see below, p. 21). Then there is the version known as the '*Précis*', which appeared exclusively in *La Philosophie rurale* (first edition November 1763) and which normally is considered as a transitory form of presentation (see Meek 1962; and especially Eltis 1996). The final form of the *Tableau* is that of the *Formule* of (June) 1766. It

is characterised by its simple line structure, marveled at by Marx, representing total exchanges in an idealised agricultural kingdom.

The I-O reconstructions of the *Tableau*, starting from Phillips (1955), have been based primarily on the final version of the *Tableau*. One of the well-known results of these exercises implies a serious objection against the validity of Quesnay's numerical demonstrations of economic decline: Leontief-theory yields a resounding negative answer to the question whether a mere shift in proprietors' preferences towards more luxuries could result in a decrease of the agricultural surplus. This result was obtained after attempts had been made to 'open up' the closed Phillips transcription. That is, by using the framework of the traditional *open* Leontief model landlords' consumption can be depicted as a so-called exogenously given final demand sector.² Once landlords' consumption is exogenous, a shift in their preferences can be easily expressed and the effects on the magnitude of the *produit net* can be examined.³ The conclusion that can be drawn from this exercise - Barna (1975, pp. 493) was the first to do so - is quite explicit: the effect is non-existent.

In the following we aim to develop a new type of I-O model that *is* capable of reproducing the phenomena of economic decline (and growth) which Quesnay sought to illustrate with his calculations. To facilitate the discussion let us start with reproducing Philips' transcription of the Formula. The table is entirely in money terms, here thousands of *livres*.⁴

Table 1

	<i>Farmers</i>	<i>Artisans</i>	<i>Proprietors</i>	<i>Total</i>
<i>Farmers</i>	2000	2000	1000	5000
<i>Artisans</i>	1000	0	1000	2000
<i>Proprietors</i>	2000	0	0	2000
<i>Total Purchases</i>	5000	2000	2000	9000

Neither Quesnay, nor any of his followers, ever used a *Tableau* of the Formula type to illustrate the effects of a shift towards the consumption of more luxuries.⁵ However the numbers used in the equilibrium version of the *Précis* in *Philosophie rurale* also strongly resemble those in Philips' table; and the *Précis* Quesnay *did* use to illustrate the effects of *luxe de décoration*.⁶ In one particular example in *Philosophie rurale* (1763, pp.307-311) Quesnay and Mirabeau examine the effect of a shift in landlords' spending to 800 units of farmers' products and 1200 units of manufactured products, from an original spending pattern of 1000 on each. The passage containing this example has been included in translation in the appendix, and we will have reason to refer to it on several occasions further along.

First, however, let us illustrate the reasoning that has motivated the, by now conventional, conclusion that the indicated shift in spending patterns will have no effect on output levels. Giving the conventional I-O interpretation to what would be the effect of the shift, we obtain the numbers in the following table:

Table 2

	<i>Farmers</i>	<i>Artisans</i>	<i>Proprietors</i>	<i>Total</i>
<i>Farmers</i>	2000	2200	800	5000
<i>Artisans</i>	1000	0	1200	2200
<i>Proprietors</i>	2000	0	0	2000
<i>Total Purchases</i>	5000	2200	2000	9200

The crucial mechanism in this table is that the shift in demand for agricultural goods from proprietors (to 800) has been matched precisely by a shift in opposite direction from the side of the artisans (to 2200). This reflects the fact that since landlords are purchasing more manufactures, artisans purchase more raw materials from the agricultural sector. Hence total purchases from (production of) the agricultural sector remains unchanged and equal to the total expenditures of that sector (which includes an unchanged amount of 2000 units of rent payment).

Thus *Leontief theory* tells us that equilibrium will not be disturbed by a shift in spending by the proprietors towards manufactures and hence that the overall level of economic activity will be left unaffected. Several modern commentators have accepted that this conclusively invalidates one of Quesnay's central contentions (see e.g. Barna 1975, Samuelson 1986, or Jean Cartelier 1998, 2000). It is interesting to note that this conclusion is not new. In fact as early as 1767 the first serious critic of the *Tableau*, François Véron Duverger de Forbonnais (1722-1800), made a number of observations that are reminiscent of the above view.⁷ Forbonnais was a famous French 'apologist' of luxury consumption and it was this position that motivated him to challenge Quesnay's idea that disproportionate spending on luxury manufactures can depress agricultural production (see Forbonnais 1767, pp. 224-245).

One might want to conclude that, very belatedly, Forbonnais' criticism has been validated by Leontief theory. However, an opposite interpretation is possible too. It is that the I-O transcriptions presented to date have not contained a mechanism for translating a shift in preferences into overall decline. In other words, what the literature up to now has done is presenting I-O transcriptions that lack the elementary features of the *Tableau économique*. This is the view that we will develop in the remainder of this paper. In sections 4 and 5 we will introduce some fundamental modifications to conventional I-O interpretations that, in our opinion, are necessary to capture Quesnay's intentions. First, however, in preparation for that exercise, we will discuss some specific characteristics of the *Tableau* which in some cases are quite unlike the conceptions that inform conventional I-O theory.

3. Specific Characteristics of the Tableau

One of the primary purposes of the *Tableau* is to express Quesnay's vision of the 'ideal state' of an Agricultural Kingdom. A characteristic of this ideal state is that it has achieved a balance: the economic system can continue to reproduce a net product at the same level. In addition, the size of the net product is considered to be the highest achievable. The term 'ideal' also means that any deviation from this state will mean that the country's surplus will decrease, with a subsequent general decline of incomes in the country. Thus the *Tableau économique* is

supposed to express two ideas. First, it gives the proportions in the ideal state. Second, it is supposed to show that any change will be for the worse.

In Quesnay's theory the ideal state exhibits specific proportions between the various expenditures within the economy. All can be expressed in terms of the so-called base of the economy, or annual advances of the 'productive' farmers' class, A . The structure of the ideal situation in the *Tableaux* is given in table 3.

Table 3

	<i>Farmers</i>	<i>Artisans</i>	<i>Proprietors</i>	<i>Total</i>
<i>Farmers</i>	A	$.5A + .5A$	$.5A$	$2.5A$
<i>Artisans</i>	$.5A$	0	$.5A$	A
<i>Proprietors</i>	A	0	0	A
<i>Total</i>	$2.5A$	A	A	

Let us denote the element in the (i,j) th position by the symbol x_{ij} . The proportion between entries x_{11} (annual advances) and x_{31} (surplus) expresses Quesnay's view that an agricultural sector that adopts modern agricultural techniques and that is benefiting from favourable government policies, in particular liberalisation of agricultural markets, will be able to produce a net product of about 100% over annual advances.

The expression of the net product as a percentage of annual advances is somewhat peculiar. It certainly does not indicate that in Quesnay's view the 'primitive advances', or more durable capital goods, are unimportant. On the contrary, only if annual advances, e.g. seed or workers' wages, are accompanied by a substantial amount of investment in machinery, animals and fertilisers, - Quesnay's customary estimate being a ratio 1:5 between the two types of advances under the system of *grande culture* - will agriculture be as productive as deemed possible. Thus the expression of surplus over annual advances seems to be no more than a practical choice.

Of course the position of the surplus in the above table implies that it is understood as a payment of rent to the proprietors of cultivable land. For several reasons it is an entry with a difference. Whereas the other two entries in the first column express commitments due to physical purchases made by the farmers' class, rent payments are rather seen as (periodically adjustable) contractual commitments whose magnitudes are based on an agreement about the surplus income that farmers can reasonably expect to raise.⁸ This agreement does, of course, entail a judgement about the agricultural techniques in use and the prices that are expected to prevail: these are economic fundamentals that together explain the existence of a surplus in agricultural activity. However, an important point is that due to the fixed nature of the lease contract, the amount of rent to be paid is not immediately dependent on the success of (the sale of) the harvest.⁹ Because of this, it is possible that actual receipts fall short of the amounts specified in the lease contract. This raises an unconventional problem for I-O theory. In a typical Leontief world, incomes are always guaranteed. That is, whenever one sells something, payment is immediate and to the full extent. Below we will propose a method to deal within an I-O framework with the conception of a payment that is specified in a contract but that may not be forthcoming.

The other entries require less explanation. Entry x_{12} is subdivided into two equal parts in order to reflect Quesnay's assumption that the total advances of the artisans' class consist for one

half of advances (raw materials) bought from the farmers during the previous round of production and another half bought during the current round. The remaining entries are not similarly subdivided. However, they are “composites” just the same. They may have the appearance of single quantities, allowing them to be transcribed using ‘simple’ input coefficients just giving proportions between more or less homogeneous input categories. However, that does not properly represent Quesnay’s conceptions. The entries should rather be viewed as being the result of a number of direct and indirect mechanisms.

Most important is that the magnitudes do not merely reflect technology. They also reflect social and behavioural phenomena.¹⁰ In fact, the coefficients are not ‘measured’ in the way inputs in production are being measured in standard Leontief methodology. On the contrary, they rather must be calculated on the basis of perceived relations between the various entries as given by the entries in Table 3. This basically amounts to the postulated existence of small sub-models.¹¹ It should be recalled that, rather than using modern terms like ‘sectors’ or ‘industries’, Quesnay always speaks of ‘classes’. The purchases by the artisans from the farmers’ class, and vice versa, and the use by the latter class of a part of its own produce do not simply occur to satisfy ‘technical requirements’, but are also understood to afford the consumption of the people within the two classes.¹²

If we accept that there is at least a social component to the determination of the amounts that are exchanged within the *Tableaux*, and that this is true not only for the class of proprietors but for all classes, then it should be doubted whether the use of fixed coefficients is appropriate.¹³ Below (section 5) we will give an alternative to fixed coefficients and show how, using this alternative, Quesnay’s view that shifts in expenditure patterns may lead to economic decline, can be validated within an I-O model.

The fact that Quesnay assumes the exchanges of the ‘productive’ and ‘sterile’ classes to have a social component too is crucial with regard to the most well-known of the phenomena that, according to him, can lead to economic ruin. This phenomenon is of course a shift in spending by the proprietors’ class towards more luxury goods, i.e. manufactures. In the places where Quesnay presents a *Tableau* describing this shift, he is careful to point out that he assumes that the change in the behaviour of the proprietors is emulated by the farmers’ class and artisans’ class. Thus as an explanation of the relevant zigzag *Tableau* in *L’Ami des Hommes* we read:

The habits are followed and taken over through imitation by all classes, the interconnections of manners being everywhere as strong as the physical interconnections. That shift [...] will be the same with the Artisan and the Cultivator (Mirabeau 1761, p. 68).¹⁴

A similar statement precedes the relevant disequilibrium précis *Tableau* in *Philosophie rurale* (Mirabeau 1763, p. 307; see the appendix).

These statements are rather concise and are left largely unexplained. Why would and how could the working classes in society imitate the fancies of the rich, leisurely proprietors’ class? It has been suggested that on this point Quesnay and Mirabeau drew on the views of Richard Cantillon (1731, esp. ch. 14 and 15), who argues at greater length the importance of the spending of landowners not only for the direction of resources in the economy but also as ‘trend setting’ behaviour.¹⁵ However this does not explain how farmers and artisans -who in other places in the physiocratic literature are presumed to have little disposable income- are presumed to be capable of imitating the luxury consumption of the rich.

It is interesting to note that Quesnay acknowledges a difficulty here. In the *Philosophie rurale* after discussing the effects of a uniform shift of all classes towards the consumption of more manufactures, he qualifies his calculations with the statement that ‘[a] luxury consumption that is entirely disorderly can exist only among men of fortune’ (Mirabeau 1763, p. 311; for the

full passage see the appendix). Thus Quesnay is well aware that the assumption of a *uniform* shift in spending by all classes is perhaps unrealistic, due to the rapidly dwindling ‘discretionary’ spending power of the farmers and artisans. It may therefore be argued that this assumption is made primarily for pragmatic reasons, to simplify the calculations in the *Tableaux* that demonstrate the effects of *luxue de décoration*.¹⁶ At the same time the passage confirms the social aspect of the exchanges that are studied in the *Tableau économique*.

Having briefly outlined some of the peculiarities with regard to the various magnitudes assumed in the *Tableau*, we will try to work out their implications for I-O theory, by proposing some alterations to conventional I-O transcriptions. In particular we will address two issues. First, how can we deal with a transfer of income that is assumed not to have a real counterpart, that is how can we model the *produit net*? Second, how can a shift in spending behaviour be introduced that is faithful to Quesnay’s conceptions?

4. The Net Product in an Input-Output Framework.

A fundamental problem with any I-O transcription of the *Tableau* is that the latter scheme depicts a combination of monetary transactions with corresponding real transactions, and a surplus part to which no real world transactions correspond. In other words, Quesnay’s conception of net product seems to violate the fundamental duality property of I-O models. That is, I-O models always come in pairs. The so-called primary or real output model gives us the technological side of the economy, in the form of the production functions and the required levels of production. The dual or price model gives us the corresponding prices and the transactions in money values.

One way of restoring duality in a I-O transcription of the *Tableau* is of course to suppose a real transaction that corresponds to the payment of rent. This solution was chosen early on by Phillips (1955, p. 141) who supposed a production of ‘rental services’ by landowners. The problem with this solution is that rent payments become indistinguishable in kind from other costs incurred in production by the farmers. Or as Ronald Meek (1962, p. 295) expressed it: ‘[The three-industry closed Leontief] model, effectively conceals the difference between the surplus-producing capacity of the productive class and that of the sterile class, and obliges us to assume that the proprietors produce ‘rental services’ in return for their revenue; [...]’. If rent payments are modeled as corresponding to a necessary service performed by the proprietors, the idea of rent as embodying a *net* product, or surplus produced in excess of reproductive requirements is effectively abandoned. Surely this is contrary to physiocratic thinking about the net product as being ‘[...] the only disposable portion [in the economy]; all the rest being necessarily engaged in the indispensable upkeep of the running of the economic machine’ [*l’entretien indispensable du rouage de la machine économique*]’ (Mirabeau 1767, p. 51).

Some commentators have concluded that it is simply not possible to incorporate a notion of surplus within an I-O framework.¹⁷ In our opinion this is overly pessimistic. It is quite possible to include the notion of a ‘disposable’ product, or surplus, in an I-O model. A suitable method to accomplish this task has been described on other occasions; see Steenge (2000) or Steenge and van den Berg (2001). Here we shall recapitulate part of the argument, though in a slightly different and simplified form.

The main thesis is that to obtain a correct *model*, we first have to return to those entries in the table that reflect real world transactions. This implies that we go back to a 2 x 2 coefficients table (showing the exchanges between farmers and artisans).

$$A = \begin{bmatrix} 0.4 & 1 \\ 0.2 & 0 \end{bmatrix}$$

So, we partly follow the efforts at opening up the model. However, unlike commentators such as Maital (1972), Barna (1975) and Samuelson (1986) we do not copy the entries for the surplus part. An economy characterized by this matrix of input coefficients is productive, because its Perron-Frobenius eigenvalue λ is smaller than unity (calculation gives $\lambda = 0.692$).¹⁸ The relation between the 2 x 2 coefficient matrix A and the surplus has been described in Steenge and van den Berg (2001). Here we give a much briefer account based on the fact that in the present case prices are unity.

Let us return now to the relation between the ‘technology-part’ of the economy and its surplus, thereby again adopting physiocratic thinking regarding the role of agriculture. In the context of our exercise we can say that in the price of the agricultural produce there must be a part that is pure surplus (as noted in the previous section the existence of this surplus is reflected in the lease contracts between farmers and landowners which is fixed for a number of years). The surplus part must be such that a fraction, say α , of landlords’ expenses on the consumption bundle is covered. With f_1 and f_2 standing, respectively, for the consumption of agricultural products and manufactured ones, we then have that the *unit price* p_1 of the agricultural product can be written as follows:

$$p_1 = [p_1 \quad p_2] \begin{bmatrix} a_{11} \\ a_{21} \end{bmatrix} + [p_1 \quad p_2] \left[\alpha \begin{bmatrix} f_1 \\ f_2 \end{bmatrix} \right]$$

where p_2 is the price of the artisans’ product, and where α is still to be determined. We know the values of the coefficients a_{11} and a_{22} . In our case we know additionally the values for p_1 and p_2 (both unity¹⁹) and f_1 and f_2 (both 1000). Thus the above expression of p_1 is a linear equation in one unknown, α . Substituting the known values for p_1 , p_2 , f_1 and f_2 , we directly obtain $\alpha = 1/5000$. This tells us that the surplus part of p_1 must be 0.4. We now obtain the following coefficient matrix:

$$M = \begin{bmatrix} 0.4 & 1 & 0.5 \\ 0.2 & 0 & 0.5 \\ 0.4 & 0 & 0 \end{bmatrix}$$

To obtain Table 1, matrix M should be post-multiplied by the intensities vector:

$$x = \begin{bmatrix} 5000 \\ 2000 \\ 2000 \end{bmatrix}$$

This procedure also can be carried out if the proportions in agriculture would change. We actually can compose various Tableaux, depending on the assumption we make regarding the surplus and the behaviour of prices; see Steenge (2000) for details. In all cases, we know exactly how the two parts of the table –the inputs and surplus parts- relate. This means that we now can work with this type of mixed tables and need not worry about having to introduce artificial activities such as ‘landlords’ services’.

In the next subsection we will use a 3 x 3 I-O table of the mixed type just discussed. We shall, following physiocratic insight, assume that the first sector, agriculture, is productive. It pays fixed rents (recorded in the third row) to a third sector which uses the rent payments only for consumptive purposes. We shall study the consequences of a Quesnay-like shift in preferences in this type of I-O model. Only the effect of a shift in spending in favour of manufactures will be examined. In subsection 5.2 we will return to Quesnay's numerical figures.

5. Disequilibrium and Debt Relief

5.1 Modelling Shifts in Preferences in a Disequilibrium Context

We have noted above that in Quesnay's views the *Tableau* illustrates two central points. First, it depicts an ideal state, and, second, a disturbance of this balanced state leads to a loss of wealth for the entire economy. What the disturbance does in effect give rise to is a situation in which money ends up "in the wrong hands". That is to say, in Quesnay's views it is possible that incomes can be spent in an unproductive way, i.e. that they are spent in such a way that agriculture, the source of prosperity, is neglected. Let us try to operationalise these ideas in terms of an I-O model. Following Quesnay we shall start from an equilibrium situation. Below, in subsection 5.2, we shall clarify the argument using the numerical example given in the passage from *Philosophie rurale* translated in the appendix. However, to see precisely what a Quesnaysian disturbance of equilibrium means, we shall in this subsection focus on an overall shift in preferences without price adaptations, using a 3 x 3 Leontief system, in equilibrium, and in monetary values.

Table 4

x_{11}	x_{12}	x_{13}	$\Sigma x_{1.}$
x_{21}	0	x_{23}	$\Sigma x_{2.}$
x_{31}	0	0	$\Sigma x_{3.}$
$\Sigma x_{.1}$	$\Sigma x_{.2}$	$\Sigma x_{.3}$	

In equilibrium we have $\Sigma x_{.i} = \Sigma x_{i.}$, for $i = 1$ to 3. (For consistency reasons we have used the Σ symbol for the marginal totals even though the summation in two cases consists of only entry). Now let us see what happens if the first two rows are subject to change and the last one is left unchanged. If sales of the first sector are reduced, and if the saved amounts are spent on purchases from the second sector, this means that in the new situation column totals remain the same. However, row totals have changed, and are not equal anymore to the corresponding column totals. In traditional *Leontief economics*, this would mean that prices must adapt to equalise incomes and outlays. Let us now see what happens if we move on to a different world in which prices do *not* adapt to a change in flows. In that case, clearly, adaptations must be realised in the real world. Let us make this more precise by assuming that outlays on agricultural goods are decreased by a uniform and fixed fraction, say θ ($0 < \theta < 1$), and let us further assume that,

simultaneously, ‘corresponding’ outlays on manufactured goods are increased with these same amounts. We obtain the following table:

Table 5

$(1-\theta)x_{11}$	$(1-\theta)x_{12}$	$(1-\theta)x_{13}$	$(1-\theta)\Sigma x_1$
$x_{21} + \theta x_{11}$	θx_{12}	$x_{23} + \theta x_{13}$	$\Sigma x_2 + \theta \Sigma x_1$
x_{31}	0	0	Σx_3
$\Sigma x_{.1}$	$\Sigma x_{.2}$	$\Sigma x_{.3}$	

We observe that outlays of the first sector now (its column total) are larger than its incomes (row total). Conversely, incomes for the second sector have become larger than its outlays. The consequences are straightforward: The first sector will not be able to meet all its commitments. The second sector, on the other hand, will have a surplus, and will be more than able to meet its commitments.

Recalling that prices cannot or will not adapt, adaptations will have to follow in the real sphere. It now depends on existing procedures what will happen precisely. If the first sector decides to give preference to its own interests and to those of sector two, it will not be able to pay the full amounts of its due to the third sector. Irrespective of what is given priority, parties will have to find a way out. Quesnay focuses on one such way, i.e. a scheme for the sharing of the arising burden of debt. We shall come back to that in the next subsection.

5.2 Disequilibrium and Debt Relief Compromise; The Quesnaysian Solution

The principle outlined in the previous subsection can be used to reproduce Quesnay’s views on the effects of *luxe de décoration*. It allows us to see more clearly the processes that he assumes to be at work (and it is also suggestive of some remarkable similarities to modern attempts to introduce dynamic elements into Leontief theory discussed in section 6).²⁰ One aspect of Quesnay’s view is that the shrinking of the surplus is not a one-off occurrence. Instead he envisages a process whereby each year the surplus declines compared to the year before, a process which continues *ad infinitum*. Thus the surplus does not stabilise at a lower equilibrium level. To see how this special mechanism can be described in I-O terms, we shall again start from Table 1, the Phillips table.

It should be recalled that the figures in Table 1 also correspond quite closely to the *précis Tableau* of *Philosophie rurale* (see the passage translated in the appendix), and that Quesnay determined the size of each entry in terms of underlying entries, reproduced in Table 3. The disturbance starts with landlords developing a preference for manufactured goods (see appendix p. 308). They shift from consuming 1000 units of both types of goods to a preference of 800 for agricultural and 1200 for manufactured goods. We do have imitating behaviour from the other classes, so their preferences change too.

The follower behaviour introduces new mechanisms. Artisans now receive 1200 (instead of 1000) from proprietors. But they themselves also shift towards lower consumption of agricultural goods. In effect, following Quesnay, they spend 10 percent less on these. So their new outlays on products from agriculture become 1080. Combined with their *avances* (still at

1000) their total outlays become 2080. Farmers also consume 10 percent less of their own product, so this becomes 1800. They spend the newly available 200 on manufactured goods, now totalling 1200.

Table 6

	<i>Farmers</i>	<i>Artisans</i>	<i>Proprietors</i>	<i>Total</i>
<i>Farmers</i>	1800	2080	800	4680
<i>Artisans</i>	1200	0	1200	2400
<i>Proprietors</i>	2000	0	0	2000
<i>Total</i>	5000	2080	2000	

However, farmers still have a contractual commitment to pay rents equaling 2000. Incomes having reduced to 4680, and outlays still totaling 5000 (though the composition has changed, see Table 6), they consequently suddenly face a *deficit* of 320. The manufacturers, naturally, have an *excess* of the same size. We thus observe that the total amount of money has not changed. However, it has changed its course and, hence, has affected the economy's productivity.

With regards to the shortfall in agriculture Quesnay assumes that this is 'divided equally between the advances of the productive class and rent, [and consequently] is for each 160 livres' (Mirabeau 1763, p.308). This statement can mean a number of things. It has been suggested that the sharing of the shortfall implies a compromise between the farmers and proprietors, a sort of renegotiation of the terms of the lease contract that offers the farmers a debt release scheme.²¹ An alternative explanation that can be suggested is that there is an implicit assumption in Quesnay's statement about the typical duration of the lease contract. If this duration is two years, then half the lease contracts would be expected to be renewed in any one year. Those farmers who would renew their lease would be able to bargain for a lower rent, so that typically the whole shortfall would fall on the proprietors. On the other hand, those farmers whose contracts would not be up for renewal would have to carry the whole burden of the shortfall. On the level of the economy the shortfall would be divided equally between the class of farmers and the class of proprietors. In this interpretation the division of the burden does not depend on a compromise, but on an institutional factor: the typical duration of the land lease.²² Quesnay points out that despite the sharing of the shortfall consequences are substantial because farmers will have to pay the remaining amount out of their advances. This means that those will shrink to 1840.

With regards to the surplus income of the Artisans, this is understood to be 'taken out of the system'. That is, the money in their hands gets a destination that is irrelevant for the workings of the productive part of the system.²³ Thus, from the perspective of farmers and landlords, it becomes unproductive and disappears.

The link with the totals as given by Quesnay in the *Philosophie rurale* (see appendix) and the figures in Table 6 is easily established. The receipts of the productive class now total $800 + 1080 = 1880$. Farmers' advances are reduced to $2000 - 200 = 1800$. Simultaneously, the advances of the sterile class have become $2400 - 1080 = 1320$. Looking at Table 6, we observe that the I-O table asks for a slightly different presentation of the same, underlying figures. Quesnay's figures, however, can be straightforwardly recognized.

It is not difficult to see that if farmers in the next year would revert to their *old* preferences, we again would have a stable equilibrium, this time with the new base 1840.²⁴ Numerically, we would have:

Table 7

	<i>Farmers</i>	<i>Artisans</i>	<i>Proprietors</i>	<i>Total</i>
<i>Farmers</i>	1840	2024	736	4600
<i>Artisans</i>	920	0	1104	2024
<i>Proprietors</i>	1840	0	0	1840
<i>Total</i>	4600	2024	1840	

However, as Quesnay argues, farmers stick to their *new* preferences. That is, the available 1840 units also are spent in the (new) proportions 0.4 : 0.6 on, respectively, agricultural and manufactured goods. Rents, however, are fixed at the new level of 1840. So, again we have a situation of non-matching incomes and outlays. If the farmers' deficit again is divided equally between their advances and rents, Table 8 results (the tables are presented in rounded numbers).

Table 8

	<i>Farmers</i>	<i>Artisans</i>	<i>Proprietors</i>	<i>Total</i>
<i>Farmers</i>	1656	1914	736	4306
<i>Artisans</i>	1104	0	1104	2208
<i>Proprietors</i>	1840	0	0	1840
<i>Total</i>	4600	1914	1840	

Let us now take a closer look at the entries in Table 8 in the light of the figures presented by Quesnay in the *Philosophie rurale*. Let us start at the fourth column of the table. Total rents are equal to 1840. They are distributed in the proportions 0.4 : 0.6. Farmers thus receive 736 and artisans 1104. Because of the shift towards lower consumption of agricultural goods, the artisans spend only nine-tenth of this on these goods. So their outlays on farmers' products become $9/10 \times 1104 = 993.6$. Artisans' advances are one quarter of the rents and the productive advances combined. So, in the new situation they total $(2 \times 1840)/4 = 920$.

We may easily recognize the other entries. In terms of Table 8, artisans' outlays are registered in element $x_{12} = 993.6 + 920 = 1913.6$. The second column of Table 8 shows farmers' expenses. The first entry (x_{11}) reflects the shift towards luxuries, so $x_{11} = 1840 - 184 = 1656$. The element x_{12} stands for farmers' outlays on products from the sterile class, so we have $x_{21} = 920 + 184 = 1104$. Table 8 also gives the deficit the farmers face, i.e. $4600 - 4306 = 294$. If this again is equally divided, their advances for the next round will decline to $1840 - 147 = 1693$. If their preference towards luxuries persists, they will again need 10 percent of this to cover their outlays on luxuries. This will result in $1693 - 169.3 = 1523.7$, i.e. element x_{11} in Table 9. The other totals mentioned in the appendix (p. 23) can easily be recovered. The receipts of the productive class equal $736 + 993.6 = 1729.6$.

In the new year, artisans spend only 1214 of their advances (instead of 1320 the previous year). They now receive 2208 and spend 1914. The surplus (294, the same as the farmers' deficit) is added to their advances which now equal $920 + 294.4 = 1214.4$. However, the additional 294.4 are transferred and retained by the sterile class. Thus, the entry x_{24} in the last column (total receipts by artisans) now is the sum of 993.6 (spent on productive goods), 920 (artisans' advances corresponding to one quarter of the sum of productive advantages and rents), and 294.4 (addition to artisans' advances without productive consequences). The remains for the net product can be found as $4306 - 1840 - 920 = 1546$ (in Quesnay's registration), or as $4306 - 1656 - 1104 = 1546$ in terms of Table 8 (where the farmers' shift to luxuries is modeled).

For the next year, similar calculations can be made. In I-O terms, Table 9 results. The shortage in this second round is 294. If again debt-sharing on a fifty-fifty basis is the proposed solution, the new base becomes $1840 - 147 = 1693$. The new disequilibrium tableau then becomes:

Table 9

	<i>Farmers</i>	<i>Artisans</i>	<i>Proprietors</i>	<i>Total</i>
<i>Farmers</i>	1523.7	1760.7	677.2	3961.6
<i>Artisans</i>	1015.8	0	1015.8	2031.6
<i>Proprietors</i>	1693	0	0	1693
<i>Total</i>	4232.5	1760.7	1693	

with corresponding shortage in the third year of 270.9 units.²⁵ This situation indeed can continue *ad infinitum*. Although, at first sight the manner in which the entries are obtained at each stage may seem laborious, the underlying logic is actually quite simple. We readily see that each disequilibrium tableau can be deducted from the previous one. In fact, each tableau is obtained from the previous one by premultiplication by the factor $1/(1.0868)$. Thus, the entries in Table 8 are obtained by multiplying each entry in Table 6 by this factor.

6. Economic Significance and Relation to Other Methods

One merit of the model presented above is that it is the first I-O model that replicates precisely the enigmatic calculations of the disequilibrium Tableau of the *Philosophie Rurale*. Beyond this satisfying feature, we believe it also affords insights in the underlying economic phenomena that Quesnay tried to illustrate by means of the calculations. To be precise, our model sheds light on the meaning of the physiocratic principle that agriculture is the only 'productive' sector of the economy. Ever since it was formulated this principle has baffled commentators and in more recent times it has often been considered a major analytical flaw of an otherwise visionary theorist. Of course some of the ways in which Quesnay and his followers chose to distinguish between the 'productive' and 'sterile' activities in the economy seem indeed indefensible.²⁶ Nevertheless, it is also possible to give a more generous interpretation to Quesnay's conviction that only the primary sector was capable of producing the 'net product' of an Agricultural Kingdom. It is that Quesnay meant to locate what according to him was the *specific and enduring potential* for economic growth of the French economy. The 'productivity' of the agricultural sector was not at all something that could be taken for granted, but a potential

strength that required nurturing through the establishment of a number of technological, economic and political conditions.

Productivity, understood as a potential, does not preclude acknowledgement of the fact that net incomes may be earned elsewhere in the economy. Rather, these net incomes, not having a direct relation with the real productive potential of the economy, are considered parasitical and of a transient nature. Hence the distinction, frequently made in the physiocratic literature between ‘true’ and ‘false’ revenues (see e.g. Quesnay 1757, p.580; 1766c, p. 849; Mirabeau 1763, pp. 106-7; Mercier 1767, pp. 261-3).²⁷ In the model discussed in the previous section we see such ‘false’ revenues arise as soon as a shift in spending patterns occurs. That is, when a deficit arises in agriculture, an excess of the same size arises in the manufacturing class. Thus this latter class can be said to be earning a net income or ‘become profitable’. As the acknowledgment of the existence of ‘false’ revenues suggests, the ‘incidental’ fact that a sector becomes ‘profitable’ does not immediately change the judgment about its fundamental unproductivity.²⁸

Unfamiliar as this position may seem, the interesting point here is that the underlying assumptions of the model discussed in the previous section explain why the emergence of an excess income in the sectors deemed to be unproductive does not save the economy from a downturn. Most important is the insight that circularity in the *Tableau* is assured by contracts that express certain quantitative expectations about the *capacity* for income generation. As was noted agricultural rents should be interpreted in terms of contracts between farmers and landlords. These contracts are concluded for a relatively long period, usually nine years. In particular, they stipulate the amount of rent to be paid, when and to whom. As mentioned, the size of the rent is linked to what may be called ‘favourable circumstances’ (such as advanced agricultural techniques and ‘proper’ agricultural prices). The size of the rent determines the level of landlords’ consumption. The sense in which circularity is regulated in the *Tableau* by the contracts is that these fix the amount of rent, and this determines the amounts that will flow back to farmers and artisans. If farmers cannot pay the full amount of contractual rent, less money will flow back into the system.

The opposite is *not* true for the profit of the artisans, which has the same magnitude as the deficit of the farmers. No contracts exist to ensure that this income is transferred and that it will subsequently flow back to farmers and artisans (in the form of proprietors’ demand for their products). In this sense one can say that ‘money ends up in the wrong hands’. In the hands of the artisans the money gets a destination which is irrelevant for the workings of the other part of the system. Thus, from the perspective of farmers and landlords, it becomes unproductive and disappears.

Summing up, following our interpretation, we may understand the term ‘productivity’ in terms of a *potential* for income generation in the future. It is this assumed potential that forms the basis of the payments stipulated in the contracts. Since this potential may differ from *actual realisation* of income, we find here an important explanation of disruptions to the circular flow. The disruption may mean that activities that are not productive in the above sense suddenly make an – unexpected – profit: they suddenly are ‘profitable’. This profit, not being part of the normal flow of activities and transactions, subsequently does not have ‘its proper place’, and leaks away.

Relation to other methods

The way the physiocrats describe the effects of imitating behaviour has a number of traits in common with methods developed during the 1930s-60s to capture the effects of structural change as a result of technological development. In fact, technological change was widely thought to manifest itself in changing coefficients in a systematic way throughout the economy. Because technological progress would manifest itself more or less simultaneously in several sectors, it was thought that changes in the relevant coefficients would probably be

observed in a recurring pattern. For example, if columns would be in money terms, increased spending on, say, automation would imply larger input coefficients for the relevant inputs. But this phenomenon would manifest itself probably simultaneously at various places in the economy.

In the I-O model we have presented, the size of the surplus moves up or down with the size of a *particular input (or sets of inputs)*. The idea, in itself, is not as farfetched as it may seem. For example, in many of today's productivity studies a connection is made between profits (as defined in the modern accounting literature) and investments in factors such as education or R&D. Basically we meet here the same idea. The early methods in this field are known under generic names like bi-proportional matrix techniques. They typically involve two sets of row and column multipliers, which were assumed to account for the type of change investigated. The methods have been used for various purposes such as technical change analysis or an update of interindustry tables. Involved were various procedures such as iterative methods, least squares, or other procedures.

Interestingly, Wassily Leontief (1936, 1937, 1941) was seminal in proposing one such method when faced with the problem of technological change. Regarding the origin of shifts in technology, Leontief (1941, p. 37) states: "[...] frequent reference is made to the proportional variation of all coefficients within any given industry. To facilitate the handling of this kind of problem, common proportionality factors can be introduced and instead of $a_{i1}, a_{i2} \dots$ we write $a_{i1}/A_i, a_{i2}/A_i, a_{i3}/A_i, \dots$. Henceforth these A 's are often referred to as the *productivity coefficients*. If A_i doubles, for example, it means that with the same amounts of all cost elements industry i can turn out twice as large a product as before."²⁹ Subsequently, Leontief introduced additional coefficients such as industrial saving coefficients B_i and a special proportionality factor β standing for general influences common to all industries, such as the interest rate. In addition, he proposed a special algorithm to investigate the change in productivity.

Later on, Richard Stone and Alan Brown (1962, Ch VII) presented an alternative procedure to solve the problem of changing input coefficients. They were primarily concerned with the problem of estimating a series of I-O tables in the presence of specific trends in the relationships. After first discussing necessary corrections for price changes in the period considered, they turn to substitution effects as a consequence of technological development. They point out that if this proceeds in an 'even way', it can be represented by multiplying the rows of the matrix of intermediate input coefficients 'by elements of a vector r which will be greater than unity for expanding products and less than unity for declining products.' Next they argue that the degree of 'fabrication' (value added per unit of output) will be 'liable to change' with technological progress. They then show that this tendency can be represented by multiplying the columns of the intermediate input coefficients matrix 'by elements of a vector s which will be greater than unity if the degree of fabrication has decreased and less than unity if it has increased.' The procedure outlined by Stone and Brown has developed into the so-called RAS-method for updating an I-O table (see further particularly Michael Bacharach, 1970). Criticisms of the method have not always been friendly. For a recent survey of pros and cons, see Karim and Polenski (1997)³⁰ calculate the effects of technological change, seem to have a close resemblance to the physiocratic views on the role of imitating behaviour. Central in each of the approaches is a simplifying step based on the assumption of uniform row and column operations interpreted as 'substitution' and 'productivity' effects, respectively. This results in different proportions between intermediate inputs and primary factors such as various forms of capital or skilled labour. If, in addition, the presence of fixed contracts would stipulate the amounts of money available for factor remuneration, we would have a situation closely analogous to the Quesnaysian one.

We may conclude that, despite certain conceptual differences, our method shares a number of similarities with what later came to be known as the set of RAS and related

methods. As a consequence, this suggests that a second look at these models may be quite useful. Unfortunately, the profession has, to a certain degree, neglected them. For example, as far as we know, the original Leontief procedure in handling technical change has not been picked up by others. Admittedly, it is a complex one; nevertheless, it has a number of properties that make that it should not be forgotten. Also, the set of methods now known as of the RAS type, seem to occupy a position somewhat on the outside. Often they are viewed as a kind of heuristic tools to obtain consistent estimates in situations where real data are lacking. They have remained approaches outside what may be called mainstream I-O analysis (which strongly focuses on multiplier analysis). This is a pity because these approaches seem to have a potential for themes of a quite different order, such as providing the right framework for conclusions on overall performance such as rise or decline of the nation *as a whole*.

7. Conclusion

The association between Quesnay's *Tableau économique* and Input-Output theory has often been made. By suggesting that his I-O tables of the American economy were a kind of modern *Tableau*, Leontief himself hinted at a more than superficial resemblance between the two theories. A question which has regularly been addressed is "Does modern I-O theory support Quesnay?". The negative answer, when it comes to the alleged effects of luxury consumption, should in our opinion not be taken to mean that Quesnay 'was wrong'. Instead it should give rise to a more interesting question: "Is modern I-O sufficiently developed to be able to investigate the ideas that are present in the *Tableau*?" In this paper we hope to have shown that the answer must be that I-O has the potential of serving as an instrument for investigating Quesnay's views, but only after some modifications have been adopted. We believe that these modifications enrich conventional I-O theory in the sense of widening its scope. The first modification, as described in section 4, is the introduction of a notion of surplus into the I-O framework. The reason why this enriches I-O is that it allows us to express the idea that productivity is localized in a certain part of the economy. In Quesnay this is of course the agricultural class. However, the approach may be generalized to accommodate different views about the particular strengths and potentials of parts of the economies under study. Modern theorists still formulate such views. For example, more recently, Michael Porter (1990) has argued that productivity often is located in specific regions characterized by a high degree of specialisation and interrelation. These specialisations are often based on century old experience, and have resulted in knowledge embodied in specific crafts and trades. These 'clusters' are geographically located and determine the character of entire regions or sectors. In his analysis Porter showed that to understand the mechanisms of growth and development, the level of analysis should not be macro level, but rather one based on developments at the meso-economic level.

Second, a specifically Quesnaysian idea is that the capacity for productivity can 'leak away'. That is to say, surplus incomes may be realised in the wrong, i.e. less productive, places: productivity and profitability are not identical in the *Tableau économique*! It seems sound advice that if a source of prosperity can be identified, it should be protected and stimulated by means of appropriate policies. This leads in a natural way to the concept of an ideal or optimal state, where the economy's full potential is realized. Maintaining this state requires a delicate balance between productive and less productive activities.

The third modification allows us to express how the balanced state of the economy may alter. Changes may be of a technological or behavioural nature; both aspects can be brought together in one I-O framework. A central point in section 4 was that shifts in the real world may not be followed by corresponding shifts in institutional arrangements (contracts,

property rights, et cetera); one reason being that institutions usually have a slower rate of adaptation than changes in consumption or production. The result often leads to painful adaptation processes.

The fourth modification is perhaps hardly a “modification”, but an invitation to what may become an alternative to the standard multiplier-oriented way of “doing input-output”. We have seen that in the Quesnaysian vision, the economy consists of what may be called a variety of submodels, including, next to economic indicators and parameters, received wisdom rather of a political, sociological or psychological nature. This translated into a departure from fixed coefficients based methodology, but, at the same time, opened up new avenues for determining the consequences of a shift in final demand. At the same time, as we have seen, this also meant a farewell to the role of strict mathematical duality which characterizes the relation between the real output and the price model in the standard way of modeling. None of these issues have lost relevance to present day economies. Therefore instead of using the sterile knife of I-O theory to dissect Quesnay, we are better advised to allow the old *Docteur* to inject new life into I-O.

References

- Bacharach, M. (1970) *Biproportional Matrices and Input-Output Change* (Cambridge, UK: Cambridge University Press).
- Bacon, R. and Eltis, W. (1978) *Britain's Economic Problem: Too Few Producers*, 2nd ed. (London and Basingstoke: Macmillan).
- Barna, T. (1975) Quesnay's Tableau Economique in Modern Guise, *Economic Journal*, 85, pp. 485-496.
- Barna, T. (1976) Quesnay's Model of Economic Development, *European Economic Review*, 8, pp. 315-338.
- Cantillon, R. (1755) *Essai sur la Nature du Commerce en Général*, ed. H. Higgs, 1931 (London: Macmillan).
- Cartelier, J. (1998) Quesnay, François and the Tableau Économique, in H.D. Kurz and N. Salvadori eds. *The Elgar Companion to Classical Economics*. (Cheltenham: Edward Elgar). Vol.2, pp. 248-55.
- Cartelier, J. (2000) Nobility and *Royaume Agricole*: The *Tableau Economique* as a Political Utopia, paper presented at the ESHET conference in Graz.
- Deming, W.E. and Stephan, F.F. (1940) On a Least Squares Adjustment of a Sampled Frequency Table When the Expected Marginal Totals are Known, *Annals of Mathematical Statistics*, 11, pp. 427-444.
- Dorfman, R., Samuelson, P. and R. Solow, R. (1958) *Linear Programming and Economic Analysis*, (New York: McGraw-Hill).
- Eltis, W.A. (1975a) François Quesnay: A Reinterpretation 1. The Tableau Economique, *Oxford Economic Papers*, 27, pp. 167-200.
- Eltis, W.A. (1975b) François Quesnay: A Reinterpretation 2. The Theory of Economic Growth, *Oxford Economic Papers*, 27, pp. 327-351.
- Eltis, W.A. (1984) *The Classical Theory of Economic Growth* (London: Macmillan).
- Eltis, W.A. (1996) The Grand Tableau of François Quesnay's economics, *The European Journal of the History of Economic Thought*, 3:1, pp. 21-43.
- Eltis, W.A. (2000a) The First Growth Model: Quesnay's (and Mirabeau's) Dynamic Tableaux in Philosophie Rurale, Paper presented at the ESHET conference in Graz.
- Eltis, W.A., (2000b) *The Classical Theory of Economic Growth*. (Basingstoke: Palgrave). Second Edition.

- Eltis, W.A., (2002) How Quesnay's *Tableau Économique* offered a deeper analysis of the predicament of France' *Journal of the History of Economic Thought*, 24: 1, pp. 39-53.
- Forbonnais, F. Véron Duverger de, (1767) *Principes et Observations Économiques*, (Amsterdam: Marc Michel Rey).
- Gehrke, C. (2000) The analysis of dérangements in the Tableau économique, Paper presented at the Thirteenth International Conference on Input-Output Techniques.
- Herlitz, L. (1996) From spending and reproduction to circuit flow and equilibrium : the two conceptions of *Tableau économique*', *The European Journal of the History of Economic Thought*, 3 : 1, pp. 1-20.
- Hishiyama, I. (1960), The Tableau Economique of Quesnay – Its Analysis, Reconstruction, and Application, *Kyoto University Economic Review*, 30, pp. 1-46.
- Korte, B. (1972) Das Tableau économique von François Quesnay als statisches offenes Leontief-System, *Jahrbuch für Sozialwissenschaft*. 23, 2, pp. 135-44.
- M. Kuczynski and R. Meek (eds., 1972) *Quesnay's Tableau économique* (London, MacMillan).
- Kurz, H.D. and Salvadori, N. (1995) *Theory of Production: A Long-Period Analysis* (Cambridge: Cambridge University Press).
- Kurz, H.D. and Salvadori, N. (2000) 'Classical' Roots of Input-Output Analysis: A Short Account of its Long Prehistory, *Economic Systems Research*, 12, pp. 153-179.
- Leontief, W. (1936) Quantitative Input and Output Relations in the Economic System of the United States, *Review of Economic Statistics*, XVIII, pp. 105-125.
- Leontief, W. (1937), Interrelation of Prices, Output, Savings and Investment, States, *Review of Economic Statistics*, XIX, pp. 109-132.
- Leontief, W. (1941), "*The Structure of American Economy, 1919-1939*" (New York: Oxford University Press).
- Maital, S. (1972) The Tableau Economique as a Simple Leontief Model: An Amendment, *Quarterly Journal of Economics*, 86, 504-507.
- Meek, R.L. (1963), *The Economics of Physiocracy – Essays and Translations* (Cambridge, Ma.: Harvard University Press).
- Mercier de la Rivière, P.-P. (1767) *L'ordre naturel et essentiel des sociétés politiques*. (London [Paris]: Desaint).
- Miller, R.E. and Blair, P.D. (1985) *Input-Output Analysis; Foundations and Extensions* (Englewood Cliffs, NJ., Prentice-Hall).
- Mirabeau, Victor Riquetti (1761) *L'Ami des hommes*, vol.6, part 2: *Tableau économique avec ses explications*. (Avignon).
- Mirabeau, Victor Riquetti (1763) *Philosophie rurale ou Économie Générale et Politique de l'Agriculture*. (Amsterdam: Les Libraires associés).
- Mirabeau, Victor Riquetti (1767) 'Notes préparatoires sur le Tableau Economique', *Ephémérides du citoyen*, I, pp. 49-54.
- Pasinetti, L.L. (1977) *Lectures on the Theory of Production*, (New York: Columbia University Press).
- Phillips, A. (1955) The Tableau Economique as a Simple Leontief Model, *The Quarterly Journal of Economics*, 69, pp. 137-144.
- Polenske, K.R. (1997) Current Uses of the RAS Technique: A Critical Review. In: A. Simonovits and A.E. Steenge (eds.), *Prices, Growth and Cycles* (Houndmills, etc.: Macmillan).
- Porter, M. (1990) *The Competitive Advantage of Nations* (London and Basingstoke: Macmillan).
- Pressman, S. (1994) *Quesnay's Tableau Économique. A Critique and Reassessment* (Fairfield NJ: A.M. Kelley).

- Quesnay, F. (1757) 'Impôts', in *François Quesnay et la physiocratie*. INED (Paris: Presses Universitaires de France).1958: 579-618.
- Quesnay, F. (1766a) 'Analysis of the arithmetical formula of the *Tableau Economique* of the distribution of annual reproduction in an agricultural nation', in Meek 1963: 150-67.
- Quesnay, F. (1766b) 'Dialogue on the work of artisans', in Meek 1963: 203-30.
- Quesnay, F. (1766c) '*Observations sur l'intérêt de l'argent*' in *François Quesnay Œuvres économiques complètes et autres textes* Eds. C. Théré, L. Charles and J.-C. Perrot (Paris: INED).. 2005: 847-53.
- Sraffa, P. (1960) *Production of Commodities by Means of Commodities* (Cambridge, Cambridge University Press).
- Samuelson, P.A. (1986) Quesnay's 'Tableau Economique' as a Theorist Would Formulate It Today, *The Collected Scientific Papers of Paul A. Samuelson, Vol. 5*. Kate Crowley, ed. (Cambridge, Mass., and London: MIT Press), pp. 630-663.
- Steenge, A.E. (1995) Sraffa and Goodwin: A Unifying Framework for Standards of Value in the Income Distribution Problem, *Journal of Economics*, 62, pp. 55-75.
- Steenge, A.E. (2000) The Rents Problem in the Tableau Economique: Revisiting the Phillips Model, *Economic Systems Research*, 12, pp. 181-197.
- Steenge, A.E., and van den Berg, R. (2001) Generalising the *Tableau économique*. Isnard's *système des richesses*', *International Journal of Applied Economics and Econometrics*, 9:2, pp. 121-146.
- Steenge, A.E. and R. van den Berg, (2007) Transcribing the Tableau Economique: Input-Output Analysis à la Quesnay", *Journal of the History of Economic Thought*, 29, pp. 331-358.
- Stone, R. and Brown, A (1962) *A Computable Model of Economic Growth* (A Programme for Growth, vol. 1) (London: Chapman and Hall).
- Vaggi, G. (1985), A Physiocratic Model of Relative Prices and Income Distribution, *The Economic Journal*, 95, pp. 928-947.
- Vaggi, G. (1987), *The Economics of François Quesnay* (Houndmills and London: Macmillan Press).
- Van den Berg, R. (2000) Differential rent in the 1760s. Two neglected French contributions, *The European Journal of the History of Economic Thought*, 7:2, 181-207.
- Van den Berg, R. (2002) Contemporary responses to the *Tableau économique*. In *Is There Progress in Economics* S.Bohm, C.Gehrke, H.D. Kurz and R.Sturn eds. (Cheltenham: Edward Elgar) pp. 295-316.
- Weulersse, G. (1910) *Le Mouvement Physiocratique en France*. 2 vols. (Paris: Felix Alcan).

TABLEAU ECONOMIQUE.

Objets à considérer, 1.^o Trois sortes de dépenses; 2.^o leur source; 3.^o leurs avances; 4.^o leur distribution; 5.^o leurs effets; 6.^o leur reproduction; 7.^o leurs rapports entr'elles; 8.^o leurs rapports avec la population; 9.^o avec l'Agriculture; 10.^o avec l'industrie; 11.^o avec le commerce; 12.^o avec la masse des richesses d'une Nation.

DÉPENSES PRODUCTIVES <i>relatives à l'agriculture, &c.</i>	DÉPENSES DU REVENU, <i>l'impôt prélevé, se partageant aux Dépenses productives et aux Dépenses stériles.</i>	DÉPENSES STÉRILES <i>relatives à l'industrie, &c.</i>
<p>Avances annuelles pour produire un revenu de 600^{fr} font 600^{fr} 600^{fr} produisent net.....</p>	<p>Revenu annuel de 600^{fr}</p>	<p>Avances annuelles pour les Ouvrages des Dépenses stériles, sont 300^{fr}</p>
<p>Production annuelle pour 300^{fr} reproduisent net..... 300^{fr} <i>main</i> 300^{fr} <i>œuvre</i> <i>propre</i> <i>des</i> <i>Ouvrages, &c.</i></p>		
<p>150^{fr} reproduisent net..... 150^{fr} <i>main</i> 150^{fr} <i>œuvre</i> <i>propre</i> <i>des</i> <i>Ouvrages, &c.</i></p>		
<p>75^{fr} reproduisent net..... 75^{fr}</p>		
<p>37.10^{fr} reproduisent net..... 37.10^{fr}</p>		
<p>18.15^{fr} reproduisent net..... 18.15^{fr}</p>		
<p>9.7.6^{fr} reproduisent net..... 9.7.6^{fr}</p>		
<p>4.13.9^{fr} reproduisent net..... 4.13.9^{fr}</p>		
<p>2.6.10^{fr} reproduisent net..... 2.6.10^{fr}</p>		
<p>1.3.5^{fr} reproduisent net..... 1.3.5^{fr}</p>		
<p>0.11.8^{fr} reproduisent net..... 0.11.8^{fr}</p>		
<p>0.5.10^{fr} reproduisent net..... 0.5.10^{fr}</p>		
<p>0.2.11^{fr} reproduisent net..... 0.2.11^{fr}</p>		
<p>0.1.5^{fr} reproduisent net..... 0.1.5^{fr}</p>		
<p>&c.</p>		

REPRODUIT TOTAL 600^{fr} de revenu; de plus, les frais annuels de 600^{fr} et les intérêts des avances primitives du Laboureur, de 300^{fr}, que la terre restitue. Ainsi la reproduction est de 1600^{fr}, compris le revenu de 600^{fr} qui est la base du calcul, abstraction faite de l'impôt prélevé, et des avances qui exigent sa reproduction annuelle, &c. Voyez l'Explication à la page suivante.

Notes

¹ The earliest zigzag may have been produced at the end of 1758, but will have been disseminated among a very select group of people only. The first *Tableau* known to a larger public was the so-called ‘third edition’ of 1759. The last use by Quesnay of the *formule* version of the *Tableau* was in the article ‘[Second] *Problème Economique*’ published in *Physiocratie* in 1767. For full accounts of the publishing history of the *Tableaux* see Weulersse (1910, I, pp. 61-71); Meek (1962, pp. 265-272); Kuczynski and Meek (1972).

² Within the closed model landlords’ consumption is in effect conceived as a ‘technique’ with fixed proportions. See Dorfman et al. (1958) or Pasinetti (1977) for an exposition of the closed Leontief model.

³ Maital (1972) and Korte (1972) first presented modeling exercises along these lines. Later discussions include Samuelson (1986).

⁴ Phillips’ units were in milliards of livres, thereby following the Formula. Another, equally unsubstantial, difference in our reproduction of Phillips’ transcription is that the classes of artisans and landlords have swapped places.

⁵ However, Quesnay did use this final version to examine the effects of two other kinds of ‘disturbances’: the imposition of indirect taxes and a decline in agricultural prices. See ‘First Economic Problem’ and ‘Second Economic Problem’ respectively. This by itself demonstrates that it is not quite right to consider the Formula version as a device that was solely designed to illustrate the ideal, equilibrium state.

⁶ Eltis, who in his earlier work on Quesnay concentrated on the original Zigzag, has in recent years emphasised the importance of the lesser known *Précis* version which made its appearance in the *Philosophie Rurale*. See Eltis (1996, 2000). This version is indeed interesting in the context of the modern controversy about Quesnay’s model. Since the *Précis* resembles the Formula quite closely, it allows for a more easy comparison between the existing I-O interpretations and dynamic interpretations like that of Eltis.

⁷ For a more extended discussion of Forbonnais’ critique of the *Tableau* (and that of other contemporaries of Quesnay), see Van den Berg (2002).

⁸ See van den Berg (2000, p.198 n.4 and 5).

⁹ In this context it is important to note that the term *grande culture* does not only stand for modern agricultural technology, but also for modern contractual relations in agriculture. The following definition is given in the *Encyclopédie*: ‘Farmer [*Fermier*],..., one who cultivates land owned by someone else, and who reaps the fruits on fixed conditions; that is what distinguishes the *farmer* from the *sharecropper* [*métayer*]: what the farmer gives to the proprietor, be it in money or in kind, is independent of the variability of the harvests. The sharecropper [on the other hand] shares the harvest itself, whether it is good or bad, in a certain proportion [...]’ (Le Roy, ‘*Fermier*’, *Encyclopédie*, vol. 6, 527).

¹⁰ Some unclarity exists about the precise function of the manufactures purchased by the farmers: are they strictly capital goods that replace the 10% of fixed capital (*avances primitives*) that is written off annually? Are they mainly consumption goods? Or are they a combination of the two? It seems fair to say that Quesnay is ambiguous on this point. Modern commentators differ about the interpretation of these ‘interest goods’. According to Meek (1962, p. 279 n.5) the manufactures purchased by the farmers are *solely* products required for their personal maintenance (clothing et cetera). The products required for the upkeep and replacement of the capital stock, on the other hand, are purchased within the agricultural sector. This interpretation has been criticised by Vaggi (1987, p. 48) who argues that at least some machinery used in agriculture must be understood to be purchased from the artisan class.

For our purposes it suffices to say that if at least some part of x_{21} represents manufactures for the personal consumption of farmers and their subordinates, then it is easy to envisage a deviation due to changes in consumption patterns.

¹¹ See also section 5.2 where these Quenaysian sub-models are discussed in more detail.

¹² Also, the amounts exchanged are related to relative sizes of the population in each class.

¹³ We believe the use of fixed coefficients in production to distort *all* versions of the *Tableau économique*. The Formula version does in this respect not really differ from the zigzag and the *Précis*. Admittedly, Quesnay and Mirabeau only demonstrate the effects of an increase in luxury consumption with the aid of the latter two versions. However, in our opinion the reason for this is not that the Formula was unsuited to this demonstration due to (implicit) fixed coefficients.

¹⁴ “Les moeurs se suivent & se repompent par réffet dans toutes les classes; l’enchaînement moral étant par-tout le même que l’enchaînement physique. Cette révolution d’un sixieme sera la même chez l’Artisan & chez le Cultivateur”.

¹⁵ For a discussion of the relation between Cantillon’s ideas and the uniform shift assumed in the *Tableaux* depicting *luxe de décoration* see Gehrke (2000, pp. 2-3).

¹⁶ Below we show that the assumption of a *uniform* shift is not essential for validating Quesnay’s conclusions. That is to say, the *direction* of the shift has to be imitated by all classes but not to the same extent or percentage.

¹⁷ This is the opinion of Pressman (1994, p127-8) who states: ‘The principle – that surpluses arise exclusively in the agricultural sector – shows up in all *non*-input-output reconstructions of the *Tableau*. But how can a surplus be shown in an input-output table where by definition inputs must equal outputs for each industry? [...] Quesnay was able to represent agricultural surpluses since he did not consider “rental services” as an input.’

¹⁸ See for the use of Perron-Frobenius eigenvalues for this purpose Kurz and Salvadori (1995).

¹⁹ Note that artisans do not pay rents.

²⁰ We observe that the precise size of the shift (here equal to a fraction θ of the first row) is not important to generate the desired effect. Only the direction of the shift and the response of the system are relevant (cf. note ²¹ See Eltis (1996, 2000a).

²² In the physiocratic literature landleases of seven or nine years are discussed. The duration of two years which, according to our interpretation, is implied in Quesnay’s statement may again have been chosen for its convenience in the subsequent calculations.

²³ Quesnay and Mirabeau give an eloquent defence of this point of view on p. 311 of the *Philosophie rurale* (see the last paragraph of the passage in the appendix)

²⁴ We have the coefficients matrix of section 4 with $\beta = 0.4$ and corresponding intensities vector.

²⁵ Quesnay’s calculations stop after two years. Therefore this third shortfall does not occur in the original example.

²⁶ One may distinguish a number of arguments used in the physiocratic literature to support the doctrine. Especially unconvincing is the distinction between the productive sector as the one ‘creating’ or ‘multiplying’ wealth, as opposed to the sterile sectors which are said to merely ‘change forms’ or ‘add’ wealth (see e.g. Quesnay 1766b: 205-7). Other unconvincing arguments are appeals to the ‘primacy’ of agriculture and its presumed self-sufficiency.

²⁷ To be precise, Quesnay and Mirabeau use the terms *vrais* (and *véritables*) *revenus* versus *faux revenus*, while Mercier contrasts *revenus réels* with *revenus factices & simulés*. Mirabeau (1763: 106) gives as examples of ‘false’ net incomes: ‘security payments, fees, [industrial] profits, pensions, house rents etc.’ (*les gages, les émolumens, profits, pensions, loyers de maisons, &c.*)

²⁸ Just like the fact that the profitability of agriculture is harmed does not immediately alter the conviction that it is fundamentally the productive core of the economy.

²⁹ Here the a_{ij} stand for the intermediate input coefficients. Note that Leontief used a transposed form of notation.

³⁰ Next to Leontief (1936, 1937, 1941) and Stone and Brown (1962), also Deming and Stephan (1940) usually are credited with the origin of the method.