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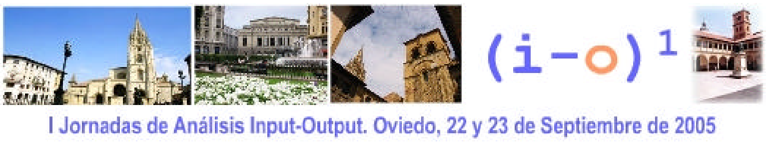

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The paper is aimed at formulating the Quesnay's Tableau économique as an input-output model. The issue has already been dealt with by several authors and notably by Phillips (1955), Meek (1960), Maital (1972), Barna (1972), Vaggi (1987), Pressman (1994), and Steenge (2000), among others. Phillips (1955), Maital (1972) and Steenge (2000), for instance, assumed that the society is composed of three classes (farmers, artisans and proprietors) and that the classes are productive sectors. Barna (1972), instead, distinguishes seven economic activities without any reference to classes. Pressman (1994) refers to both settings. Apparently nobody has distinguished classes from sectors and this seems to obscure the income circuit which is at the very heart of the Quesnay's construct. The approach adopted in the paper, seems therefore rather new in the literature concerning the input output formulation of the Tableau as it separates the two producing sectors (agriculture and urban activities or "industry") from the three classes which form the society i.e. the final sector. A few arguments are presented to back the separation itself which, by no means, is in the Tableau. I use figures from the "formula" and others and from the “zig zag” as well. The model is open which means that the consumption of landowners is exogenous, while the other two classes’ consumption is endogenous. By distinguishing sectors from classes, we can write the “sectors time sectors” model, which solves for sector production, and the “classes time sectors” models which solve for distributed income. In both cases different formulations are possible, but we limit to show that three different formulations are equivalent only in the “classes times sectors” case. The solution can be written in a multiplicative and in an additive fashion and used to separate the different components of total production and income. It is shown, in particular, that the circular income process has its origin in the proprietor’s expenditure. As Quesnay gave precise policy prescriptions regarding the effects of income distribution and expenditure on the whole economy, the proposed input-output reformulation of the Tableau appears an useful exercise in the Quesnay’s mode.

INCOME DISTRIBUTION AND EXPENDITURE IN THE TABLEAU ECONOMIQUE A LA LEONTIEF

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SUMMARY

The paper aims to formulate Quesnay's *Tableau Economique* as an input-output model. The issue has already been dealt with by several authors, notably by Phillips (1955), Meek (1960), Maital (1972), Barna (1972), Vaggi (1987), Pressman (1994), and Steenge (2000), among others. Phillips (1955), Maital (1972) and Steenge (2000), for instance, assumed that society is composed of three classes (farmers, artisans and proprietors) and that these classes are productive sectors. Barna (1972), instead, distinguishes seven economic activities without any reference to classes. Pressman (1994) refers to both settings. Apparently nobody has distinguished classes from sectors and this seems to obscure the income circuit which lies at the very heart of Quesnay's construct. The approach adopted in this paper adds to the literature concerning the input output formulation of the *Tableau* as it separates the two producing sectors (agriculture and other activities or "manufacturing") from the three classes which form society. A few arguments are presented to back this separation, which is not to be found anywhere in the *Tableau*. I use figures from the *Tableau "formula"* and from the *Tableau "zig zag"* as well. The consumption of proprietors is exogenous, while that of the other two classes is endogenous. By distinguishing sectors from classes, I can set the model both in the "*sectors - sectors*" space and solve for sector production, and in the "*classes - sectors*" space and solve for distributed income. In both cases, different formulations are possible. As Quesnay gave precise policy prescriptions regarding the effects of income distribution and expenditure on the whole economy, the proposed input-output reformulation of the *Tableau* appears a useful exercise *à la* Quesnay.

1. INTRODUCTION

In the middle of the eighteenth century François Quesnay developed an macroeconomic theory which is a well-known contribution to economic knowledge. It is an early and very interesting theory as it contains elements and intuitions which foreshadowed advances in economic thinking that were only to be achieved muh later on, i.e. only during the nineteenth and twentieth centuries. The *Tableau Économique*, which is the formalization of the main part of Quesnay's economic theory, was considered an antecedent of input-output theory by Leontief himself (1941), but it was only fifty years ago that the connection was specified. Phillips (1955) gave the first reformulation of the *Tableau* as an input-output system. Others (e.g. Maital, 1972; Barna, 1975, Pressman, 1994 and Steenge, 2000) extended his work. The available reformulations, however, fail to recognize that in the *Tableau*, Quesnay tried to show how products circulate among the different sectors and, at the same time, how various types of income circulate among social classes. Apparently nobody has tried to distinguish classes from sectors, which seems to explain why the existing input-output reformulations of the *Tableau* fail to clarify the double circuit which is at the very heart of Quesnay's construct.

In this paper I keep the productive sectors separate from the social classes and I try to reformulate the static *Tableau* as an input-output model in order to clarify the effects of the consumption of proprietors, carefully taking into account the circulation of income between classes and of goods between sectors. In this way it is possible to show, better than ever, how total output and income are dependent on income distribution and consumption composition. One of the great merits ascribed to Quesnay is the intuition that even in the case of an economic system where the technology is up-to-date and all the necessary capital is in place, as is the case in the economic system he considered, output can increase or decrease according to the level of aggregate demand. It was crucial for him, therefore, to understand what lies behind demand. Quesnay thought that distribution and demand composition were key in this regard, but he also gave great emphasis to the role of circulating capital.

In Sections 2 and 3 a short summary of some aspects of the *Tableau* are provided. The algebraic details of the input-output model are presented in Sections 4 and 6 and applied to the original figures in Section 5. Section 6 briefly summarizes.

2. THE STRUCTURE OF THE ECONOMY IN THE TABLEAU ÉCONOMIQUE

The economy in mid-18th century France as described by Quesnay can be decomposed into a pair of producing sectors: one formed by the surplus-producing activities, mainly agriculture, fishing and mining; the other formed by all the other activities which, according to Quesnay, are unable to yield a surplus and can thus be considered sterile. By and large, the sterile rest of the economy coincides with what nowadays is the urban sector (handicrafts, chefs, musicians, merchants and, in particular, individuals engaged in foreign imports and exports). Each sector has its own technology. There are four productive factors: fixed capital, circulating capital, labour and land. One problem focused by Quesnay was to ascertain whether, given the proprietors' consumption, the system is able to reproduce the initial stock of circulation capital. In mid-18th century France, there were a number of groups of actors, namely: agricultural workers, capitalist farmers, self-employed artisans, capitalists, manufacturing workers, landlords, the Sovereign and the clergy. However, in order to make the *Tableau* manageable, Quesnay simplified the social framework by considering only three classes, notably farmers, sterile workers (i.e. self-employed artisans, capitalists, manufacturing workers all together) and proprietors (i.e. landlords, the Sovereign and the clergy). He actually disregarded agricultural workers, and aggregated all the remaining groups into three classes. In his writings, Quesnay often called the resulting three classes 'sectors'. Farmers are merely the most representative group in the productive sector; proprietors, by definition, do not engage in any productive activity. All the rest are sterile workers. The partial coincidence between sectors and classes has always created confusion as there are actually two sectors and three classes (i.e. farmers, artisans and proprietors).

It was sensible to limit the analysis to those three as they were dominant and key in the production and circulation of the surplus. Most importantly, the class of farmers supplies capital and work services, while sterile workers basically supply work services. Other actors, such as agricultural workers, get a subsistence income and merely represent an input cost in the production process and thus are un-important from the point of view of surplus. The third class (proprietors) supplies capital and land services. In the Physiocratic economy, farmers and proprietors supply all fixed and circulating capital. In the most simple case, proprietors spend their after-tax income in consumption goods; savings are absent as the necessary fixed capital has already been accumulated. The economy described in the *Tableau* is regulated by the policy prescriptions suggested by the Physiocrats and is in the "state of bliss". The level of activity in the economy, in particular, seems to depend on the level of the consumption of the renters alone, given its structure and technology.

To model the *Tableau* economy, I suggest distinguishing sectors from classes. In the two sectors, Quesnay's assumptions are as follows:

	Agriculture	***Urban activities or rest***
Farmers	Labour income + Profits	
Sterile workers		Labour income
Proprietors	Profits + Rents	

The net product is formed by commodities in modern terminology one could say that that their value is represented by the sum of profits and rents. Profits are shared by farmers and proprietors. In this economy, as Meek (1960) correctly points out, sectors are different from classes and each class income does not coincide with the net income produced in the sectors where they operate.

3. THE ROLE OF ADVANCES AND FINAL CONSUMPTION

Four big merits, at least, have been ascribed to Quesnay. One is the understanding that the economic system is something that can be modelled; the other is the intuition that the equilibrium of the system can be described as the solution of the model without any reference to markets. The third merit was the ability to conceive the relevance of income distribution in the determination of demand and production. It was this intuition that brought him to investigate the role of fiscal and commercial policies. Quesnay, furthermore, understood the existence of a relation between technology and net product and was thus able to understand that there are differences across sectors from the point of view of their ability to be productive.

By formulating the *Tableau* economy as an input-output system where sectors are different from classes, it is possible to refine the model of circulation offered by the available input-output reformulations and to clarify the role of demand. In the model discussed here, the final consumption of farmers and sterile workers is endogenous while that of proprietors is exogenous. With this asymmetry, we reproduce Quesnay's basic theory, which aimed to clarify the role played by the decisions of proprietors. Proprietors lived above the subsistence level and there were the possibility that the surplus they were receiving were not returned to the economic system and, in particular, to agriculture. For Quesnay this would have been a loss for the country as a whole.

In Quesnay's economy, the production process of each year is set in motion by annual advances from proprietors to the producers of both sectors. The concept of advances is rather elusive as Quesnay did not clarify what they were actually made of, but it can be argued that advances were circulating capital. This means that advances were related to net product as the initial stock had to be reproduced, at least, in order to avoid economic depression. In this interpretation, advances can be considered as the initial stock of circulating capital and the macroeconomic problem boils down to understanding whether at the end of the year the stock has changed or not. As Quesnay assumed that a surplus or net product is only possible in the agricultural sector, advances are to be related to the agriculture surplus. In the many examples offered by Quesnay, the amount of advances, indeed, turns out to be equal to net product and in this case advances are said to reproduce 100%. In some cases, however, the amount of advances is different from the resulting net product and in this case advances are said to reproduce less or more than 100%.

A different interpretation of advances is, however, possible. If we interpret advances as the initial guess of the model solution in terms of net product, one can assume that the level of activity depends only on the exogenous final demand, as is customary nowadays. In this case the *Tableau* is a tool for finding the solution and for verifying whether the solution — which reflects the exogenous final demand — is equal or not to the assumed initial guess.

Quesnay recognizes that the consumption decisions of proprietors have a role in the production process; a role which is very important in the economy as it bears upon the level of effective demand and upon the net product. However, he was not able to build upon this intuition and get rid of the elusive concept of advances. In the following section we will disregard advances and focus precisely on the relation between final consumption and net product.

4. THE ALGEBRAIC MODEL

The symbols we are using are conventional and the relation between production, income and consumption are fairly standard in input-output analysis. Technologies, as described in the *Tableau "formula"*, i.e. in the diagram presented in an article published in a Journal (Quesnay, 1766), are defined by the trinagular matrix:

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & 0 \end{bmatrix} \equiv A,$$

where: $1 = agriculture$, and $2 = rest$. It is rather surprising that Quesnay were assuming that the second sector (i.e. "manufacturing) was not buying from itself.

The composition of final consumption in an economy where there are two sectors and three classes is, in general, described by a six-element matrix:

$$\begin{bmatrix} c_{1f} & c_{1s} & c_{1p} \\ c_{2f} & c_{2s} & c_{2p} \end{bmatrix} = E,$$

where: f = *farmers*, *s=sterile workers*, and $p = proprietors$. To deal with the asymmetry in final consumption cited above, it is useful to split matrix E in two parts, as follows:

$$\begin{bmatrix} c_{1f} & c_{1s} & 0 \\ c_{2f} & c_{2s} & 0 \end{bmatrix} = C; \qquad \begin{bmatrix} 0 & 0 & c_{1p} \\ 0 & 0 & c_{2p} \end{bmatrix} = D; \qquad C + D = E.$$

To represent the polarized income distribution taking place in the economy described in the *Tableau*, i.e. an economy where farmers and proprietors share the net product of agriculture and sterile workers live with what is produced in their activities, I use a matrix of distribution coefficients showing how revenue is distributed among the social classes:

$$\begin{bmatrix} v_{f1} & 0 \\ 0 & v_{s2} \\ v_{p1} & 0 \end{bmatrix} = V,$$

The coefficients in the first column show that there is a conflict between farmers and proprietors. The vector of disposable incomes is:

$$\begin{bmatrix} y_f \\ y_s \\ y_p \end{bmatrix} = y.$$

There are two more vectors: one for total production levels and one for the exogenous final consumption levels in the two sectors, respectively:

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = x \; ; \qquad \begin{bmatrix} f_1 \\ f_2 \end{bmatrix} = f \quad .$$

It is obvious that the final consumption of proprietors is related to their disposable income, which can be formalized with the equation:

$$f = Dy \, ,$$

but, as we assume that the vector *f* is exogenous, the equation is inactive.
By defining the Leontief inverse:

$$(I - A)^{-1} = B$$

the balance equation of the partially open system can be readily written as:

$$x = Ax + Cy + f$$

or:

(1) $x = B(Cy + f)$

The equation defining how income is distributed :

(2) $y = Vx$

By using (1), equation (2) gives the solution in the *classes-sectors* space:

(2.1) $y = VBCy + VBf = (I - VBC)^{-1} VBf$.

Notation can be simplified by defining:

$$K = (I - VBC)^{-1}$$

or:

(2.2) $y = KVBf$.

This is the first way of solving the model when cast in the *classes-sectors*. The equation shows that the circular flow of income can be summarized as a one-way relation between exogenous final consumption of proprietors and income. The six coefficients of the matrix KVB, can be interpreted as income multipliers.

The solution of the model can be also cast in the *sectors-sectors* space. To do this it is sufficient to insert equation (2) in (1):

(1.1) $x = Ax + CVx + f$.

By exploiting the definition of Leontief inverse, equation (1.1) reads:

$$(B^{-1} - CV)x = (I - CVB)B^{-1}x = f \; .$$

The solution in the *sectors-sectors* space showing how final consumption of proprietors translate in total production, then is:

(1.2) $x = B(I - CVB)^{-1} f$.

Equation (1.2) shows that the circular flow of income can be summarized as a one-way relation between exogenous final consumption and production. Definition (2) allows us to write the following solution in the *classes-sectors* space:

(1.3) $y = VB(I - CVB)^{-1} f$,

which is obviously equivalent to (2.2).

5 RETURNING TO THE *TABLEAU*

At this stage we can insert values in the algebraic expressions. To do this we could choose from the wealth of examples given by Quesnay, who offered various formulations of the Tableau and numerous examples. The original version of the *Tableau* (the so called "*zig-zag*") was published between December 1758 and December 1759 and comes in three different editions and in a very limited number of copies. In 1759 the *Tableau* was made available to the general public as a work co-authored with the Marquis de Mirabeau (*L'Ami des Hommes*, 1759). The various examples it contained did not differ very much from the original formulation of the *Tableau*. A real clarification was reached with the *précis,* i.e. the summary of the "*zig-zag*" (*Philosophie Rurale*, 1764) and later on with the "*formula*", i.e. a new simplified diagram of the *Tableau*, presented in the article published in the *Journal de l'Agriculture, du Commerce et des Finances* (1766). In the "*formula*" various cryptic aspects present in the previous formulations of the *Tableau* were clarified. The level of total production in each sectoris shown, as well as the level of net production in agriculture and the role of advances, which is essentially that of circulating capital. Not surprisingly, the first person to attempt to translate the *Tableau* into an input-output format (Phillips, 1955) used the values of the *Tableau* "*formula*". We follow him by assigning the values in the *Tableau* "*formula*" to our symbols. The following correspondence is obtained:

$$A + CV = \begin{bmatrix} a_{11} + c_{1f}v_{f1} & a_{12} + c_{1s}v_{s2} \\ a_{21} + c_{2f}v_{f1} & 0 \end{bmatrix} = \begin{bmatrix} 2/5 & 1 \\ 1/5 & 0 \end{bmatrix}$$

$$B(I - CVB)^{-1} = \begin{bmatrix} 5/2 & 5/2 \\ 1/2 & 3/2 \end{bmatrix}.$$

The multipliers, which sum to 7.0, include the intermediate and final consumption of farmers and sterile workers. Sterile workers, however, do not buy in their own sector.

The solution of the *Tableau* "*formula*" in the sector-sector space, equation (1.2), then is:

$$\begin{bmatrix} 5 \\ 2 \end{bmatrix} = \begin{bmatrix} 5/2 & 5/2 \\ 1/2 & 3/2 \end{bmatrix} \cdot \begin{bmatrix} 1 \\ 1 \end{bmatrix}.$$

The complete *Tableau* of flows in the closed economy of the *Tableau* "*formula*", then is:

	Agriculture	*Sterile sector*	*Final sector*	*Total*
Agriculture	2	2	1	5
Sterile sector	1	0	1	2
Final sector	2	0		(2)
Total	5	2	(2)	7

It is worth noting that the sterile sector does not have a surplus, but it is not completely unproductive as it supplies intermediate goods to agriculture.

A different exercise is based on the values discussed by Quesnay in the original *Tableau zig-zag* (1758-9), and used by Barna (1975) in Table 1 of his essay (1975). The multipliers are different from those discussed above; the information is more detailed and an interesting decomposition is thus possible. The coefficients are:

$$A + CV = \begin{bmatrix} a_{11} + c_{1f}v_{t1} & a_{12} + c_{1s}v_{s2} \\ c_{2f}v_{f1} & c_{2s}v_{s2} \end{bmatrix} = \begin{bmatrix} 0.571 & 0.75 \\ 0.143 & 0.25 \end{bmatrix}$$

$$A = \begin{bmatrix} 0.423 & 0.499 \\ 0 & 0 \end{bmatrix}; \qquad V = \begin{bmatrix} 0.285 & 0 \\ 0 & 0.499 \\ 0.285 & 0 \end{bmatrix}; \qquad CV = \begin{bmatrix} 0.1428 & 0.25 \\ 0.1428 & 0.25 \end{bmatrix}.$$

In this case, matrix *A* is different from the previous case and even singular which does not prevent the existence of inverse matrix *B.* To compare the two economies, we need the following matrix:

$$(I - A - CV)^{-1} = B(I - CVB)^{-1} = \begin{bmatrix} 3.5 & 3.5 \\ 0.6668 & 2.0006 \end{bmatrix}.$$

	Agriculture	*Sterile sector*	*Final sector*	*Total*
Agriculture	0.571· 7=4	0.749· 2.6675=2	1	7
Sterile sector	0.143· 7=1	0.25· 2.6675=0.67	1	2.67
Final sector	2	0		(2)
Total	7	2.67	(2)	9.67

As the multipliers now sum to: 9.6674, one could say that the level of the multiplicative process embedded in the *"zig-zag"* is significantly higher than that in the *Tableau formula*. By the same token, the economy in the *"zig-zag"* is less efficient than the economy in the *"formula"* as to produce the given surplus, a larger total production is required. As consumption coefficients are the same, the difference can be ascribed to both technology and distribution coefficients.

Distribution coefficients were not identifiable in the previous case, which means that we cannot readily separate the two single contributions to overall inefficiency. The table shows the complete *Tableau* of flows in the closed economy.

6. DECOMPOSING THE TOTAL EFFECT

A further manipulation of the classes-sectors model allows us to evaluate the role of the proprietors' consumption better than do the more traditional formulations. By using the theorem regarding the inverse of the sum of two matrices to the matrix $(I - CVB)^{-1}$ appearing in equation (1.2) we get:

$$I + C(I - VBC)^{-1}VB\,.$$

By using the definition of matrix *K*, the last expression can be written as $I + CKVB$ and used to write in a new way the solution in the *sectors-sectors* space:

(1.4) $\quad x = Bf + BCKVBf$

or, equivalently:

(1.5) $\quad y = VBf + VBCKVBf\ .$

As is obvious, equation (1.4) is equivalent to (1.2), while equation (1.5) is equivalent to (2.2) and (1.3).

From the economic point of view, equations (1.4), and (1.5), offer an interesting decomposition of the total impact into different rounds. The expression (1.5), for instance, splits the total income effect into two different parts. The first *(VBf)* is the income that can be ascribed to the proprietors' consumption. The second, i.e. *(VBCKVB),* quantifies the induced income effect. The latter completes the former by introducing the effect of income distribution as the initial impact is followed by the induced effect. More precisely, equation (1.5) allows us to separate the following components:

(1.5a) *VBf* direct income effect of proprietors' consumption.

CKVBf consumption of farmers and sterile workers induced by the proprietors' consumption.

(1.5b) *VBCKVBf* indirect income effect of proprietors' consumption.

The above formula really decomposes the circular process that Quesnay formalized with his *Tableau*. The process implies two distinct processes: one related to the direct effect (1.5a) , the other consisting of the indirect effect (1.5b); each round in the first is matched by a round in the second.

In the economy considered by Quesnay savings are absent, which means that all classes cannot borrow. It would be possible and interesting, therefore, to verify whether the solution in terms of income -- equation (1.3) or (2.2) or (1.5) -- is consistent with the equation $f = Dy$, which so far has been considered inactive. If there were a discrepancy, Quesnay could probably conclude that the distribution and consumption patterns are not optimal, i.e. able to allow full reproduction.

7. SUMMARY

In this paper I have tried to reformulate the *Tableau Economique* as an input-output system, an exercise which is hardly new as many others have already tried it. Unlike Phillips (1955), Maital, 1972, Barna, 1975, Pressman, 1994, Steenge, 2000 and others, I have made a clear distinction between sectors and classes in order to look into the black box of the economy considered by Quesnay. I have instead followed the tradition by disregarding advances.

In a static model, where foreign trade is absent, the final consumption of proprietors is exogenous and determines the level of production and income. More precisely, total production by sector can be determined in two ways; respectively by (1.2) or (1.4). Total income by class, instead, can be determined by (2.2), (1.3) or (1.5). The various expressions that have been provided show that the level of total production and, more importantly, the level and composition of surplus in one particular year are uniquely determined by such factors as technology, income distribution, the consumption composition of farmers and sterile workers and the consumption level of proprietors, as Quesnay had argued with his *Tableau*. With the suggested model it is further possible to verify the consistency between the surplus accruing to proprietors and their final consumption which is exogenous in the model, i.e. the internal consistency that Quesnay himself tried to investigate using the concepts of reproduction and advances.

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