The physiological roots of the *Tableau Économique*

Abstract

The paper discusses the physiological inheritance from Quesnay's previous training and practice in natural sciences to the *Tableau Économique*. By reviewing his medical writings from 1720 to 1747 it was possible to identify Quesnay's affiliation among the various medical schools of thought in 18th-century France. It is argued that Quesnay developed an eclectic approach towards physiological processes that merged vitalistic principle with the canonical Galen and Hippocratic humors theory. This identification provided the analytical means by which it was possible to deconstruct the somehow traditional understanding that the Tableau was inspired by the circulatory system. Thus, the paper sheds light on the interfaces between medicine and the birth of Political Economy. The article leaves open for further analysis the relation between capital expenditure and the ecological role played by the Vital Principle.

Key words: François Quesnay - *Tableau Économique* – Physiocracy.
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Autores:

Fernando Ribeiro Leite Neto – Pontifícia Universidade Católica de São Paulo e INSPER

Nelson Mendes Cantarino – FECAP e INSPER

I. INTRODUCTION

François Quesnay obtained his surgeon degree in *Saint-Côme*, in 1717. Later, in 1744 he became a physician acquiring a medical degree at the *Faculté de Pont-à-Mousson*. Ironically, as a surgeon Quesnay played the most important role in the long and bitter battle between the Surgeon's Order and the Medical Order.[1] His theoretical and practical works on physiology granted him nominations to the *Académie des Sciences* in Paris and the Royal Academy of Sciences in London.

Thanks to his prudent behavior as a surgeon of the nobility members and also his strong relation with La Peyronie, Quesnay became Madame Pompadour's private physician early in 1749. It seemed to be the highest professional level for someone who was born from a small peasant family (Schelle, 1907).

However, once lodged in an entresol in Versailles, Quesnay became an active scholar in political economy. Biological images and physical analogies were part of the long-term process that gave birth to political economy as an autonomous science (Schabas, 2005 and 2009; Christensen 1994). At first, *Quesnay le fils* contributed to the *Encyclopédie* with the articles *Fermiers* (1756) and *Grains* (1757), not to mention the methodological and epistemological article *Evidence* (1756) which was anonymously published there. Other articles would became entries in the *Encyclopédie*, such as *Hommes*, *Impôts* and *Interest de l'argent*, but royal censorship prevented them from being published by Denis Diderot (1713-1784) (Grenewegen, 2002; Steiner, 2003; Théré and Loic, 2008).

This paper discusses Quesnay's transition from his previous practice of natural sciences to political economy and proposes an alternative route to understand the French author's works in special the *Tableau Économique*. To put in the words of Foley (1973 p. 121): "whether Quesnay might have gotten his notions of the circulation of goods and money in society from his previous acquaintance with Harvey's researches on the circulation of the blood". In doing so, the article pursues what Marcuzzo (2008, p. 111) describes as "contextual analysis"[2]

By reviewing his medical writings from 1720 to 1747, it was possible to identify Quesnay's affiliation to several 18th century medical schools of thought in France. It is argued that Quesnay developed an eclectic approach towards physiological processes that merged the vitalistic principle with the canonical theory of humors developed by Hippocrates of Kos' (460 BC – 370BC) and Galen of Pergamon (130 BC. – 200 BC.). This identification led us to deconstruct the somehow traditional understanding that the *Tableau Économique* was inspired by the circulatory system.

Hence, the contribution of the paper is two-fold: on one hand the article provides strong criticism to Foley's proposition that the *Tableau Économique* should be understood as an analogy to the circulatory system. The criticism is built upon the debates undertaken in the 18th century

[1] Aiming to his independence from the physicians' domain, the surgeons, led by François Gigot de la Peyronie (1678-1747) and Quesnay, released Saint-Côme surgery faculty from the Medical Facultè de Paris' monopoly in teaching anatomy and physiology in 1750. From then on, Saint-Côme was able to have its own anatomical and surgical teaching (Shelle, 1907).

[2] "By context I mean the set of questions and answers which framed theories and concepts, the intellectual interlocutors to whom they were addressed and 'the state of the art' at the time of their conception. The framework consists of facts regarding time, place and circumstances, about which knowledge and information have first to be dug out and then used to make sense of what is being interpreted or, as far as possible, illuminated." (Marcuzzo, 2008, p. 111). In this paper Marcuzzo presents and discusses other methods related to the Historiography of Economic Thought.

medical thought. The critics towards Foley's approach hits Banzhaf (2000) and Christensen (1994) only to the extent that both authors accept and share Foley's analogy relating the *Tableau* to the circulatory system. Apart from that issue, the article mergers with Banzhaf (2000) and Christensen (1994) on the quest to unite Quesnay's natural thought to his political arithmetic system.

On the other hand the paper invites to a deep digression in a rather unknown territory to most of historians of the economic thought: medical, physiological and chemical thought during the French enlightenment. It is argued that one of the most relevant issues in dispute in the awake of political economy, i.e. the origin of production, is related to Quesnay's filiation to the Vital Principle theory, which was one of several other theories in dispute regarding the causes of motion in organic matter.

This paper is organized as follows: in the first section, we provide an overview of Quesnay's work in the context of the object of study proposed here; in the second section, we describe the debates in medical thought in the mid 18th century to pinpoint Quesnay's medical affiliation, and in the third section, we focus on the so-called vital principle which accounts for the physiological origin of the *Tableau Économique*. We conclude with a brief discussion about the findings and point to further research in the area.

II. A LONG-LASTING DEBATE: THE *TABLEAU ÉCONOMIQUE* AS A BIOLOGICAL IMAGE OR AUTONOMOUS POLITICAL ARITHMETIC?

Much has been said to explain Quesnay's interest in political economy and rural economy *circa* 1750. As Steiner (2003) and Théré (1998) point out, economic affairs were quite frequent in public debates all over the 18th century in France. Théré (1998) managed to count 1,946 authors of publications in economics (pamphlets, booklets, books and so on) from 1550 to the French Revolution, out of which 127 were doctors and surgeons (6.5%). However, by the time Quesnay started to publish on political economy, doctors and surgeon accounted for 7.8% of the total number of known authors (Théré, 1998, p. 36-37).[3]

Quesnay's change from physiology and natural science to political economy did not surprise his contemporaries. For George-Louis Leclerc, Comte de Buffon (1707-1788), Quesnay only changed his interest from healing people to practicing medicine for governments. Pierre Samuel Du Pont de Nemours (1739-1817) also argued that, for Quesnay, political economy was medicine applied to the whole nation (Vardi, 2012, p. 61). Camile François Claude, Comte D'Albon's (1753-1789) *Élogue Historique de François Quesnay* (1775) seems quite clear about this position:

> After completing his work *Essay Physique sur L'Oeconomie Animale* (1747), Quesnay found himself naturally compelled to be involved with Political Economy. By addressing the influences of the effects of the soul on the body, we were soon convinced that men could not be truly healthy if they were not happy and they could not be happy if they did not live under a good government (Comte D'Albon, 1775, p. 33-34).[4]

[3] One reason for the emergence of the economic debate of that time might be found in the series of crop shortfall due to weather condition in the turning of the 17th century to the 18th century. Also, events such as the recurrent war between the Netherlands and the Austrian Empire and the Seven Years Wars against England created famine, high mortality among population and fiscal crisis (Orain, 2013 and Steiner, 2003).

[4] Après avoir terminé son travail sur l'Economie Animale, Quesnay se trouva naturellement conduit à s'ócuper de l'Economie Politique. En refléchissant aux influences des affections de l´âme sur le corps, on ne tarde guere à se convaicre que les hommes ne sçauroient avoir une veritable santé s'ils ne sont heureux et ne peuvent être heureux s'ils ne vivent sous un bon government (Comte D'Albon, 1775, p. 33-34).

In the 'Wealth of Nations,' Adam Smith (1723-1790), discussed the physiocratic doctrine. According to Smith (2005[1776], p.549), Quesnay was a "very speculative physician." In Smith's viewpoint, the possible inheritance from medical training to economic reasoning was once again based on the analogy of the political body as something similar to the human body. In a digression about the effects of different political economy systems on the progress of a nation, Smith pointed out that:

> Mr. Quesnay, who was himself a physician, and a very speculative physician, seemed to have used the same kind of notion of the political body, and thought it would thrive and prosper only under a certain precise system, the exact system of perfect freedom and perfect justice (Smith 2005 [1776], p. 549).

As is well known, Smith criticized Quesnay's approach to agriculture as the only source of wealth. Even if the true nature of value was a subject of dispute between Smith and Quesnay (not to mention Étienne Bonnot de Condillac (1715-1780), Ferdinando Galiani (1728-1787) and Jean Baptiste Say (1767-1832)), Smith planned to dedicate 'Wealth of Nations to Quesnay. Nevertheless, despite Smith's critical approach, the *Tableau Économique* had a long-lasting influence on both political economy and economics.[5]

The *Tableau Économique* provided Karl H. Marx (1818-1883) with the design of the dynamic schemes of capital reproduction, depicted in Book II of 'The Capital.' Marx's (1867) simplest dynamic model referred to an economy that reproduced the same level of output throughout time. Marx acknowledged Quesnay's *Tableau* influence in a letter addressed to Engels in July 1863 (Marx, 1966, p. 469; Gherke and Kurz, 1995).[6]

Although criticizing the weak physiocratic approach to prices, Léon Walras (1834-1910) praised Quesnay's remarks. In Section VII, Lesson 37th of *Élements d'économie politique pure* ([1874] 1926), it reads:

[5] However, his influence came later by the mid19th century when Eugéne Daire (1843, 1844 and 1846) published a set of 18th century French economic texts, including *Turgot* and the *Physiocrats* (Vardi, 2012). The reception of the *Tableau Économique*, probably the version published in 1761 in the sixth volume of Honoré Mirabeau's *L'ami des hommes*, might be considered in two ways: first, there was general skepticism on the *économistes*' methodological approach, too much based on deductions derived from general principles that were available if evidence was free to penetrate one's mind (Van den Berg, 2002 and Vardi, 2002); and second, there was a more technical and precise criticism of the *Tableau* from François Véron Duverger de Forbonnais (1767) and Jean-Joseph-Louis Graslin (1767), as detailed in Van den Berg (2002).

[6] Marx (1863) developed an analysis of *Physiocracy* and Quesnay's *Tableau* in his "Theories of Surplus Value". Marx praised Quesnay and the phisiocrats for having identified the source of surplus value in direct production instead of exchanges. Although the physiocrats presented the capitalist mode of production under a feudal theoretical framework, the most important contradiction lied in identifying the surplus value generated in agriculture as a social surplus-use-value generated by nature forces: "Hence the contradictions in this system: it was the first to explain *surplus-value* by the appropriation of the labour of others, and in fact to explain this appropriation on the basis of the exchange of commodities; but it did not see that value in general is a form of social labour and that surplus-value is surplus-labour. On the contrary, it conceived value merely as use-value, merely as material substance, and surplus-value as a mere gift of nature, which returns to labour, in place of a given quantity of organic material, a greater quantity" (Marx, 1863, p. 70).

> Theferore, we will be led to really criticize the imperfections, what does not prevent us from recognizing, however, that they were not just the first but the only school of economists which in France have had an Pure original political economy […] (Walras [1874] 1926, p. 390).[7]

Late in the 19th century, both physiocracy and Quesnay seemed to have been forgotten and were under strong criticism. Bauer (1890) provides a testimony, even if somehow incomplete, about the skepticism towards the physiocratic model by the time. At the *Archives Nationales* in Paris, Bauer (1890) found out the first edition of *Tableau's* original manuscript (1758), three copies of the second edition (1759) and a set of Quesnay's letters to Mirabeau. At the *Bibliotheque Nationale*, Bauer (1890) also found out a copy of Quesnay's *Hommes* (1757). That might explain why Oncken's (1888) edition of Quesnay's works do not present a copy of the *Tableau Économique*, only the *Arithmetic Analysis* (1766).

By the mid 20th century, there was an issue about whether Quesnay's economic works inherited the natural philosophy approach from his previous practice as a surgeon and physician. Schumpeter (1954) and Meek (1960, 2003) argued in favor of the dissociation of Quesnay's economic reasoning from any medical, physiological or natural philosophy model he could have acquired during professional life.

Sutter (1958) was the first to make an attempt to acknowledge physiological and natural philosophy influences on Quesnay's social thought. In turn, Foley (1973) was able to shape the coming debates about the matter by addressing the relation between the circulatory system and wealth circulation in the *Tableau Économique*. His contribution will be discussed and deconstructed later on in this paper.

Christensen (1994) and Banzhaf (2000) provided a detailed account of the various disputing and complementing theories of the nature of matter, its motion and generation, nutrition, chemistry and metaphysics from Descartes (1677) to Quesnay (1759). In doing so, the authors provided an outline of the possible influences on Quesnay's natural thought, particularly described in Quesnay (1747). Nevertheless, the theoretical paths that could merge Quesnay's social and natural thought were only briefly explored. In Christensen (1994), the physiology of the *Tableau* reproduces Foley's (1973) arguments in a briefer discourse.[8]

According to Groenewegen (2001), the theory of knowledge, as presented in Quesnay (1736, 1747 and 1958 [1756]), was the main channel for the author's change from natural philosophy to social theory. The evidence was based on Quesnay's text reconstruction in the light of the broader philosophical debates at that time about the true nature of matter (its different manifestations, its motion and so on). The theory of sensitive functions in body tissues entailed the rule of nature (vegetative soul) that gave order to both natural and social realms.[9] But when it came

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[7] On serait ainsi amené à leur reprocher bien des imperfections, ce qui n'empêche pas, cependant, qu'ils aient été non seulement la première mais la seule école d'économistes qui, en France, aient eu une économie politique pure originale […] (Walras [1874] 1926, p. 390).

[8] "We argue that Quesnay's economic theory of production and circulation (the *Tableau Économique)* and his unique theory of agricultural productivity (and manufacturing sterility) reflect not only his physiological model of the circulatory system, as argued in Foley (1973) but also his physical, chemical, physiological, and "ecological" theory of production and circulation of materials in nature. " (Christensen, 1994, p. 249-259).

[9] Interestingly, Groenewegen (2001) followed the same theoretical viewpoint in Comte D'Albon (1775, p. 24-34) who claimed that Quesnay's interest in political economy came from the psychological and philosophical/epistemological approaches developed in the latest edition of *Essay Physique sur l'Oeconomie Animal* (1747): "Je ne parlerai pas des principes constitutifs et des élémentaires qui n'on rapport qu'à la Physique ou à la science Physico-médicale. Je

to medicine and economics in Quesnay's works, the author did not provide any new evidence as to whether Quesnay's economic thought was autonomous in relation to his practice of natural sciences.

More recently, the hypothesis of a sort of a genetic path that linked physiology to economics in Quesnay's works had apparently been dismissed. Charles (2003) argued that one must understand the *Tableau Économique* as a heuristic and rhetoric device used to elucidate and simplify Quesnay's model. In that sense, the *Tableau Économiqu*e came up as a 'rational recreation' inspired by the rolling ball clock of French inventor Gaspard Grollier de Servière. In the 17th and 18th centuries, rational recreations were artifacts designed to offer magic, sensorial and pedagogical experiences.

A research agenda compounded by a rather mathematical interpretation of the *Tableau Économique* showed itself more fruitful. In fact, a whole literature had emerged since Meek's (1960, 2003 [1962]) reinterpretation of the *Tableau*. This literature was characterized by the use of what Marcuzzo (2008) labels as "rational recreation", which aims to translate the ideas of the past into modern economics by means of mathematical language (Maital, 1972; Barna, 1975; Bilginsoy, 1994; Eltis, 1975; Vaggi, 1985; Serrano and Mazat, 2013).

III. MEDICAL THOUGHT IN THE MID 18TH CENTURY: IN THE SEARCH FOR QUESNAY'S MEDICAL AFFILIATION

> I have to say that I have abandoned you to your bad constitution, to the stiffness of your entails, to the corruption of your blood, to the bitterness of your bile, and to the feculence of your humors (Moliére, 1815 p. 197).[10]

The 18th century scientific thought was still under the influence of metaphysics. One form of manifestation of this distinctive feature is the long- lasting influence of theories of humor and temperament in medicine as a direct Hippocrates's and Galen's tradition. Humors represent the nature's fundamental elements in the body's physiology. Fire is related to yellow bile. Air is associated to blood. Water can be translated into phlegm and earth is black bile. Each of those humors is responsible for a given temperament, for example, yellow bile is related to a choleric soul, sanguine and phlegmatic temperaments are self-evident and melancholic individuals suffer from a relative excess of black bile.

Health was granted by a sort of very personal imbalance in the individual's endowment of humors. Humors were in constant motion (what caused the motion of matter is one of the main concerns of the 18th century natural philosophy) in order to assure health. Illness was characteristically a manifestation of a great imbalance between the endowment of humors and flows in the body. As nature aimed at restoring the original personal imbalance, or the original personal temperament the body tries to expel the exceeding humor. The physicians' goal was to help nature in its work by delivering antiemetics, laxatives and naturally bloodletting (Mitchell 1979).

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m'attacherai seulement aux facultés sensitives et intellectuelles que ces derniers principes renferment" (Comte D'Albon, 1775, p. 24).

[10] J'ai a vous dire que je vous abandonne à votre mauvaise constituition, à la intempérie de vos entrailles, à la corruption de votre sang, à l'àcreté de votre bile, et à la féculence de vos humeurs (Moliére, 1815 p. 197).

Published in Frankfurt, William Harvey's (1993 [1628]) discovery was far from threatening this system. One must recall that physicians' practice, like law professionals or theology scholars in the 18th century, was based on antique traditions. It meant that any breakthrough in science was much of an elaboration in canonical knowledge rather than a radical transformation (Hamilton, 1951; Broman, 1989). That explained, at least in part, why Harvey (1993 [1628]), Giovanni Alfonso Borelli (2011 [1680, 1681]) and Marcello Malpighi (1958 [1661]) findings lasted in a context where Hippocrates's and Galen's paradigms remained untouched. Friedman and Friedland (2000) stressed just how often the path towards Harvey's discovery was blocked by the difficulties to fit the anatomical and physiological discoveries of Andreas Vesalius (1514-1564) and his followers, such as Bartolomeu Eustachio (1520-1574) and Gabriel Falopio (1525-1562), into Galen's tradition.

The circulatory system depicted by Harvey (1993 [1628]) was in line with the theory of humor insofar as humors are fluids running within body tissues. That is where René Descartes (1596-1650) articulated his metaphysics of circular motion in dynamical system theory. Descartes (1677) argued that the human body is a mechanical system controlled by a rational soul located in the pineal gland and working under the laws of hydrodynamics. The human body was a hydraulic system operating according to the laws that shape structure and motion in the universe, which was also regarded as a mechanic system. Harvey (1628) fits perfectly Descartes's (1677) mechanistic theory. This approach, shared by Descartes, Isaac Newton (1642-1727) and Robert Boyle (1627-1691), was based on a metaphysical ontology of action in which matter was entirely passive, it could neither think nor move of its own volition. All motion in nature was made by God at the time of Creation. Here the analogy with the image of the clock is quite clear. Motion, created at the dawn of life, perpetuated itself in all living creatures by means of inertia.

In the late 17th century and early 18th century, the debate over natural philosophy was centered on the causes of the motion of matter. The iatrophysics (also iatrophysiology or iatrochemistry) represented the research agenda of the period, an agenda that included metaphysics and experimental science. The most fundamental issue in dispute was the primary cause of the motion of matter, particularly in body tissues, liquids and so on (Mitchell, 1979; Christensen, 1994; Maquet, 1992, Banzhaf, 2000). Herman Boerhaave (1668-1738), a most important influence on Quesnay's physiological approach, clearly remarked: "We are totally ignorant of the origin and communication of the motion in bodies" (Christensen, 1994, p. 252).

Iatrophysics was further developed by Borelli (2001 [1680, 1681]) who was the chair of Mathematics at the University of Pisa and worked together with Marcello Malpighi in the early 1660s. Malpighi (1958 [1661]), by means of dissection in living animals and the use of microscope, discovered the capillaries in the lung, an extension of Harvey's circulatory system.

Borelli's (2001 [1680, 1681]) work was published in two parts focused on the very core of the iatrophysics concern: motion. *De motu animalium* was a remarkable physiological and anatomical work in the context of the scientific revolution of the 17th century. As an extension to Harvey's findings, Borelli (2001 [1680, 1681]) applied the laws of fluid mechanics to calculate the flow of blood filtered by the kidneys in relation to heart contractions and also measured the quantity of air in the thoracic cavity. Most interestingly, both Borelli's *De motu animalium* and Harvey's *Exercitation anatomica de motu cordis et sanguinis in animalibus* did not refer to metaphysical causes underlying the forces that create motion.

However, by the mid 18th century, the mechanistic agenda was challenged. Biological and chemical experiments and observations all evidenced sensitivity in living tissues. Moreover, the assumption of preformation, that is, the mechanistic scholars' explanation that generation was the simple enlargement of the germs was inconsistent with the existence of hybrids, monsters and, more

importantly, the regeneration of the parts, as revealed by Tremblay's Polyp in 1740[11] (Christensen, 1994) .

As mechanistics faced an intellectual crisis, a sort of synthesis took place in natural philosophy. Neomechanists, materialists and vitalists provided a set of assumptions to explain the motion in matter. In that context, the vital principle was one of the competing theories. In any case, in the 18th century medicine in France, the theories of humor and temperament were predominant. Hence, they were mixed with different 'schools' of physiological thought and provided medical practitioners with a somewhat general approach to illness (Mitchell 1979; Delacy 1993).

Firstly, illness represented an imbalance of the whole body system. Although located in any specific region, organ or tissue, it spread throughout the system. At that time, physicians developed a 'macroeconomic' approach to understand illness dynamics similar to medical practice and the *Tableau*. Secondly, the most usual practice of the 18th century physicians was the 'bedside physician' (Mitchell 1979). Medical practitioners gave very detailed descriptions of illness symptoms as, for example, the fact that there were no less than 210 terms used to describe fever. This evidenced the great difficulty physicians went through to diagnose an illness, except for well-known ones such as tuberculosis and typhus (the most common respiratory pathologies) and smallpox and scarlet fever (eruptive illnesses) (Bercé, 1997).

Thirdly, since pathologies had an underlying root in the individual's imbalances of humors and temperaments, there were no etiological assumptions as to any general causes of illnesses. In fact, illness was a manifestation of individual imbalance rather than a social or external phenomenon, which meant that part of the treatment depended on the individual himself. This was in line with Hippocrates's remarks that healing was fastened as long as the patient kept his hopes and strength (Mossé, 1997).

That was how the vital principle added to Hippocrates's and Galen's paradigms gave sense to medical practice in the mid 18th century. Quesnay's natural philosophy, as described in the second edition of *Essai physique sur l'oeconomie animale* (1747) fits both the vitalistic approach and the ancient theory of humors.

> [...] As soon as the blood circulation was known, Human Body was taken for nothing but a hydraulic machine, we have considered in the treatment of diseases the movement of humors rolling in vessels; all the intentions of physicians were confined to maintain the balance between solids and liquids [...](Quesnay, 1747, p. 418-419).[12]

The vital principle was to be found in chemistry. For Boerhaave (1743) fire is a universal instrument used in chemical processes, it is the material that explains heat, combustion, fluidity and light. Likewise, Georg E. Stahl argued that phlogiston was the main material found in minerals, vegetal and animals. Phlogiston is the principle of fire. It has an ecological dynamics since it circulates among the natural kingdoms by means of its regeneration from dead animals and plants to minerals, than to earth and to plants and animals once again (Christensen, 1994).

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[11] The experiences of John Abraham Trembley (1710-1784) with freshwater polyps demonstrated the regenerative capacity of the body tissues. "Somehow, it was believed that the way by which the polyp regenerates itself certifies that matter was a dynamic and not just only passive entity." Bernat (2013, p. 36).

[12] [...] aussitôt que la circulation du sang a été connue, on n'a plus regardé le Corps Humain, que comme une machine hydraulique, on n'a envisagé dans la cure des maladies, que le movement des humeurs qui roulent dans les vaisseaux; toutes les intentions des médicens se sont bornées à entretenir l'equilibre, entre les solides et les liquides […] (Quesnay, 1747, p. 418-419).

According to Quesnay (1747), fire could be further reduced to a more general element. That is where metaphysics and medical practice were introduced in the argument. Quesnay recalled an old idea he got from Boerhaave and Sthal. The motion of matter, the most relevant issue in dispute in the 18th century natural philosophy, was due to a generic and abstract element. This vital principle is ether, a general, atomistic and active element that penetrates all pores of each living creature. As long as it creates motion, ether is also the source of heat and energy in the body. The most important physiological processes within the natural realm are explained by the operation of this subtle and general element. Generation, nutrition and motion all come from the functions of ether in the body. Ether is nothing but the "vegetative soul" of all living creatures which provides sensibility, motion and natural wisdom to tissues, organs and fluids. (Quesnay 1747).[13]

> But what is this primitive Agent? It is neither difficult to separate it from the other principles of the Body nor from the other fluids; since only Ether has its own activity and fluidity and from which all other fluids derive their active qualities (Quesnay, 1747, p. 110).[14]

Most interestingly, Quesnay (1747) pointed out that nutrition was a process that take place in very small vessels and tissues, not blood vessels, but the smallest ramification of the nerves into the muscular tissues. That's where nutrition and humors motion happens influenced by the vital principle – ether:

> Say more, the fact is certain; since the Vital Principle actually has a very large activity, and it does not receive it but from that Ether. It is therefore not other parts that can cope with the Ether but the fluid of nerves, where resides the Vital Principle, whose activity is the primary cause of all movements of the Body: The Vital Príncipe is nothing but the Ether, retained in Nerves […] (Quesnay, 1747, p. 111-112).[15]

This was important because it led Quesnay's to be aware of Harvey's (1993 [1628]) conclusions:

> Like all things, both arguments and visual demonstration showed that the blood passes through the lungs and heart by the action of the ventricles and atrium and is distributed to all parts of the body, where it passes through the veins and pores of the flesh, and then flows through the veins surrounding all sides towards the center, from the smaller to the larger veins, and is by then finally discharged into the vena cava and right atrium of the heart, in such quantity and at such ebb and flow through the arteries and veins *in such a way that it cannot be supplied by the diet, and much larger than necessary for the mere purpose of nutrition*. It is absolutely necessary to conclude that the blood is in constant state of motion and that is the act or function which the heart performs by means of pulse and which is the only function of the movement of contraction of the heart (Harvey 1993 [1628] p. 145. Italics by the author).

Quesnay (1747) provides a very clear insight on his relative stance towards the physiological and chemical theories in dispute in the mid 18th century. Quesnay's (1747) medical thought was based

[13] In his *Élogue Historque de François Quesnay*, the Comte D´Albon (1775, p. 23) highlighted this physiological discovery in the *Essay Physique sur l'Oeconomie Animale*: "Boerhaave avoit fait une physiologie, dans laquelle il avoit répandu la lumiere sur la structure des organes du corps et leurs fonctions particulieres; mais il avoit omis d'expliquer les premieres causes Physiques qui leur donnent de l'action, ou du moins n'en avoit il parlé que fort légérement. Quesnay comprit toute l'importance de cette partie de la Physiologie; elle étoit neuve […]."

[14] Mais quell est cet Agent primitive? Il n'est pas difficile de le démêler d'avec les autres príncipes des Corps, ni d'avec tous les autres fluides; puisqu'il n'y a que l'Ether qui ait par lui-même son activité e sa fluidité et que tous les autres fluides empruntent de lui toutes leurs qualités actives (Quesnay, 1747, p. 110).

[15] Disons plus, le fait est certain; puisque le principle Vital a réellement une très grande activité, et qu'il ne pas la recevoir que de l'Ether. Ce n'est donc pas dans les autres parties que peuvent composer avec l'Ether, que le fluide des nervs, que reside le príncipe Vital, dont l'activité est la première cause de tous les mouvements du Corps: Le príncipe Vital n'est donc que l'Ether même, retenu dans les nervs avec le fluide qui peut être refermé avec lui dans ces mêmes nervs (Quesnay, 1747, p. 111-112).

on a process of general changes in natural philosophy ranging from the mechanistic approach to a more wide-ranging view that merged neo- mechanistic, vital principal defenders and others. We can see now Quesnay's medical and physiological practice in its own context: he was a practitioner in bloodletting and as such he was still influenced by antique wisdom (the theory of humors).

Nevertheless, at the same time, he was aware of the chemistry advances to meet the limitations of the mechanistic theory. In that sense, Quesnay was able to identify the very nature of the motion in tissues, organs and the body through chemical processes. In fact, life is mostly a set of chemical reactions. That is the most fundamental message of the Vital Principal theory. For Quesnay (1747), ether was the primitive chemical substance that provided motion to muscles through tiny nerve vessels. Moreover, ether was an ecological element that guaranteed the maintenance and continuous reproduction of both natural order and social reproduction by means of the agricultural activity. If there was anything similar to a physiological tradition in the *Tableau Économique*, it was the ecological feature of the vital principle and not the analogy with the circulatory system.

IV. THE VITAL PRINCIPLE: THE PHYSIOLOGICAL ORIGIN OF THE *TABLEAU ÉCONOMIQUE*

The most long-lasting contribution to the idea that the *Tableau Économique* had its origin in Quesnay's medical practice is found in Foley (1973). The author first reported the bitter academic battle between Quesnay (1750) and Silva (1727) about the effects of bloodletting on healing wounds, fevers and so on. Silva's (1727) argument was based upon the assumption that blood flows have different speeds in the bloodletting process. By opening a wound in the opposite direction of the illness spot, blood would flow quickly from the illness spot to the opened wound. This forced the balance in the humors' restoring health once again (Silva, 1727; Foley, 1973; Christensen, 1994).

Quesnay used the most important scientific subjects available at the time to impose his victory on the imminent physician: dynamic hydraulics. Through his tin tube experiment, Quesnay was able to prove that "the speed of the blood in the circulatory system would be nearly the same" (Foley, 1973, p. 129).

Foley (1973, p. 130) claims that "Quesnay believed that the pulmonary circulation was so slow that it was insignificant to the metabolic economy of the body". Curiously, Quesnay (1750, p. 88-91), as cited in Foley (1973, p. 130), deals with the melancholic temperament and how spoliation could treat fevers related to these types of imbalances. This was in full agreement with the 18th century medical thought in France, as mentioned before.

However, how could Quesnay assumed that there was different blood speed in the human system since he had argued Silva's (1727) bloodletting practices in terms of the equalization of the water flow rate stemming from his experiment with the tin tube? Moreover, Quesnay was aware of the circulatory system discoveries made by Borelli (2011 [1680, 1681]) and Malpighi (1958 [1661]), which meant that, as a physician, Quesnay sustained that blood flows tended to flow throughout the human body at the same speed. It certainly encompassed pulmonary circulation:

> It is obvious that if the amount of blood that comes out of the bleeding is repaired by a similar amount of blood that occurs, everything is restored to the same state as before; the resistances will gather around the same balance. However, this balance is the term of the branch; because the derivation always assumes

> less resistance in the vessels where it is. Thus, there is little or a lot of blood in the vessels, the amount that goes into more in those where there is revulsion, is always equal to the amount of blood that comes out by bleeding. (Quesnay, 1750 p. 190).[16]

Foley (1973, p. 130) links his "origin of the *Tableau*" to Quesnay's neglected pulmonary circulation. This claim is important since blood, like noble rents in the *Tableau*, was divided into two flows when it came out of the heart. This two-fold division "brings to focus several key points about the hypothesis that Quesnay's economic theory borrows from his medical views" (Foley 1973, p. 130).

However, Quesnay (1747, p. 422-423) did not neglect pulmonary circulation in in *Oeconomie Animale*. Actually, pulmonary circulation was very important to Quesnay's natural system because it is through respiration that ether, the vital principle, entered the body. Moreover, air in the lungs provided one more source of power to the circulatory system besides heart and artery contraction. This was exactly opposite to Foley's claim.

> When blood is coming to the right ventricle of the heart, it is pushed into the pulmonary artery that distributes it in the lung, and is taken over by the pulmonary vein, which reports the left ventricle of the heart, where it is expelled immediately to repeat the same movement.
>
> The continuous pressure of the air that we breathe, much contributes to the movement of blood flowing through the lung. It is even absolutely necessary to route the blood in the vessels of this organ [...]
>
> [...] And our body is a machine, which the interior movements depend on an external cause, and it resembles to those machinery powered by water or wind (Quesnay, 1747, p. 422-423)[17].

An important element mentioned above is the analogy of the human body with a machine (hydraulic and air machine). If political economy was related to political body, then the use of machines as an analogy to explain *Oeconomie social* perfectly fit the 18th century discourse. The *Tableau Economique* was a machine, a model that aimed to explain the effects of fiscal policy on income and expenditures flows:

> I have tried to construct a fundamental *Tableau* of the economic order for the purpose of displaying expenditure and products in a way which is easy to understand, and for the purpose of forming a clear

[16] Il est evident en effet que si la quantité de sang qui sort par la saignée est réparée par une pareille quantité de sang qui survient, tout est rétabli dans le même état qu'auparavant; les resistances se retrouveront partout dans le même équilibre. Or, cet équilibre est le terme de la dérivation; car la dérivation suppose toujours une moindre résistance dans les vaisseaux où elle se fait. Ainsi, soit qu'il y ait peu ou beaucoup de sang dans les vaisseaux, la quantité qui en passe de plus dans ceux où il y a révulsion, est toujours égale à la quantité de sang qui sort par la saignée (Quesnay, 1750 p. 190).

[17] Lorsque le sang est arrive au ventricule droit du Coeur, il est poussé dans l'artere pulmonaire qui le distribue dans le poumon, et il est repris par la veine pulmonaire qui le rapporte au ventricule gauche du Coeur, d'où il est chassé aussitôt pour recommencer la même circulation. La pression momentanée et successive de l'air, que nous respirons, contribui beaucoup au mouvement du sang qui circule dans le poumon. Elle est même absolument nécessaire pour faire cheminer le sang dans les vaisseaux de ce viscere […] […] ainsi notre corps est une machine, don't les mouvemens interieurs dépendent d'une cause extérieure, et qui ressemble en cela aux machines que l'eau ou le vent mettent an movement (Quesnay, 1747, p. 422-423).

> opinion about the organization and disorganization the government can cause (Quesnay, 1758 as cited in Meek, 2003, p. 108).[18]

Therefore, the twofold division could be seen as a legacy of physiological reasoning to economic theory only if pulmonary circulation was neglected. Foley (1973, p. 130-131) argued that Quesnay was not aware of the physiological relevance of pulmonary circulation because "at some point, Harvey's contributions were corrupted". Here three important claims must be raised: first, since Harvey played very important role in medical history and the scientific revolution, it was necessary to sustain exactly when Harvey's discoveries were corrupted by documentary sources and second, it was possible to demonstrate that Harvey's circulation system was in the very center of mechanistic approach in the early 18th century.

Finally, and most importantly, Quesnay (1747, p.418) was aware of Harvey's depiction of the circulatory system saying that "the discovery of the circulation has shed light on the physics of *Animal Oeconomy*."[19] The twofold division of the circulatory system from the left ventricle also gave rise to the famous analogy that could translate physiology in economics:

> Thus a major similarity between the circulation of the *Tableau* and the circulation of Quesnay's medical scheme published a quarter-century before lies in the fact that they both begin with an initial division of the circulating medium into two separate and equal flows (Foley, 1973, p. 134)

At this point, Foley (1973, p. 134) argues that this was exactly the reason why Quesnay "decided to split his hypothetical society into two and only two social classes." But this is a misleading statement. In a later version of the *Tableau*, the *Analyse de la formule arithmétique du Tableau,* Quesnay (1766 [1888], p. 305) was quite explicit about his economic classification of society claiming that "the nation is reduced to three classes of citizens: the productive class, the owners' class and the sterile class."[20]

Reducing Quesnay's social scheme into only two classes was important to Foley's discussion as it gave rise to the analogy between social classes and the circulatory system. Foley argues that, in the mid 18th century medical thought, arteries were believed to have the property of contraction which put pressure and motion to blood flow. The productive class was identified with arteries since only this class added value, that is, this class, just like arteries, played active role in both physiological and economic system. Veins, as long as they served as passive channels whereby blood flows, could be understood as the sterile class in social structure (Foley, 1973, p. 134-136).

Foley (1973) tried to translate the most important feature of physiocratic thought: agriculture as the exclusive source of social output into the basic structure of the circulatory system. Nevertheless, anatomy gives evidence against Foley's analogy: it was the aorta, an artery that leads the blood from the left ventricle to both sterile and productive class. This was well-known by medicine practitioners at that time. To claim that sterile class could be translated as veins in the system implied that this class transformed arterial blood into venous blood. But then again, since

[18] As Théré and Loic (2008) pointed out, Quesnay was a rather unnoticeable figure in the context of Versailles court. Publishing articles with pseudonymous was part of his strategy to remain discreet. So Quesnay was not supposed to be as an enthusiastic spokesman of his own theories within French nobility, particularly about tax related issues.

[19] La découverte de la circulation a répandu de grandes lumieres dans la Physique de l'Oeconomie Animale […] (Quesnay, 1747, p.418).

[20] La nation est réduite à trois classes de citoyens: la classe productive, la classes des propriétaires et la classe sterile (Quesnay, 1886, p. 305).

Borelli (2011 [1680, 1681]) and Malpighi (1958 [1661]) in the late 17th century, physiologists knew that gas exchange occurred in the lungs.

Even if Quesnay (1750, p. 166) explicitly recognized that "blood is divided out of the left ventricle of the heart into two currents,"[21] it can only be viewed as a simple physiological statement and not a genetic trace that was to be found in Quesnay's economic theory. As pointed out by Forbonnais (1766), even if the nobles' rents were not split from the very first expenditure of the fiscal year, further subdivisions of the expenditures within and across the productive and sterile classes would guarantee the final balance in terms of the composition of aggregate demand and exchange value. That outcome was possible because the sterile class's spend its total income on the output of the productive class.[22]

However, it is not only blood that should be translated into wealth in the *Tableau*. In order to support the physiological origin of the *Tableau*, the net product cannot be identified with blood but rather with the vital principle that gives rise to the motion in the system. A misleading or incomplete reading of Quesnay's medical writings gives rise to false conclusions and analogies. The vital principle's operation did not take place in blood, but in the nerves: "It was recognized by all terms that this first principle lies within the nerves and experience does not allow any doubt about it (Quesnay, 1747, p. 104).[23] This approach was in line with the blend of neo-mechanistic and vital principle schools of natural thought to which Quesnay was affiliated to.

Any legacy of physiological and natural philosophy to political economy must be traced in Quesnay's broader approach to chemistry. As mentioned before, ether was the source of motion, heat and natural processes. In that sense, agriculture as the exclusive source of the net product can be explained in terms of the chemical and ecological role played by this general principle, the ether.

Quesnay's second contribution to *Encyclopédie* shows the macroeconomic role played by agriculture in the political body:

> [...] But the principle of all these benefits is in agriculture, which provides the first need of material, which provides reserves to the king and to the owners, tithes to clergy, and profits to farmers. These are first wealth, always renewed, which support all the other states of the kingdom, which give the business to all other professions, which blooms the trade that favor the population, which animate the industry, which maintain prosperity of the nation (Quesnay, 1888 [1757], p. 215-216).[24]

[21] Le sang est partagé a la sortie du ventricule gauche du Coeur en deux courans […] (1750, p. 166).

[22] As early as 1767, there was a debate about the effects of the sectorial composition of aggregate demand on the output level in the *Tableau Économique*. Forbonnais (1767) claimed that a decrease in total output would take place only if the sterile class did not spend his whole income on agricultural goods, otherwise all income would return to the productive class regardless of nobility expenditure pattern. Abbé Baudeau, chief-editor of the *Ephémérides du Citoyen* answered such criticism without addressing neither the methodological nor the theoretical points identified by Forbonnais (Van der Berg, 2002).

[23] On a reconnu de tous terms, que ce premiere principe reside dans les nerves et l'experiénce ne permet pas d'en douter (Quesnay, 1747, p. 104).

[24] […] mais le principle de tous ces avantages est dans l'agriculture, qui fournit les matières de premier besoin, qui donne des reserves au roi et aux propriétaires, des dîmes au clergé, des profits aux cultivateurs. Ce sont ces premiéres richesses, toujours renouvelées, qui soutiennent tous les autres états du royaume, qui donnent de l'activité à toutes les autres professions, qui font fleurir le commerce, qui favorisent la population, qui animent l'industrie, qui entretiennent la prosperité de la nation (Quesnay, 1886 [1757], p. 215-216).

In the latest and expanded edition of Quesnay's treatise on physiology, *Essai Physique sur L'Oeconomie Animale* (1747), the author describes the "macroeconomic" role played by the vital principle, that is, ether as the source of motion in animal economy:

> This requires that the Vital Spirit is itself an activity that in order to give birth to all these movements need not but simple causes: Muscles that are the organs through which the parties are set in motion, derive their strength from a force driven to them by the continuous blood flow in their fibers, which puts them in contraction as early as the liquid is either delayed or intercepted in these fibers; but the interception or delay the circulation of blood in the muscles, depends itself upon a first force that produces the fibers of these muscles to change by which the blood has stopped it. Now this first strength lies in the Nerves [...] (Quesnay, 1747, p. 109-110).[25]

This 'premier force' is the "principle to which we must attribute this huge activity of the Animal Spirit, which gives us all our sensations and moves all our organs" (Quesnay, 1747, p. 112-113). Not blood, but ether was the nutritive substance of both social and animal economy. Therefore, the *Tableau Économique* is not an analogy with the circulatory system but rather a subtle heuristic device that depicts the role played by ether in animal and social economy.

To conclude, although nature provides the power to constantly renew the net product, what moves the whole economic system is the capital expenditure undertaken by the agricultural entrepreneur (*le fermier*). In fact, even in Quesnay's very first economic essays (1757, [1888]), capital expenditure is a central element in his economic system. Moreover, nature is able to reproduce itself, but political economy might indicate the proper ways nature forces should be used in order to assure abundance to the political body.

V. FINAL REMARKS

François Quesnay developed an eclectic approach to his physiological thought. As a surgeon, he was a bloodletting practitioner aligned with Galen's and Hippocrates's long lasting theory of humors. Even before getting his medical degree, Quesnay (1736) was working on natural philosophy and physiology. In a context in which mechanistic school was questioned, Quesnay was in line with the most relevant developments in chemistry that ultimately led him to adopt the vitalistic approach without affecting his rather mechanistic view towards the human body. Hydrodynamics, the theories of humors and the vital principle were blended in Quesnay's physiological thought just before he changed to political economy.

The analysis of the intellectual context of the 18th century debates about natural philosophy provided the historical and analytical tools to retrace a possible inheritance from physiology to political economy to the *Tableau Économique*. Rather than the circulatory system, the *Tableau* might share some physiological influence in a broader sense: vital principle plus capital expenditure render possible the continuous reproduction of the political body over time. It is the ecological and cyclical feature of the vital principle chemistry that provides capital yields in agriculture. Therefore, the *Tableau* was not an analogy to the circulatory system but rather the application of Quesnay's physiological thought to political economy.

[25] Il faut donc que l'Espirit Vital ait par lui-même une activité qui n'ait besoin, pour faire naître tous ces mouvements que des causes simplement déterminantes: les Muscles qui sont les organs par lesquels les parties sont mises en mouvement, on à la verité une force que leur comunique le Sang qui coule continuellment dans leurs fibres, et qui les met en contraction aussi-tôt que le cours de ce liquid est ou retardé, ou intercepté dans ces fibres; mais cette interception ou ce retardement de la circulation du Sang dans les Muscles, depend lui-même d'une premiere force qui produit dans les fibres de ces Muscles un changement par lequel le Sang y est arrêté. Or cette premirer force reside dans les Nerfs […] (Quesnay, 1747, p. 109-110).

Apart from identifying Quesnay's relative position in the debates about the 18th century medical thought, we criticize the somehow traditional approach to the *Tableau Économique* as an analogy to the circulatory system as proposed by Foley (1973) Christensen (1994) and Banzhaf (2000). Based upon Quesnay's medical writings it was possible to relate the *Tableau Économique* to the author's physiological thought in a far more subtle and sound theoretical way.

Moreover, the paper identifies an agenda to conduct further research on the relation between *fermier's* capital expenditure and the ecological role played by the vital principle. Capital and chemistry sustain the political body.

The article concludes that it is possible to reunite the *Tableau* with previous physiological thought developed by Quesnay. Actually, this possible genetic line from physiology to political economy in Quesnay is wide spread everywhere in the metaphysical form of an ether.

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