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Multidimensional Trade Theory and Ramsey Effects: Biological Metabolism as Experimental Test on Sustainable Life Expectancy

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ABSTRACT

In this paper the following question is answered: Is the sustainable growth or optimal life expectancy generated by the constancy of the production possibilities frontier (PPF)? At this end, I study the effects of growth volatility — a perturbation in the PPF of a given economy (human organism)—on growth's sustainability. I use a laboratory experiment's results and propose a theory to address this issue. I find the human organism's multidimensional exchange mechanism, consisting of more or less integral compensation processes for negative and positive externalities, is responsible for the volatility of human growth, the main determinant of life expectancy, analogous in principle to the relationship between the processes of economic growth volatility and sustainability. Because the analogy is established the PPF appears to be the sole determinant of the sustainability of economic growth (life expectancy).

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Introduction

The only basis for any sustainable system i.e., normal, is a natural analogy. It is very rare to find phenomena in nature that are not analogous. Thus, everything that flies is the true precursor of the airplane. The same is true of the ladybug and the car, the train and the centiped. The term analogy indicates that one thing is sufficiently similar to another, from a certain point of view, that their analogy makes it possible to say of one or do with one what also applies to the other. If we could show that the theory of multidimensional trade (simultaneous trade between all the generations of a country and between all the countries) is sufficiently similar to a biological mechanism, we could say of one or do with the other what also applies to the other. We would then have more powerful analytical tools than the very approximate econometric methods, and economic policy would become normative. Economics could move more confidently toward the status of an exact science. The reliability of data and, above all, of econometric methods is one of the greatest challenges facing economics. In the 1970s, leading economists used the same statistical data to obtain contradictory results, bringing our science into great disrepute. For centuries, many economists have preferred positive analysis to normative analysis, as if human behaviour were error-free, virtually neglecting the analogical method, which is the source of the glory of the great sciences. The theory of multidimensional trade states: Factors of production that exist in abundance in one generation and are not intensively used to produce goods and services in that generation are exported to other generations in exchange for scarce factors of production intensively used to produce goods and services that should be scarce in the generation under consideration. Low-consumption goods and services are indirectly exported from one generation to the next, whereas high-consumption goods and services are indirectly imported from other generations. In this way, positive externalities (non-natural resources) are exchanged for negative externalities (overconsumption of natural resources) [1].

Production and consumption externalities are effects on the wellbeing of certain organs resulting from the actions of other organs without biological compensation. Production externalities are explained by the interdependence of organ functioning, while consumption externalities are linked to consumption choices; these externalities can be positive or negative. Clearly, this exchange of externalities is the fundamental mechanism that generates links between growth and volatility. T h e abbreviated multidimensional exchange model (2x2x2x4), i.e., two countries, two goods, two factors of production, and four generations, resembles the biological mechanism of consumption. The various organs of the organism function in dazzling interdependence, exchanging almost finished products with one another. If we follow the circuits of consumption of goods and services in the human body, many constants come to our attention. This biological mechanism is performed with the help of several neurotransmitter secretion centres, two of which in particular spark my curiosity: the brain and the intestine in their functions during the consumption

process. These two secretion centres, along with the goods whose consumption activates them, are considered to be two distinct countries. The neurotransmitters (serotonin and dopamine) synthesized by both centres play an important role in the organism, transmitting the information needed to produce two goods that we call carnal satisfaction on the one hand and cerebral or spiritual satisfaction on the other. Therefore, we have two goods (carnal satisfaction and spiritual satisfaction) and two production factors: serotonin and dopamine. Because the secretion centres themselves are made up of cells that renew themselves every month, we have generations of neurotransmitter secretion centres throughout the life of the organism. For simplicity, I will consider two generations of secretion centres, although all generations of secretion centres are also considered. This gives us the multidimensional exchange model (2x2x2x4).

In the neoclassical model, which considers two countries, two goods, and two factors of production, each country has a fixed quantity of labour and capital, which remains unchanged even after trade opens up. Wheat and cloth, for example, are naturally endowed with the capacity to induce the production of fixed quantities of serotonin and dopamine (factors of production of satisfaction), i.e., once consumed by a given consumer, they are unchanging.

In this way, the individual's immune system controls the production of fixed quantities of serotonin and dopamine. Let us remember that we are dealing with a normal individual, i.e., one whose conduct is regulated, systematic, sober, balanced, irreproachable, addiction free, with unvarying tastes, in good health, and whose characteristic aggregates grow at a constant rate of almost zero. The first, known as carnal, is predominantly serotonin, whereas the second, cerebral or spiritual, is predominantly dopamine. In fact, the consumption of a food item controls the production of 90% intestinal serotonin and 10% cerebral serotonin, indicating a partial specialization of secretion centres in the production of both carnal and spiritual satisfactions, exactly as in the factor proportion model.

Thus, our aim in this paper is to determine whether the theory of multidimensional trade is sufficiently similar to a biological mechanism so that what can be said of biological metabolism or done with biological metabolism also applies to multidimensional trade. Hence in this paper the following research question is answered: Does a multidimensional exchange mechanism exist in the human organism, involving more or less complete compensation between negative and positive externalities, to determine either a volatility of human growth that reduces life expectancy, or an optimal life expectancy analogous to either the volatility of economic growth, or the optimal or sustainable growth of an economy? In economics, growth volatility refers to the fluctuations or variations in the rate of economic growth over a period of time. It measures how much the growth rate of an economy deviates from its average growth rate, indicating the stability or instability of economic performance. More specifically, I will investigate the impact of non-Pareto-optimal Walrasian equilibria in the exchange of externalities between neurotransmitter secretion centres and/or between generations of neurotransmitter secretion centres as a fundamental mechanism of human growth volatility leading to life expectancy perturbations. This would confirm the theory of multidimensional exchange, enabling policymakers to use the same remedies as in modern medicine.

To our knowledge, this quasi-experimental study bringing the two sciences together is the first of its kind, both theoretically and empirically, on the economic (biological) links between growth and volatility, based on the trade in externalities on the scale of overlapping generations of nations (generations of neurotransmitter secretion centres) and between countries (secretion centres).

The paper includes the introduction section (1), Results and discussion (2), the section on data, results, and discussion (3), and conclusions and recommendations (4).

Comment N°4 . The manuscript draws analogies between economic mechanisms and biological processes that are overly simplistic and scientifically unfounded, such as comparing neurotransmitter actions to international trade.

Answer/
In a study of analogy between two phenomena, the aim is not to show that the two phenomena are identical, in which case the study is pointless. When Christ said that eternal life is like 10 virgins, 5 of them foolish and 5 wise, he wasn't trying to make his disciples understand that heaven will be made up of foolish and wise virgins. He wanted people to understand that the reserves of divine qualities (faith, patience, kindness, longsuffering...) are indispensable and are themselves eternal life. Whoever has these values, which are impossible to offer anyone else, has eternal life. In the analogy, a similar well-known phenomenon is evoked to enable the listener to gain a deeper understanding of the unknown phenomenon. For example, the wings of a bird are not identical to those of an airplane. What we're looking for in the analogical study is an index of similarity from which we can derive laws, policies and so on. Aren't Newton's laws the same as those that explain the lift generated by the wings of a bird and those of an airplane? By applying Bernoulli's and Newton's natural laws, Solow–Swan show how a pressure differential exerted by the difference between consumption and production creates the lift of a given economy toward its steady state.

Results and Discussion the Model and Methodology
The multidimensional trade theory to be tested is completely described in (Edgeweblime) "Multidimensional trade and Ramsey effects: Sustainable growth versus volatility" https://doi.org/10.1016/j.jclepro.2019.03.318.

This theory states that generations import from other generations productive factors intensively used in the production of goods and services highly consumed in the current generations and export productive factors intensively used in the production of goods and services weakly consumed in the same generations. Even though the neoclassical growth model goes back to Ramsey (1928) or Von Neuman (1935), the recent versions are closely related to the analysis of optimal growth by David Cass (1965) and Koopman (1960, 1965) [2-4]. Ramsey (1928), assuming that the population is constant and considering that global output is a function of capital and labour, admits that consumer utility has a superior final limit. He established the well-known Keynes– Ramsey rule of optimal saving, which characterizes steady- state optimal consumption. Rawls (1974), in his study of optimal growth, assigns the same weight to each generation by fixing a fair saving rate. However, it is now generally accepted that the implementation of the Rawls criterion for successive generations constitutes a growth limitation. But, if you want to bring to evidence that generations of a nation separated by a very long period (100.200 . 1000, 5000. … years) exchange goods for productive factors so that current growth is a by-product, what should be the best formula? In the original evidence on the multidimensional trade theory, Edgeweblime's hard question was as follows: How can the potential impact of the optimal policies

of externalities trade to uncouple growth and volatility in order to generate sustainable growth and clean production be explored by the means of agent-based modelling (ABM)? Because of the crucial importance of cleaner production, more clean and sure evidence on the fundamental mechanisms of sustainable growth is needed. In this paper, I turn to the exact science of biology, borrowing from electronics and aerodynamics the invaluable method of analogue y. Both fields use the analogy method to model and understand the complex phenomena that occur in their respective domains. This simplifies calculations while providing valid results (https://fr.wikipedia.org/wiki/%C3%89lectronique_analogue ique).

I would like to know whether the theory of multidimensional exchange is sufficiently similar to that of food metabolism, from a certain point of view, that their analogue y makes it possible to say of one or do with one what also applies to the other.

Data and Discussion

The main method here is a scientific comparison through experimental results 2.2.1- Analogue model configuration

2.2.1.1 Specification of the analogue system

The Approach to Factor Proportions is Based on The Following Assumptions:

- Everything happens in a market of pure and perfect competition (a multitude of competing goods to produce either carnal satisfaction or cerebral satisfaction);
- The individual has at his disposal two secretion centres (the brain and the intestine) producing either dopamine or serotonin with the help of two goods, wheat or cloth, candidates for the production of carnal satisfaction or cerebral satisfaction. Each produces two homogeneous categories of goods, (carnal satisfaction and spiritual satisfaction). These goods are produced from two homogeneous factors (serotonin "S" and dopamine "D");
- -Each good is produced with a distinct relative intensity in dopamine or serotonin: the production of cerebral satisfaction is intensive in dopamine and that of carnal satisfaction in serotonin.
- The factors of production available in fixed quantities are used to their full potential in production and in an optimal manner. It is assumed that each secretion centre of the organism (using factor goods) produces both goods (partial specialization).
- The production (secretion) function is the same in both secretion centres for a good; the production (secretion) functions are
- Homogeneous of degree 1, with constant returns to scale and decreasing marginal productivities.
- Production or secretion factors (serotonin and dopamine) are immobile between secretion centres;
- The marginal utility of each good (carnal satisfaction and cerebral satisfaction) always decreases.

From this, we can define the following expressions: CdC, units of D required for carnal satisfaction; CsC, units of S required for carnal satisfaction; CdS, units of D is required for spiritual satisfaction,

CsS: units of S required for spiritual satisfaction D: total supply of dopamine to the brain (controlled production per unit of wheat), S: total supply of serotonin to the intestine (controlled production per unit of clothes).

The production of spiritual satisfaction is D-intensive, □ CdS/CsS >CdC/CsC or CdS/CdC > CsS/CsC.

2.2.1.2- The strict parallel between the theory of international exchange and metabolic processes

"A metabolic process is a set of chemical reactions that occur in living organisms. There are two opposing types of metabolism: anabolism, where smaller molecules are synthesized to make larger ones, and catabolism, where larger molecules are broken down into smaller molecules composed into smaller ones" (en.lamscience.com/cellular-metabolism-definition). These processes appear to be analogous to multidimensional exchange.

Let us start by denoting by ∂ the rate of positive or negative change of dopamine in the body and by ∂* that of serotonin. The final goods are virtually mobile from one secretion centre to another but not from one secretion centre generation to another, whereas production factors (serotonin, dopamine) are mobile from one secretion centre generation to another but not between current secretion centres at time t1. The mobility of production factors (Dopamine or Serotonin) is achieved by exchanging positive externalities for negative ones. Positive externalities are produced when the consumption of a good factor by one neurotransmitter secretion centre enables the adequate functioning of the other, and vice versa. Negative externalities occur in the opposite case. Bajona and Kehoe's [5]. model is compatible with what is described here.

Consumption of one of the two primary products (clothes or wheat) induces a subsequent wave of dopamine and/or serotonin flow from

Their production sites to different parts of the body and indirectly between secretion centres. The initial endowment ratio of product i or secretion centre i (where yi = neurotransmitter secretion capacity) is equal to yi/Y= ý. Y is the body's overall capacity to secrete neurotransmitters. The body uses its yi/Y capacity to secrete serotonin and dopamine from secretion centre i to secrete knowing which levels and types of satisfaction the individual wants to have and which to export (store) in exchange for importing which levels and types of satisfaction (use). These exports and imports will follow metabolic processes (convergent, divergent, complex, anabolic and catabolic) and will affect the consumer's health and life expectancy. The body's capacity to secrete neurotransmitters changes from Y to Y′. The capacity of the intestinal centre becomes yi', and y'i/Y'= ý' becomes the new ratio of neurotransmitter secretion capacity.

The organism uses the new capacities of each secretion centre to produce new waves of neurotransmitters destined either for its own carnal satisfaction or for export against an import of spiritual satisfaction. At the end of this first wave, the secretion centres in the organism will have co-ownership

$$\Delta Y\text{-}\Delta Y[\beta+\delta \vdash Y\text{-}\Delta Y\text{-}\Delta Y[\beta+\delta \vdash Y[\beta+\delta \vdash \beta+\delta \vdash (1-\beta)]\dashv]. \quad (4)$$

β is the internal absorption rate (absorption per unit of secretion capacity), while δ is the intensity of the relationship between secretion centres (β = (Ci+Ii+Gi)/yi, δ = (xi+mi)/yi). Ci is wheat consumption, Ii is the restocking of wheat's capacity to produce serotonin, and Gi is the proportion of wheat consumption destined for brain serotonin production. At the start of the second wave, the stock of additional serotonin is

$$\Delta Y\text{-}\Delta Y[\beta+\delta \vdash Y[\beta+\delta \vdash (1-\beta)(1-\delta)]. \quad (5)$$

The second wave of processes generates dopamine. Neurotransmitter production is calculated as $\Delta Y\text{-}\Delta Y[\beta+\delta \vdash Y[\beta+\delta \vdash (1-\beta)(1-\delta)][\beta+\delta \vdash (1-\beta)(1-\delta)]=\Delta Y\text{-}\Delta Y[\beta+\delta \vdash Y[\beta+\delta \vdash (1-\beta)(1-\delta)]^2$. (6)

At the end of the process waves, the impact on the overall stock of neurotransmitters in the body is equal to the sum of the geometric Progression, with a reason less than one. This sum can be described as follows:

ΣΔY-ΔY[β+δ ├yit/Y[β+δ ├(1-β)(1-δ)] =ΣΔY-ΔY[β+δ ├yit/[β+δ ├β+δ(1-β)] =ΣΔY-ΔY[β+δ ├Yit . (7)

The multiplier for optimal neurotransmitter production is 1/[β+δ ├β+δ(1-β)] .

At each instant, consumers of product i decide how much of each of the two goods to consume, how much dopamine to accumulate for the appropriate neurotransmitter secretion centre and, consequently, how much serotonin to borrow from the appropriate neurotransmitter secretion centres. Each consumption wave generates neurotransmitter flows throughout the body, which follow sinusoidal functions, represented as follows:

$$\Sigma\Delta yit = yi0\ cos((\ Wijt - (\ \varphi 1 + yi1\ cos((Xit - \varphi 11.), \quad (8)$$

$$\Delta Yt = \Delta Yit = \Sigma\Sigma\Delta yit\ . \quad (9)$$

The study of periodic functions indicates that each Ᵽ periodic motion is a sum of sinusoidal motions whose sub-periods are Ᵽ, Ᵽ/2, Ᵽ/3,..., Ᵽ/n. These represent the harmonics of the system. Following the proposal of Grossman and Helpman (1991b), wij(t) is modelled as the ratio of the total exchange of neurotransmitter secretion

control capacities of the secretion centre i with secretion centre j. This ratio is calculated for secretion centre i's bilateral exports and imports divided by secretion centre i's aggregate production. This ratio is calculated for the bilateral exports and imports of secretion centre i divided by the aggregate production of secretion centre i. This ratio is represented by wij(t), wij(t), wij(t), wij(t), wij(t), wij(t), and wij(t). It is expressed as follows: wij= (Pj(t)/(Pi(t)) Li(t)gij(t)+Lj(t)gji(t))/(Li(t)yi(t)) i≠j. (10)

Gi(t) represents the actual imports by secretion centre i of neurotransmitters generated by secretion centre j. Pi(t) is the price of factor i, where Li(t) is the weight of product i at period t.

We now define aij (0≤aij ≤ 1) as a constant, representing the share of serotonin accessible to the secretion centre j that can be imported by product i into the dopamine secretion process attributable to its own abilities to control the secretion of this neurotransmitter (dopamine). Using Abramovitz's social capacity (1986), aisj determines a product's potential to adopt existing technologies (in this case, its ability to control neurotransmitter secretion). Using these definitions, the accumulation of dopamine due to product i can be written as follows: X*i (t) = Φ[β+δ ├Σaijwij(t) Xj(t)] + (Φ -δX)Xi(t), (11)

where Φ represents the common neurotransmitter secretion parameter and δX the rate of dopamine stock depreciation (aging, inhibition, or not). It is assumed that Φ ≥ δX> 0. The measure of the exchange of product i, Ci with secretion centre j, Cj (wij) is given by

$$Wij = aij + aji\ air/i, i\ . \quad (12)$$

If, as we assume here, the food ration is balanced and each secretion centre maintains a multilateral exchange equilibrium at all times, we have

Li(t) ΣPj(t)cij(t) = ΣPi(t)Lj(t)cji(t), where i w and πi is a function of âij = aijQi/[β+δ ├1+tij] , (13)

where tip is the transmission rate of neurotransmitters from secretion centre i to secretion centre j, and Qi is the output. Depending on the state of the secretion centres, this speed may be low, normal, or high. The case of normal speed is illustrated by points P0 and C0. The metabolism of the representative agent is represented by points P0 and C0. The agent produces more dopamine and less serotonin at P0 than it consumes at C0. By consuming the quantities corresponding to point C0, he achieves a higher level of utility I0 than he would achieve by simply consuming what he produces at any point on the production curve. He achieves this level of utility by exporting dopamine in exchange for importing serotonin (M0), according to the ratio of equilibrium food intake values.

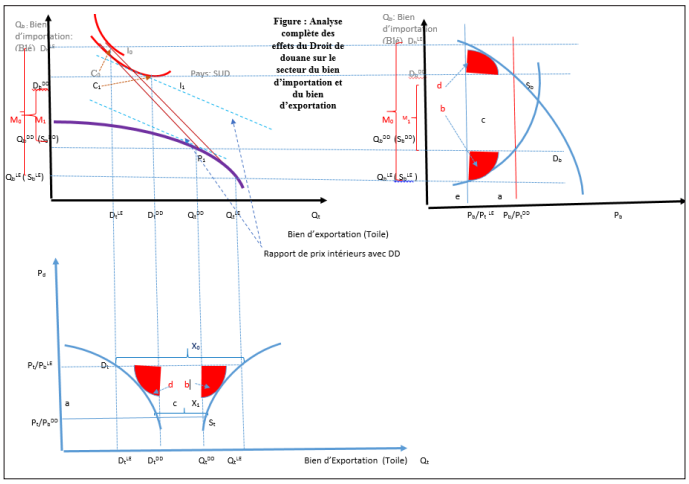
If the rate of transmission of serotonin from secretion centre j to secretion centre i is uninhibited, secretion centre i imposes a customs duty on the serotonin imported from centre j; this increases the dopamine value of serotonin in the areas inhibited by centre i compared with that of normal food intake. This difference in concentration generates balancing osmotic pressures by transferring resources from the dopamine secretion centre to the serotonin secretion centre until the marginal cost of producing each unit of serotonin is equal to the ratio of values resulting from osmotic pressure. This situation corresponds to point P1.

The cells, for their part, make an adjustment and set their consumption at the C1, where the ratio of the marginal utilities of the two neurotransmitters is equal to the ratio of the values resulting from osmosis. During this process, the exchange between secretion centres collapsed, and Serotonin imports by centre i decreased from M0 to M1.

It is clear from the figure that this obstacle to the circulation of serotonin reduces well-being. At point C1, the representative agent only obtains utility level I1, which is lower than I0 achieved under equilibrium food intake.

The representative agent records an overall loss made up of the "effect on serotonin production" (the switch from P0 to P1 (production cost higher than the equilibrium serotonin value) and the "effect on consumption" (the difference in osmotic pressure forces cells to bring their consumption to a point where the indifference curve is tangent to the ratio of values resulting from osmotic pressure - point C1). This overall loss, which is made up of the two effects (b and d), corresponds to the results obtained using the supply and demand curves. Indeed, the vertical and horizontal projections allow us to represent the production and consumption of dopamine (bottom or vertical projection) and serotonin (horizontal projection). slowing down the transmission of serotonin from centre j to centre i is a tax on the export of dopamine from centre i to secretion centre j, and therefore a deceleration in the transmission of the neurotransmitter dopamine, a kind of disruption of the organism's efficiency frontier affecting the individual's well-being and life expectancy.

Comment N°5. The theory section speculates on the exchange of neurotransmitters affecting life expectancy without citing empirical evidence or existing literature to support these claims. On this aspect, see the work of Pataky, M. W et al.(.2021), "The gradual and progressive age-related decline in hormone production and action has a detrimental impact on human health by increasing risk for chronic disease and reducing life span' These authors have also shown how hormonal changes expose people to various diseases such as diabetes, frailty and cardiovascular disease. Other authors like wildly studied theses aspects ". Lamberts SW et al. (1997), Greendale GA et al(1999), Stachowiak G, et al, Polocki GN,et al.



D_t^{LE}: Demande du bien d'exportation en LE
D_t^{DD} : Demande du bien d'exportation en présence d'un droit de douane sur le bien d'importation
Q_t^{DD}: Production du bien d'exportation en présence d'un droit de douane sur le bien d'importation
Q_t^{LE}: Production du bien d'exportation en Libre échange

Considering the dynamic behaviour of the secretion centre i, the specification of the transversality condition lim┬(t→∞) {k ̂.exp(∫_0^t▒ ⟦[β+δ ├f^' (k ̂)- ⟧ δ-x-n] dv} gives X*(t) = Φ. X(t), (14) where X*(t) = X1(t), ..., Xj(t) and

$$\Phi = \begin{bmatrix} \Phi - \delta X & \Phi a12w12 & \dots & \Phi a1jw1j \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \Phi aj1wj1 & \Phi aj2wj2 & \dots & \Phi - \delta X \end{bmatrix}$$

The transversality condition is deduced from Hopf's bifurcation theorem. According to this theorem, there is a local birth or death of a periodic solution from an equilibrium point, if a parameter crosses a critical value. We use the transversality condition to ensure that the eigenvalues of the bifurcation theorem cross the imaginary axis at a non-zero speed. In biology, this condition is essential for understanding stable changes and the appearance of periodic solutions in dynamical systems. Herlenius E and Lagercrantz H (2011) have shown that, "In particular, at birth a cascade of neurotransmitters and transcriptional factors is activated. For example, the norepinephrine surge at birth may be important for initiating the bonding of the infant to the mother by increasing the ability to sense odors (Sullivan et al., 1994). Imprinting at birth and visual input to form the ocular dominance columns also occur during critical periods, and are probably dependent on the switching on and off of neurotransmitters". The figure 1 describes this condition through neurotransmitters transmission rates and production over different stages of life of a human individual.

Furthermore, by studying the equalization of the biological value of all exchanges, we can better understand the mechanisms of hormonal imbalance the latter (biological value). Hormones are chemical messengers which regulate essential biological mechanisms so that a more or less permanent overall balance is maintained in a normal individual. However, hormonal imbalance can occur. For example, growth hormone regulates all metabolic and physiological processes, so that a deficiency in the production of this hormone (due to acquired or inborn dysfunction of the pituitary gland) affects the physiological development of the individual, with numerous pathological consequences. For more details on these issues, see the work of Copeland JL et al.(2002), Heaney JL and Carroll D, Phillips AC.(2013), Aldred S, Rohalu M, et al. (2009), Sutton J, and Lazarus L. (1976 or Raynaud J et al.

Referring to the work of Viguié C.et al.(2012) on Endocrine disruptors: consumer issues and scientific challenges, I begin with individual consuming multiple products. Therefore, I can consider multiple interferences. In this case, if the R-rays are (R= R0, R1, R2, ..., Rp) with a neurotransmitter amplitude τ (τ², τ²p², τ²p4, ...,τ²p2p) and the phases are(0, Φ+2fr, 2Φ+4fr, ..., pΦ+2pfr), the induced amplitude is

$A = \tau^2 + \tau^2 p + \tau^2 p^2 e\text{-}j(\Phi+2fr) + \tau^2 p\ 4e\text{-}j2((\Phi+2fr)....$
$+\tau^2 p^2 e\text{-}jp^2(\Phi+2fr)$, (15)
$=\tau^2/(1- p^2 e\text{-}j\ \Phi')$, (16)
and
$\Phi' = \Phi + 2fr$. (17)

2.2.3- The strict parallelism between the theory of intragenerational exchange in a nation and the generations of secretion centres in metabolic processes

There is a process of cell periodic renewal in a human organism, but much less or none for secretion centers. Nevertheless, the three-phase weakening of secretion centers allows us to postulate the existence of generations of secretion centers. "The aging of an individual leads him to 3 states: vigorous, poly-pathological and dependent or frail". If every state involves cell renewal, we are indeed in the presence of a new generation of secretion centers The aging of an individual leads him to 3 states: vigorous, polypathological and dependent or frail". If every state there cell renewal, we are indeed in the presence of a new generation of secretion centres each state, with new neurotransmitter secretion capacities.

Narrative Component

Comment N°9. The manuscript does not consider or refute potential counterarguments or alternative explanations for the observed phenomena, which is a critical oversight in scholarly writing.

Although neurobiologists do not always agree on these phenomena, we have considered the latest developments on these issues on which there is greater unanimity. So far, I have analyzed the relationship between primary goods (clothes and wheat), secretion centres, and carnal and spiritual satisfaction. Consumption of these primary goods triggers metabolic processes in humans, the functioning of which is considered analogue to the factor proportion model. However, we have not considered the process of cell renewal, which affects the secretion capacities of the centres. Thus, there is a new type of exchange between these secretion centres throughout the life of the organism. The exchanges described were superficial, since they only concerned the primary relations between current secretion centres and elementary consumer goods, so that the exchange of neurotransmitters between secretion centres was only virtual. An exchange of neurotransmitters between current and future secretion centres is inevitable because the latter have different comparative advantages due to the variation in their capacities to secrete dopamine and serotonin over time. This variation in secretion capacity is attributable either to endogenous internal metabolic processes or to the adoption of new behaviours related to increasing medical progress (exogenous processes). To fully understand this aspect, we assume the existence of debts and receivables between current and future secretion centres, as an individual's consumption habits today can positively or negatively affect the neurotransmitter secretion capacities of future

secretion centres. Consequently, each secretion centre operated under intertemporal autarky conditions. Each secretion centre had a different but partial specialization, insofar as what happens in the gut, for example, can influence cerebral serotonin activity, just as the substantia nigra reticulata (SNr) is mainly composed of GABAergic neurons, but also of dendrites of dopaminergic neurons originating from the SNc. When the body lacks dopamine, the essential functions mentioned above are inhibited, whereas excess dopamine is often associated with psychiatric disorders. Likewise, because serotonin serves to inhibit many areas of the brain, the same areas are "uninhibited" when there is too little serotonin. In humans, impulsive, aggressive, or even violent behaviour is generally associated with abnormally low serotonin levels. Serotonin could thus be potentially involved in the whole aging process via its links with various organs and the immune system in particular, notes Prof. Agid.

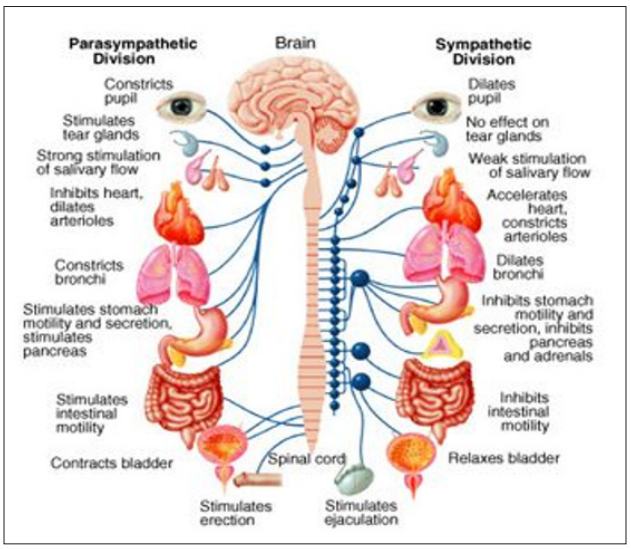


Figure 2: Authomatic nervous system in Human

Source: https://i.pinimg.com/474x/00/5d/f7/005df7acf9c50c862e30177d6a7e633b.jpg

As Prof. Agid explains, inappropriate behaviour in terms of consumption of primary goods (clothes and wheat) generates negative

Externalities that can affect our hormonal balance. Just as in the universe, global warming is perceived as an externality of production or consumption by certain economic agents.

The potential for inhibition or disinhibition of brain regions due to neurotransmitter shortages or excesses describes interactions between current and future secretion centres. We therefore consider the following model: Let's denote by ∂ the rate of positive or negative change in dopamine due to the evolution over time of the body's capacity to secrete this neurotransmitter, and by ∂^* under the same conditions, that of serotonin. Final goods (the level of satisfaction achieved by an individual in consuming a primary good) are directly mobile between current and future secretion centres in terms of approximately integral compensation between neurotransmitters over time. An individual's good consumption habits improve, or at least preserve, good secretion capacities for future generations of secretion centres. In the same way, poor consumption habits degrade the secretion capacities of future generations of secretion centres. Similarly, secretion centres that have negatively affected an individual's life expectancy through difficult living conditions (negative externalities) can transmit a certain immunity (positive externalities). The mobility of production factors of production (Dopamine or Serotonin) is achieved by this exchange of negative externalities for positive ones.

Analogue Specification

Inter-secretary centre exchanges are based exclusively on production factors and technology. Technology is therefore considered a productive factor, and its production depends only on the current capacity of the neurotransmitter secretion centre to hoard serotonin. The technology production function T(t) = (G(ρ),), E(t), N(t)) is neoclassical, with the usual properties.

Let us consider two secretion centres in a human organism. The serotonin secretion centre is represented by (Gs) and the dopamine secretion centre by (Gd). The two secretion centres are separate According to Max Lugavere, author of Brain Nutrition, "Serotonin produced in the intestines does not cross the blood–brain barrier (international immobility here "inter-secretion centres" of production neurotransmitters "here serotonin"). However, what happens in the gut can influence brain serotonin activity through its ability to modulate inflammation. Therefore, there is a direct exchange of brain serotonin for dopamine in the substantia nigra pars reticulata (SNr), which is composed mainly of GABAergic neurons, as well as by the dendrites of dopaminergic neurons from the SNc. Thus, each secretion centre has different initial endowments, which are interdependent. We assume that all the secretion centres of an organism are co-owners of the neurotransmitters available at each instant, whose yield in terms of the organism's life expectancy is estimated at y'i. If the compensation between brain serotonin and SNr dopamine is complete, i.e., just sufficient to ensure the vital functions of the organism so that it lives yi' years, i.e., 100 years, we say that there is hormonal coherence or balance and the prescribed life expectancy can be achieved. Otherwise, there is an exchange of externalities that are necessarily harmful to the organism, and life expectancy decreases. If the life expectancy of the representative agent was in the first period, then it would decrease, for example, according to a coefficient of non-compensation of neurotransmitter exchanges varying from n=0 to 1.2, since, as some studies assert, "any death before the age of 120 is a premature death.

What's more, if the life expectancy at birth of each secretion centre is from the first period, the life expectancy at birth of the organism is equal to 100n years, over the course of its life, each secretion centre lends and borrows neurotransmitters from other secretion centres in more or less appropriate proportions (this lending and borrowing of neurotransmitters between secretion centres can be likened to exporting and importing). Consequently, the total amount of serotonin in a secretion centre in the first wave is equal to

$$\frac{\frac{\Delta y_{ri}}{1}}{\Sigma S'_{ij}} n + \Sigma S'_{j1} \qquad (15)$$

ΣS ij Is the import of the first generation of secretion centres, borrowed from subsequent generations (imported). the quantities of serotonin of

The second generation, at the beginning of the second period, are given by:

$$\frac{\Delta y_{rin}}{1} - S_{21} + k_{12} + \cdots + \Sigma S_{j2}) \qquad (16)$$

where k12 represents the quantities of dopamine reimbursed from the first to the second generation. k12 must be equal to S21. k12 represents

Exports from the first generation to the second generation, and S21 imports from the second generation to the first generation. The total serotonin quantities for the last generation are equal to

$$\frac{\Delta y'i}{1}n - \Sigma S_{ni} + \Sigma k_{in} = \frac{S}{1}n = S + K_n \qquad (17)$$

The first generation uses all of its serotonin (dopamine) to compensate for the body's various deficiencies and to produce

Neurotransmitters for their own function. At the end of the first period, the second and subsequent generations will have joint ownership.

$$\Delta y'i - \Delta y'i[\beta + \delta(1 - \beta)]. \qquad (18)$$

β is the self-consumption ratio (consumption per neurotransmitter unit), while δ is the neurotransmitter ratio (the share Of neurotransmitters to be returned to future generations). At the start of the second period of the organism's life, the remaining quantities of serotonin are ΔY-ΔY[β+δ ├y'i[β+δ ├(1-β) (1-δ)] (19)

The quantities of neurotransmitters in the second generation are given in equation (16). This generation proceeds as the first and at the end of its life, the remaining quantities of serotonin are given by ΔY-ΔY[β+δ ├y^' i[β+δ ├(1-β)(1-δ)]-ΔY-ΔY[β+δ ├y^' i[β+δ ├(1-β)(1-δ)][β+δ ├β+δ(1-β)]= ⟦ Δy^y^' i[β+δ ├(1-β)(1- δ)] ⟧ ^2. These are primitive neurotransmitters of the third generation. At the start of the body's third life period, the remaining quantities of serotonin are as follows: ⟦ Δy^'i[β+δ ├(1-y β)(1-δ)] ⟧ ^2. (20)

We note that the new quantities of serotonin follow a geometric progression, with (1-β) (1-δ) as the reason
The initial serotonin quantities of the nth generation are
⟦ΔY-ΔY[β+δ ├y'i[β+δ ├(1-β)(1-δ)] ⟧^(n-1). (21)
The total amount of new serotonin is equal to the sum of the geometric progression with a reason of less than one. The limit of this sum is given by the following expression:
ΔY-ΔY[β+δ ├y'i/ΔY-ΔY[β+δ ├y'i[β+δ ├(1-β)(1-δ)] =ΔY-ΔY[β+δ ├y'i/[β+δ ├β+δ(1-β)] =ΔY-ΔY[β+δ ├Y' . (22)
The optimal growth multiplier is 1/[β+δ ├β+δ(1-β)]
. (23)
In this way, each exchange wave generates neurotransmitter flows across generations, following sinusoidal functions such as

$$\Sigma\Delta yit = y'i0 \cos(Wijt - \varphi 2). \quad (24)$$

$$\Delta Y't = \Sigma\, \Delta y'it\ . \qquad (25)$$

The sinusoidal shape is due to the law of value added in each generation. When a good (in particular a productive factor) is imported into a secretion centre, its value-added increases in terms of life expectancy during the first period and decreases as cells age or as a result of the inhibition-disinhibition process. Starting from the age of 30 a decrease in organ function can be observed. Guilbaud A. et al. have shown "the aging of an individual leads him to 3 states: vigorous, poly-pathological and dependent or frail. The state of fragility is reversible. We have to be an actor in our aging and no longer suffer it. The centenarians of the blue zones have achieved, culturally, active aging which has led them to successful aging" Although nerve cells can last a lifetime, the different phases of their aging are considered in this paper as successive generations of neurotransmitter secretion centres. Indeed, with age, there are changes or decreases in neurotransmitters due to behavioural, physiological or environmental factors.

The sinusoidal shape is also explained by the different comparative advantages of the secretion centres, leading to differences in the gains from the exchange (increases and decreases in neurotransmitter values in the different centres over time, and in the eating and other habits of the representative agent). Studies of periodic functions indicate that every periodic motion P is the sum of sinusoidal motions with p, p/2, p/3,..., p/n as subperiods.

These represent the harmonics of the system ...
W'ij(t) is the ratio of generation i's total trade with generation j (i.e. generation i's bilateral exports and imports divided by generation i's aggregate production) is represented as follows:

$$W'ij = \frac{\frac{Pj(t)}{Pi(t)}\, Lri(t)gij(t) + Lrj(t)gji(t)}{Li(t)yi(t)} \quad i \neq j \quad (26)$$

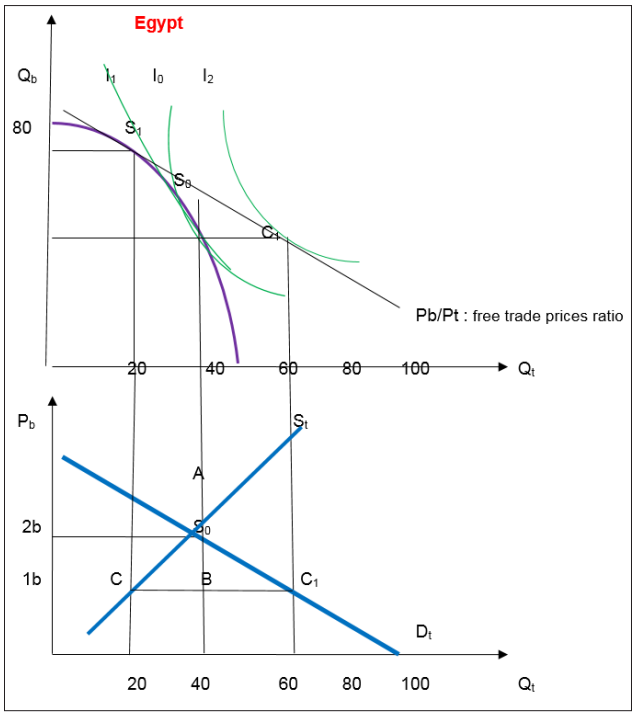
Gij(t) represents the actual consumption per secretion centre of generation i of neurotransmitters of generation j. Pi(t) is the value of factor i, and L'i(t) is the quantity of neurotransmitters of generation i at each period t.
We now define aij (0≤aij ≤ 1) as a constant, representing the share of generation j's accessible serotonin (dopamine) that can be consumed by
Generation i as a part of its own serotonin (dopamine). According to Abramovitz's (1986) social capacityair determines a generation's potential to adopt
Existing technologies. Using these definitions, the quantities of dopamine accumulated by generation i can be written as follows: X'*i (t) = Φ [β+δ ├Σaijwij (t) Xj (t)] + (Φ -δX) Xi (t), (27) where Φ represents the productivity parameter of common neurotransmitter secretion and δX the aging rate of dopamine or serotonin
Stock(obsolete or not), assuming Φ ≥ δX> 0. The measure of the exchange of generation Gi with generation Gj, Wij, is as follows: Wij = aij + aji i/j, i≠j. (28)
Assuming that each generation maintains a multilateral equilibrium at each instant, we have Li(t)ΣPj(t)cij (t) = ΣPi (t) Lj (t) cji (t) i≠j, (29) with i being a function of âij = aijQi/[β+δ ├1+tij] , tij is the rate of flow of imports from generation i to generation j, and Qi is the total Secretion of neurotransmitters. Taking into account the dynamic behaviour of generation i, the specification of equation (33) gives X*(t) = Φ. X (t), where X*(t) = X1(t), Xj (t) and For example, subsequent generations cede serotonin used intensively in the production of carnal satisfaction, or indirectly transmit carnal satisfaction to the current generation in exchange for dopamine used intensively in spiritual satisfaction. This exchange occurs at the end of their lives, or indirectly via spiritual satisfaction. Although the organism did not benefit from this degree of spiritual satisfaction during the previous generation, the latter indirectly ceded this degree of satisfaction to the current generation (the organism's current state) by providing it with the neurotransmitters needed to produce this degree of spiritual satisfaction (positive externalities).
2.2.4- The strict parallelism between the theory of multidimensional exchange and metabolic processes
2.2.4.1-- Assumptions common to exchange between consumed goods and secretion centres
A1- The goods produced (degrees of satisfaction) available in fixed quantities in each generation are used for full consumption. During the time of each generation and in an optimal manner; A2-

At the opening of exchanges, quantities of neurotransmitters are immobile (mobile) between consumed goods (generations) but mobile (immobile) across generations (goods); produced goods are mobile (immobile) between consumed goods (generations) but immobile (mobile) across generations (goods). A3- The exchange of neurotransmitters is characterized by perfect competition; quantities of serotonin can be used interchangeably in All productions; there is full employment in both goods and both generations;
A4- The satisfaction production function is the same for both goods and both generations; the production functions are homogeneous for degree 1, with constant returns to scale and decreasing marginal productivities; however, the satisfaction production technique is different. A5- The marginal utility of each satisfaction is always decreasing.
A6- Neurotransmitter transport costs and other barriers to exchange are zero.
A7- The two goods consumed exchange only the satisfaction they produce; these satisfaction are perfectly mobile between the goods consumed (in the organism; t h e two generations (secretion centres) exchange only serotonin (dopamine) for dopamine (serotonin), these neurotransmitters are perfectly mobile between the secretion centres ;
A8- Each satisfaction is produced with a different relative intensity of serotonin and dopamine. The production of spiritual satisfaction is
Dopamine-intensive, and carnal satisfaction is serotonin-intensive. Our hypothesis contradicts the neoclassical model ofinternational exchange. We propose that only the factors of production can be traded,
While final goods (satisfactions) cannot be stored.
2.2.4.2- Steady state (or adult age)
If we consider that a generation of secretion centres that changes its serotonin management and therefore its ability to secrete, simultaneously acquires or loose the ability to secrete serotonin efficiently, it will pay back (transfer) to future generations of secretion centres a higher (less) level of technology (ability to secrete), we have : $\delta = (\partial gij(t)+\partial' gji(t))/(yi(t))$ (30).

In this model, the net increase in the stock of dopamine at any given time is equal to the capacity to secrete raw dopamine minus the rate of cell aging plus miscellaneous effects (improvement in the general level of consciousness, advances in medicine and knowledge). If one generation grows at the rate of Ni, K increases in parallel, increasing the productivity of subsequent generations. The marginal secretion of K should be equal to the intergenerational transfer rate, Igc= Sgf. The rate of transfer is determined by the first generations, who decide how much serotonin future generations should use to produce satisfaction. This overconsumption of serotonin constitutes the consumption of the current generation and a debt to be paid to future generations, in terms of dopamine. Insofar as serotonin serves to inhibit many areas of the brain, the same areas are "disinhibited" when there is too little serotonin. In fact, in these cases, dopamine-secreting capacities are spared or overused, depending on whether the current generation secretes more or too little serotonin. The more serotonin the current generation overconsumes, especially if it consumes a high level of carnal satisfaction, the more it should improve its secretory capacity and provide a higher level of secretory technology (ability to secrete) to future generations, thus ensuring Igc= Sgf. It is not possible to have Igc< Sgf, or vice versa. Igc is the current generation's ability to secrete, while Sgf is a stock of future generations' ability to secrete. Since the production function of technology is neoclassical, technology clearly decreases over time.

. Comment N°6- The descriptions of the model configurations in section 3.1 are convoluted and hard to follow, lacking clarity which could be rectified with simplified explanations or visual aids.

Now let consider step by step what happens before and with open trade and before and with goods consumption and its figures



Autarky, productive factors immobility, lack of trade gains but possible if trade is open, different comparative advantages condition in international (intergenerational) trade In a situation of autarky, the North and South (here Egypt) clothes markets balance out at different prices. In the North, a cloth would cost two wheats at point A. In the South, supply and demand would meet at point H, at a lower price of 2/5 wheat per clothes. Autarky, different relative utilities, fixed quantities of the neurotransmitter secretion factors of the different goods and their immobility (clothes and wheat), and possible gains for the different organs involved during consumption condition in (intergenerational) trade:
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-Open trade
In the event of free trade, new opportunities open up for buyers of Nord lais cloth and sellers of Sudiste cloth. North Lai buyers

will find that they can obtain clothes more cheaply in the South, where clothes was sold at 2/5 wheat per clothes. Also, Southern sellers will discover that they don't have to accept the low price of 2/5 wheat per clothes, when they can sell for more in the North. The rapprochement of the two groups will affect the international price, which will be set at an intermediate level.

Now that we know demand and supply, we can determine the international price. There is only one price ratio for which world supply and demand are in equilibrium, a price ratio easily known by examining graphs 1 and 3 in Figure 3. The excess of Northern demand over supply is offset by an excess of Southern supply over Southern demand at only one price: that of wheat per clothes. At this price, excess Northern demand, the CB segment, is equal to excess Southern supply, represented by the IJ segment.

- Consumption of goods, secretion and transmission of neurotransmitters, production of calculable satisfactions, disappearance of the utility felt by the consumer, thus contradictory evolution and equalization of relative utilities...

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Before and After Goods Consumption (Human Organism)

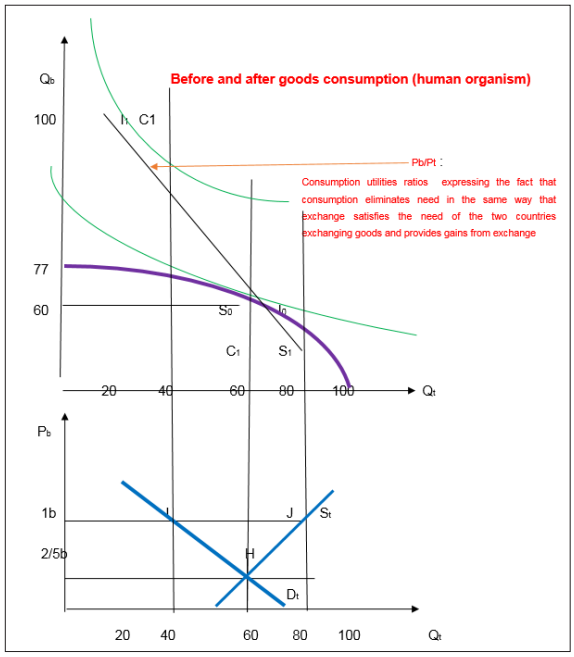

Figure 3: Effects of International Trade (Consumption) on Production (Transmitters ecretion), Consumption (Satisfaction) and Prices in a Country and Human Organism.

Conditions and Equilibrium

Conditions

The technical production function T(t) = (G(ρ),), E(t), N(t)) is neoclassical and has the following properties: g(.) exhibits constant returns to scale, i.e. G(λE,E, λE,N) = λE, G(E, N), a property that is also known as degree-one homogeneity in E and N.

When a secretion centre chooses an initial secretion that is different from W, it must compensate for the overconsumption of serotonin with an

Equivalent supply of dopamine to establish or maintain a constructive multidimensional exchange. Otherwise, the secretion centre and the organism may experience a hormonal imbalance. This hormonal imbalance varies according to the differential between effective secretion (Wi) and initial optimal secretion and the sensitivity of interdependencies between secretion centres. As a result, the FPP of the secretion centre shifts around the organism's technological frontier. Derived growth is not Pareto-optimal (see Figures 1 and 2). 2.2.4.2.2-Equilibrium

The function of hormonal imbalance between secretion centres is described as follows:

$$(Xf - X) = f(Wf - W, \theta'). \quad (31)$$

ɵ' is the inter-centre sensitivity factor. Hormonal imbalance becomes explosive (through other secretion centres) if the inter-centre.

Interdependencies are highly sensitive. In pure economics, Hsieh and Klenow (2009) and Klenow (2012) examine this point in detail. They used micro data from manufacturing establishments to quantify and compare potential resource misallocation between the USA and India. Their research indicates that resource misallocation can reduce total neurotransmitter productivity (TTP) and growth.

For the same reasons, when a generation initially chooses a secretion differently from W, it must compensate for its overconsumption with an equivalent supply of dopamine. This will maintain or establish a constructive multidimensional exchange. If this compensation is not made, the generation and the organism suffer a potentially significant hormonal imbalance. This hormonal imbalance varies with the differential between effective secretion (Wi) and optimal initial secretion, as well as the sensitivity of intergenerational interdependencies. As a result, generational PPF shifts around the organism's technological frontier. Derived growth is not Pareto-optimal (Figures 1 and 2). Intergenerational hormone imbalance function can be described by the following relationship:
(Xf - X) = f(Wf - W, ɵ'), (32) where ɵ is the intergenerational interdependence sensitivity factor. Hormonal imbalance becomes explosive (across other centres and generations) if interdependencies are particularly sensitive. The factors of hormonal imbalance in the centres of secretion and generation (neurotransmitters and satisfactions) are the values, quality, and flexibility associated with them.

In general, the process of adjusting values, qualities, and quantities is widely described for inter-centre and intergenerational exchange. The values of goods stabilize, as does the quality of neurotransmitters in all secretion centres. We conclude that there is convergence toward a constant rate of equilibrium growth, where the serotonin and dopamine stocks are above their equilibrium levels. At general intergenerational equilibrium, all values will stabilize because their variations are symmetrically opposite in different periods. Productive factors in intergenerational exchange reduce the levels of scarce neurotransmitters in each period and enable the production of satisfaction consumed in a given period. The decline in the values and quality of satisfaction and neurotransmitters in a given period enables the consumers and producers of a given period to benefit from the gains of intergenerational exchange. As we can see, this general case is the rule, but many factors, such as hormonal imbalances in certain organisms (due to poor consumption habits), shift PPFs in such a way that the directions taken by these movements in each secretion centre and/or generation interact with inter-centre or intergenerational exchange to determine long-term growth per neurotransmitter. The direction of these movements depends on how consumption patterns and other shocks influence neurotransmitter allocation. Neurotransmitter levels may rise or fall, and secretion technologies or the marginal rate of neurotransmitter substitution between generations may change. Even if only the difference in neurotransmitter evolution of one secretion centre/generation should lead to a change in comparative advantages and the organic/intergenerational pattern o f exchange, these differences in satisfactions and neurotransmitter values should disrupt the relationship between growth and hormonal imbalance. The sign of the relationship between growth and hormonal imbalance should then depend on these movements and their interaction with inter-central secretion and intergenerational exchange. According to King et al. (1988), a temporary disruption of PPFs can have permanent effects on the trajectory of secretion growth. The extent and nature of these effects depend on the type of disturbance.

Discussion of the ABM Analogue Model Specification Material and Method/ Agent Based Modelling (ABM)
ABM is one of the few suitable tools to capture heterogeneity, relationship between individual actors, and non-rational, preferences and behaviours in a single methodology"(Maidstone, 2012). "This makes this methodology very suitable for the analysis of complex adaptive systems such as economies where local economic interactions influence regularities which in turn influence future interactions" (Tesfatsion), and for the analysis of public policy impacts on the behaviour of social and economic actors" [6,7].

Analogue Model Discussion
Comment N°7: The use of technical terms, especially in the discussion of serotonin and dopamine pathways, is often incorrect or misleading, which could confuse readers familiar with neurobiology.

Although nerve cells can last a lifetime, the different phases of their aging are considered in this paper as successive generations of neurotransmitter secretion centres. Indeed, with age, there are changes or decreases in neurotransmitters due to behavioural, physiological or environmental factors. So waves of neurotransmitters refer to neurotransmitters of different ages.

In accordance with equations (8), (9) and (24), (25), each consumption wave generates neurotransmitter flows throughout the body, which
Follow sinusoidal functions, just as intergenerational exchange waves generate neurotransmitter secretion centres flows across generations.
Comment N°8. The manuscript inaccurately represents biological processes, suggesting a direct trade of neurotransmitters between generations which is not biologically plausible.
The intergenerational trade of neurotransmitter secretion centres is an exchange of negative externalities for positive externalities. A consumption or production externality represents the positive or negative effect that either the consumption or the production of a given good has. The cigarette smoke inhaled by a smoking neighbour is a cigarette consumption externality. Since neurotransmitter secretion centres of different ages have more or less strong secretion capacities depending on the behavior of the individual, it is considered that if at a given period, the individual has led a good life, his neurotransmitter secretion centres are healthier during the following periods and vice versa and therefore generate positive or negative externalities depending on the case.

For Multidimensional Horizontal Exchange

$$(\varphi_I = \varphi_2)\ \text{et}\ \Delta Y_{O,I}{}^2 = y_{i_o}^2 + y'_{i_o}{}^2,$$
$$\text{Ln}(\tfrac{Y}{L})i,t = \ln(A_i + A'_i) + (\alpha_K + \alpha'_i)\ln(\tfrac{E}{L} + \tfrac{E_r}{L_r}) + (\beta_N + \beta'_N)\ln(\tfrac{N}{L} + \tfrac{N_r}{L_r}) + (a_{ij} + a'_{ij})[(W_{ij}(t) + W'_{ij}(t)\,(Xj(t) + X'j(t))] + \delta''_X X'i(t)$$
$$+ (\alpha_E + \beta'_N + a_{ij} + \delta'_i)(W_0 \ln N) + (\mu i, t). \quad (37)$$

For Multidimensional Vertical Trade
(φ1 = φ2 + π), we have

$$\Delta Y_O{}^2 = y_{i_o}^2 - y'_{i_o}{}^2 = \text{Ln}(\tfrac{Y}{L})i,t. \quad (38)$$

$$\text{ou}\ \Delta Y_O{}^2 = y_{i_o}^2 + y'_{i_o}{}^2 + \tau + \tfrac{1}{[2\pi j(\partial\delta\, i(t))]}\ \text{or}\ \Delta Y_O{}^2 = y_{i_o}^2 + y'_{i_o}{}^2 + \tau + \tfrac{1}{[2\pi j(\partial\delta\, i(t))]}. \quad (39)$$

If we consider the latter form, we have :
which is neither vertical nor horizontal

$$\text{Ln}(\tfrac{Y}{L})\text{i,t} = \ln(A_i+A'_i)+(\alpha_E+\alpha'_E)\ln(\tfrac{E}{L}+\tfrac{E'}{L'}) + (\beta_N+\beta'_N)\ln(\tfrac{N}{L}+\tfrac{N'}{L'})+ (a_{ij} + a'_{ij})[(W_{ij}(t)+W'_{ij}(t)(Xj(t)+X'j(t))] + \delta''_X X'i(t) + (\alpha_E+\beta'_N+a_{ij}+\delta'_X)(W_{ij}\ln N) +$$

* tt ' +/i , t),with (.) = Ln -l- }x Ln(- - -l- .) }40)

These three scenarios can be used to determine the relationship between growth and hormonal imbalance. In these cases, (αE+α'E),E+αE+α'E),'E), (βN β'N), (aij+ a'ij), δ"X , (αE+α'E),E+ β'N+ aij + δ'(X)), (αE+α'E),E-αE+α'E),'), βN-β'N), (aij - a'ij), -δ"X , and -(αE+α'E),E+ β'N- aij- δ'X) are all exogenous parameters, whose sign and magnitude are crucial in determining the sign of the relationship between growth and hormonal imbalance in Eqs. (37), (38) and (39).

We know that Xi(t) includes two scale effects. The first is the stock of serotonin (secretion capacities of neurotransmitters centres) and unnatural external effects, defined by the interaction between serotonin secretion centre and dopamine secretion centre, and the second is that of dopamine and current secretion capacities air determines the potential of a secretion centre to adopt existing secretion capacities. The accumulation of dopamine (or secretion capacities) in secretion centres i is relative to these definitions.

Table 1: Multidimensional Trade nd Per Capita GDP Growth: Panel of Three Decades (1980-2010)

Dependent variable: $Ln(\frac{Y}{L})i,$

Independent Variables	*Definition*	*Model1*	*Model 2*	*Model 3*	*Specific effect on growth volatility*
$(A_i+A'_i)$	*Time invariant factor*	*-0,6581 (-7,21)*		*1,2584 (6,27)*	
$Ln(\frac{E}{L}+\frac{E'}{L'})$	*-Log of natural resources Authority per inhabitant*	*(160,6)*	*0,6967 (7,34)*	*0,29278 (2,68)*	+
$Ln(\frac{N}{L}+\frac{N'}{L'})$	*Log of « unnatural resources» per inhabitant*	*2,202217 (239,79)*	*0,039851 (1,06)*	*0,199865 (9,86)*	+
			0,34942 (10,36)		
[(Wij(t)+W'ij(t) (Xj(t)+X'j (t))]	*Multidimensional trade and high technology level*	*3,50e-23 (2,31)*		*-1,12e-25 (-3,59)*	±
			-3,57e-36 (-2,78)		
[Xi (t)+X'i(t)] (1)	*Generational and National accumulation of « unnatural resources»*	*8,76e-12 (1,99)*	*1,70e-11 (4,23)*	*1,03e-13 (5,97)*	+
[Xi (t)+X'i(t)] (2)	*Generational and National accumulation of « unnatural resources»*	*8,55e-12 (1,93)*	*-4,20e-12 (0,91)*	*-2,81e-12 (-0,55)*	
[Xi (t)+X'i(t)] (3)	*Generational and National accumulation of « unnatural resources»*	*-8,43e-12 (-4,26)*	*0,7779 (11,0)*	*0,6919 (8,40)*	±
[Xi (t)+X'i(t)] (4)	*Generational and National accumulation of « unnatural resources»*	*2,04e-12 (1,54)*	*-2,80e-12 (-2,21)*	*1,43e-12 (0,83)*	±
[Xi (t)+X'i(t)] (5)	*Generational and National accumulation of « unnatural resources»*	*-0.3228 (-4,10)*	*9,80e-12 (5,34)*	*9,04e-12 (4,94)*	±
[Xi (t)+X'i(t)] (6)		*-0,3719 (-163,44)*		*-0,00446 (-2,17)*	±
(WijLnN) Wij	*Generational and National accumulation of « unnatural resources»*	*3,74 (2,36)*	*-0,021633 (-3,66)*	*3,80 (1,32)*	-
$Ln(\frac{E}{L}+\frac{E'}{L'})$			*2,96e-23 (2,10)*	*9,54e-14 (1,38)*	+
$Ln(\frac{N}{L}+\frac{N'}{L'})$	*Multidimensional trade scale effect*	*9,15e-23 (3,32)*	*7,79e-23 (2,22)*	*-0,03602 (-3,21)*	+ -
	Interaction between Natural and unnatural resources ' trade	*-0,04685 (-3,11)*	*-0,04297 (-2,89)*		
	R-sq: Within= (model 1)	*0,9919*	*R-sq: Within= 0,48 (model 2)*	*R-sq: Within= 0,289 (model 3)*	

Therefore, in the general case where the inter-secretory centre and inter-generational values balance, there is no hormonal imbalance in growth due to general equilibrium. This general balance means that dopamine secreted and "exported" to the future generation will offset any imports (e.g., serotonin hoarding) used by the current generation to support growth. In other cases, the organism will experience a hormonal imbalance, and the choice of discount rate will ensure that exports and imports are compensated for. The expression (i,t)i,t) is very important in this analysis. It quantifies the uncertainty due to model specification errors or measurement problems. Its values verify the model.

Conclusions and Recommendations

The multidimensional trade theory (Edgeweblime, 2019) states: Factors of production that exist in abundance in one generation and are not intensively used to produce goods and services in that generation are exported to other generations in exchange for scarce factors of production intensively used to produce goods and services that should be scarce in the generation under consideration. Low-consumption goods and services are indirectly exported from one generation to the next, whereas high-consumption goods and services are indirectly imported from other generations. In this way, positive externalities (nonnatural resources) are exchanged for negative externalities (over-consumption of natural resources). Clearly, this exchange of externalities is the fundamental mechanism t h a t generates links between growth and volatility.

The existence of several hormone or neurotransmitter secretion or synthesis centres and their distribution throughout the organism according to their specificity and, above all, their productivity in terms of carnal or spiritual satisfaction merit consideration. In multidimensional exchange, the existence of multiple generations of human beings succeeding one another in the same country, just as generations of cells are continually renewed during the life of the organism, on the one hand, and the existence of various separate centres of synthesization, just as countries are separated by borders so that the hypotheses of virtual immobility of neurotransmitters and real mobility of carnal and spiritual satisfactions can be retained in both systems of exchange, on the other, is truly intriguing. Moreover, multiple concepts and phenomena (volatility, stationary states, equilibria, exchange, time, information, marginal utility, productivity, marginal productivity, partial specialization, the frontier of production or consumption possibilities, efficiency etc.) have been deemed relevant in both types of exchange.

Our aim in this paper was to determine whether the theory of multidimensional trade is sufficiently similar to metabolic processes, so that what can be said about or done with metabolic processes also applies to multidimensional exchange. Hence, the following research question was posed: Is there in the human organism a multidimensional exchange mechanism that is realized t h r o u g h a more or less integral compensation between negative and positive externalities to determine either a volatility of human growth reducing life expectancy or an optimal life expectancy analogous to either the volatility of economic growth or the optimal or sustainable growth of an economy? More specifically, the aim was to investigate the impacts of nonPareto-optimal Walrasian equilibria in the exchange of externalities between neurotransmitter secretion centres and/or between generations of neurotransmitter secretion centres asa fundamental mechanism of human growth volatility leading to disruptions in life expectancy. This would confirm the theory of multidimensional exchange, enabling policymakers to summon the same remedies as in modern medicine.

The analogy seems surprisingly well established. However, given that metabolism is a very specific phenomenon, we need more elaborate comparative studies on both sides of the veil between the two sciences. The multidimensional exchange model and the Neoclassical model have devised many hypotheses that remain a mystery to biologists and need to be confirmed. At first glance, a rapprochement between the two sciences would be salutary. Economics would gain in precision and rationalization, while biology would have so many hypotheses to study.

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