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The Virtual International Exchange of Extreme Productive Factors and Sustainability: Case Study of an Efficient Educational Vector

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

In this paper we investigate if The Heckscher Ohlin Model (HOM) acts as an international hero, imposing an optimal import tax on countries or generations operating within the World Technology Frontier (WTF), and an optimal export tax on countries whose Production Possibilities Frontier (PPF) is above the WTF, in order to ensure an equivalent level of satisfaction for all. Using Agent based Modelling on cross-generation and cross-country panel data *I find, when HOM* imposes an optimal tax, formal sector (industrialized countries or generations) productivity is at its highest, resulting in a low cost of production, and the volume of the informal sector (under-industrialized countries or generations) is at its absolute minimum, with an equilibrium informal sector output at point A on the Graph 1. Economic agents (local authorities), being rational, formalize their activities to take advantage of the low cost of production in the formal sector(industrialized countries or generations). On the other hand, when the volume of the informal sector tends to increase, and

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their PPF threatens to fall below the WTF, the HOM imposes an optimal export tax (deprotection) to discourage sub-industrialization. This means, the behavior of local authorities tends to bring all companies in the formal sector whose marginal cost is higher than the market prices, close their doors to enter the informal sector (under-industrialized countries), resulting in an increase in informal sector. In other terms, human capital tends to transform multidimensional trade vertically and destructively, indicating that an accumulation of resources is favorable for current generations (developed countries). Intergenerational knowledge and technology barriers (or knowledge and technology barriers between developed and developing countries) harm long-run growth. Although the accumulation of different resources (physical capital, human capital, natural resource endowments, institutional capital, and wealth distribution), generates comparative intergenerational or international trading advantages and gains, it harms global welfare in the long term. This conclusion is a high-level generalization of the Lerner symmetry theorem, which states that a country limiting imports through barriers tends to discourage exports. We therefore recommend a systematic implementation of the HO model with its basic assumptions as the only economic policies for the nation.

Keywords: HO trade model; optimal tax; PPF and MTF; formal sector or industrialized countries; Informal sector or under- industrialized countries or generations.

JEL Codes: B4CFF1F2O.

1. INTRODUCTION

HO model states: "countries export products which intensively use the productive factors that they have in abundance and import products which use intensively the productive factors that at home are scarce" (Heckscher and Ohlin, 1933). Furthermore, Heckscher and Ohlin have translated their finding saying “Thus, indirectly, it is factors with abundant supply that are exported, while factors with limited supply are imported”. It’s therefore crucial, if you want to test this model, to investigate if the abundant productive factor is really indirectly exported and the scarce factor indirectly imported, i.e through goods exchange only (Aghion et al., 2006; Scheuermeier, 1988; Aghion et al., 2010). But, can we, after the trade is opened, measure the decreasing of the supply of abundant productive factor and the increasing of the quantity of the scarce one in each country? Since these productive factors are indirectly exchanged (incorporated in traded goods), the measure will be difficult in the context of representative agent. I think, we’ve two ways to overcome this great problem:

1) If these productive factors’ prices are equalised in the countries through goods’ trade, we’re justified to assume that their offers are also; but sometime other economic and none economic factors contribute to price determination. However, In HO’s world these latter effects can be neglected. 2) A qualitative evaluation of the decreasing of abundant factor's supply and the increasing of the scarce one, is to measure the movements of the Production Possibilities Frontier (PPF)’s effects on aggregate production, assuming an absolute PPF’s fixity or null growth volatility in autarky or in steady state level. It’s shown, growth volatility in the cross-country and cross-generation’s evidence, is due to PPF disturbance. The disturbances in the (PPF) due to differences in the change of production factors’ supply- in the average growth volatility seems to have an important impact on growth volatility [Bedu et al., 1987, Eppstein et al., 2011). Defining a country’s technology as a combination of unskilled labour, skilled labour and capital efficiencies, Caselli and Coleman (2000) found a negative cross-country correlation between the efficiency of unskilled labour and efficiencies of skilled labour and capital (Caselli et al., 2000). They interpret that link as the proof of the existence of a World Technology Frontier (WTF) in which increases in the efficiency of unskilled labour are obtained at the cost of declines in the efficiency of skilled labour and capital. The same negative association exists between natural resources’ efficiency and unnatural resources’ efficiency, both in intergenerational and international trade (Ardeni, 1989; Arrow, 1962; Azariadis & Drazen, 1990; Bajona & Kehoe, 2006). Consequently, if intergenerational and international levelling out of goods and factors prices is not realized, the change in the supply of goods and factors is unbalanced, inducing generations and nations PPF ‘s movements, the key cause of fluctuations. With the Solow’s growth model based on a

constant saving rate, the movements in the (PPF) is impossible (Pareto efficiency criterion). In such a model, there is no economic volatility (constant growth rate) (Bachmann et al., 2013; Baker & Bloom, 2013; Baker et al., 2016). To understand how trade is the major vector of resources allocation and economic volatility, the study of how the overall efficiency or total factor productivity determines countries' or generations' comparative advantages, is essential. Caselli and Coleman (2000) have shown how the optimal choice of technology depends on the country's endowment of skilled and unskilled labour and how barriers to technology adoption are crucial. Thus, a weak resources allocation always generates shocks that affect growth path.

The key causes of the link between growth and volatility should be found, instead, in the movements of the (PPF) and their interactions with international and intergenerational trade. Subsequently, it is important to revisit the factors generating growth model in order to find its sources of fluctuations. The Neoclassical growth theory is essentially based on the supply side while the Schumpeterian growth theory is from the demand side (Barro & May, 1991; Blackburn, 1999; Bloom, 2014). But we should admit that all the factors who cause economic growth, put the (PPF) in a sort of movement in a way that the directions took by these movements in each country and/or generation interact with international or intergenerational trade to determine economic volatility. Thus, in fact, (PPF) are in a permanent movement, balancing from the left to the right side and vice versa. The direction of the movements depends on productive resources allocation. The level of resources could rise or drop and the production technologies or the intergenerational marginal rate of substitution of resources could change. If, only differences in the change of countries/generations' resources can lead to a change in the comparative advantages and international/intergenerational trade configuration, the sign of the relationship between growth and volatility would be affected by these movements and their interactions with international and intergenerational trade (Blyn, 1973; CIEPA, 1991; Ramsey, 1928; Stiglitz, 2016; University of California, Los Angeles, 2016; United Nations, 2023). For King et al., (1988), a temporary disturbance to (PPF) can have permanent effects on the path of the output growth. The importance and the nature of these effects depend on the types of disturbances. Thus, higher variability in the production factors' supply should be a source of higher variability of the production level due to a great disturbance in the (PPF) (Vincent & Campbell, 1989; Wheat, n.d.; NORAD, 1989; Zahoor et al., 2022; Campbell & Mankiw, 1991). To understand the role of the differences in the productive resources quantities' change and technological progress interactions with trade, we introduce the notion of "natural resources exchange against unnatural resources between generations" that is until now ignored in economics but which can highly disturb the (PPF). In the existing literature, there is no rigorous formulation of how intergenerational free trade interacts with the international free trade to determine general macrodynamic equilibrium in terms of optimal growth (CICIBA, 1989; G.R.E.P.I., 1976; International Monetary Fund, 2015). Optimal allocation of economic resources should lead to optimal growth and sustainable development (Koopmans, 1965; Levine & Renelt, 1992; Li et al., 2017; Mania & Rieber, 2019; Nakamura et al., 2017; Naudé & Rossouw, 2011; Ng & Wright, 2013). However, none of the studies has established a link between successive generations' behaviour, current prices and economic volatility. As we can see, studies of economic volatility have made great progress in the past 20 years but, there remains much to be learned about the determinants of long-run productivity growth and its links with business-cycles. Previous studies on economic volatility do not integrate the movements of the (PPF), intergenerational trade effects and their interactions with economic growth (Agosin et al., 2012; Bloom, 2014; International Monetary Fund, 2017). In this paper the following research question is answered: How can the Heckscher – Ohlin trade model (HOM) operate as an optimal tax to generate an efficient educational vector? Thus, the aim is to investigate if The HOM acts as an international hero, imposing an optimal import tax on countries or generations operating within the World Technology Frontier (WTF), and an optimal export tax on countries whose Production Possibilities Frontier (PPF) is above the WTF, in order to ensure an equivalent level of satisfaction for all.

The remainder of the paper is presented as follows: section 1 presents the introduction; the second section deals with background; Section3 deals with material and method. Section 4 presents the empirical plan, results and discussions. Then we've the section 5 of conclusions and recommendations and References in section 6.

2. BACKGROUND ON THE RELATIONSHIP BETWEEN HOS MODEL AND GROWTH VOLATILITY

The factor proportions model and its extensions into neo-factorial approach and model with specific factors are very important to show how goods trade is a substitution to productive factors exchange between countries. Breaking down the labor factor, from the different skill levels into distinct sub-categories making these ones more or less substitutable with each other depending on the nature of the goods to be manufactured has had crucial results theoretically and in testing HO model. Another way to test HO model has been to considers that skilled labor is the result of the combination of capital and unskilled labor Vanek (1968) and Keesing (1965, 1966, 1968, 1971). The differences in factor abundances and international trade in skilled labor is considered to be the result, the output, of the combination of two primary factors: capital and unskilled labor (Cass, 1965; Charemza, 1990; Cook & Weinsberg, 1979). The empirical difficulty will lie in the measurement of human capital, that is to say in the evaluation of the quantity of capital incorporated in each unit of skilled labor. In general, the level of qualification is considered to be entirely due to the amount of capital invested in education by an individual. Empirically, the rate of return on capital invested in training will be estimated from the wage differences between unskilled and skilled labor.

3. MATERIALS AND METHODS

3.1 Approach to the Relationship Fluctuations and Growth in International free Trade in the Context of the Representative Agent

We have become accustomed to defining a tax as a discretionary financial levy imposed on economic agents (consumers, producers, foreigners) by the public authorities to finance its regalian functions. However, any type of tax distorts relative prices and is responsible for economic distortions in any country. So, more generally, tax is anything that creates distortions in the economy. Thus defined, there is no limit to the scope of taxation. All kinds of imperfections such as market imbalances, bad economic policies, poor education, obstacles to freedom, monopolies etc. fall into this category. In the 1990s, many authors saw the unemployment of unskilled individuals in industrialized countries, and of skilled individuals in non-industrialized countries, as a consequence of these countries' trade with non-industrialized countries. If this hypothesis were to be verified, it would echo the Heckscher-Ohlin model of factor proportions, which indicates that although factors of production are immobile from country to country, there is an indirect exchange of them through the international exchange of final goods. In the broadest sense, therefore, there would be a tax on the export or import of these two categories of countries, since international trade creates imbalances in at least one market. In a neoclassical context, this type of trade resembles an economy composed of a formal sector and an informal sector, if we consider that the formal sector has the characteristics of a developed country compared to the informal sector. In what follows, we will develop a model to reduce the effects of this exchange using an optimal tax. The optimal tax should be measured by the disutility of tax avoidance. The best way to measure the optimal tax is to deduct it from the marginal cost of belonging to the informal sector or non-industrialized countries (difference in productivity compared with the formal sector). The low productivity of the informal sector is due to the absence of credit, the impossibility of benefiting from economies of scale, the exclusion of the informal sector from economic and social infrastructures, etc. When the tax is equal to the marginal cost of belonging to the informal sector, then it is optimal. We know that it is optimal because belonging to the formal sector provides a level of comfort that no rational economic agent would be willing to forego for a lower level of comfort. We buy a good if its marginal utility is at least equal to the marginal cost of the utility we give up to obtain the good. This is the only way in economics to eliminate the non-criminal informal sector or non-industrialization (as opposed to the fraudulent informal sector). Generally speaking, countries with monopsony or monopoly power set the optimum import or export duty or tax (Bayoumi & Eichengreen, 1996). Entering the informal sector when the tax we pay is lower than the marginal cost of belonging to the informal sector means placing ourselves in a position where our net tax gain begins to diminish (net tax gain = C2 tax revenue paid by foreigners - our deadweight loss). C2 is the comfort of belonging to the formal sector. The deadweight loss is the marginal cost of belonging to the informal sector, resulting from the effect on production (under-productivity in the informal sector) and the effect on consumption (selling less because average costs in the informal sector are higher than in the formal sector). The same analysis can be made by considering the informal sector as a regulating stock in the economy. By setting taxes at a given level, we have a given volume of regulatory stock to finance temporary imbalances, etc.

If the state were to reduce the tax rate to its optimum level, the informal sector would simply disappear. The total output of the economy (old formal sector and new formal sector due to the reconversion of the current informal sector) would have increased.

To illustrate our arguments, we propose a successful temporary disequilibrium financing model in the context of a fiscal transition. Consider the following variables: Pf: Output/worker in the formal sector= Qf/Cf where Qf is the total output in the formal sector and Cf is the total cost in the formal sector composed of labor supply minus taxes. For simplicity's sake, we consider that there is only one factor of production. All other factors are converted to their labor equivalent simplicity's sake, we consider that there is only one factor of production, labor. All other factors.

When public authorities impose an optimal tax, formal sector productivity is at its highest, resulting in a low cost of production, and the volume of the informal sector (Under-industrialized countries and generations) is at its absolute minimum, with an equilibrium informal sector output of 45 million F (point A on the graph). Economic agents, being rational, formalize their activities to take advantage of the low cost of production in the formal sector (industrialized countries). That means HOM operates as an optimal tax to generate an efficient educational vector. All of which show that there is no such thing as underdevelopment or involuntary under-industrialization. On the other hand, the volume of the informal sector increases rapidly as soon as the public authorities adopt irrational tax policies, creating various distortions in the economy. All companies in the formal sector whose marginal cost is higher than the market price, close their doors to enter the informal sector, resulting in an increase in informal sector production from 45 million F to 55 million F.

These movements of production along the demand curve are akin to the rational behavior of a social planner, enabling equilibrium to be permanently re-established by a regulatory stock of 10 million F. This heroic behavior of national patriots enables the economy to derive a greater welfare gain than would have been the case had production fluctuated permanently between the two contradictory policies of the public authorities. This behavior by part of the population can keep the relative price between the two sectors at 1.2F/I indefinitely, allowing the economy to reap the benefits of ACD and BDE. Therefore, using this Agent-based Modelling (ABM), I show growth volatility in the cross-country and cross-generation's evidence is due to PPF disturbance. ABM can be used to explore the underlying complexities in the market to reveal crucial processes and possibly effective strategies for management (Afman et al., 2010; Eppstein et al., 2011; Lempert, 2002; Lengnick, 2013). This disturbance shall depend on the assumption that economic agents in a given nation or generation can commit more or less serious miss-choices, which they can then repent of. But these miss-choices affect production and consumption more or less considerably, in terms of purchasing or production rights. However, the great global community's tendency to return to right choices, ensures a serendipitous equilibrium in a context of overlapping generations and nations. There is an auto-errors correction between old and young (living and dead generations and between old and young countries) ensuring a permanent equilibrium in the economy, so that the continuous movements of the PPF are not perceptible. (nominal growth volatility). Therefore, the sustainable growth generated by this continuum of opposing shock-vectors of equal intensity, i.e. an exchange of positive externalities for negative externalities between generations and countries, is the normal state of any economy. Because, shocks on PPF have two origins: external (from other generations or nations) and internal (current generation or the same country), the integration of the two conflicting mechanisms for endogenous technological change, eliminates growth volatility. This result confirms at a high level, the Hecksher-Ohlin-Edgeweblime hypothesis that scarce factors are indirectly imported (increasing) and abundant factors exported (decreasing) through the exchange of final goods, and that, the scarce final good in a generation is indirectly imported (increasing) and the abundant final good in a given generation is indirectly exported(decreasing) through the exchange of factors between generations of a given country.

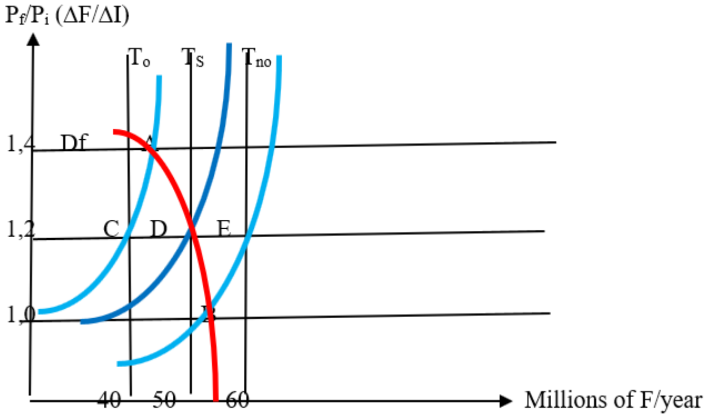


Fig. 1. Financing a successful temporary imbalance as part of a tax transition

3.2 Equilibrium of Multidimensional Trade

In a multidimensional trade model, the first component interacts with the second component. Then, the relationships between intergenerational trade and international trade appear like the movements that are propagating vertically (through generations) and horizontally (current generations or the nations). We are in a world of overlapping generations and international free trade. It is clear that such movements are interfering to create a recursive, triangular or causal system.

Let's start with the expressions of separate movements:

$$S(t) = S_O \cos(\omega t - \varphi_1) \quad (1)$$

for international trade.

$$G(t) = G_O \cos(\omega t - \varphi_2) \quad (2)$$

For intergenerational trade.

If these two flows have the same rhythm but different generation weights the macro-dynamic equilibrium is determined through the calculation of the multidimensional trade with the following relation:

$M(t) = S(t) + G(t) = M_O \cos(\omega t - \varphi_2)$ for the multidimensional trade (3)

If we develop (3), we obtain:

$$M \cos\omega t \cos\varphi + M_O \sin\omega t \sin\varphi = S_O \cos\omega t \cos\varphi_1 + S_O \sin\omega t \sin\varphi_1 + G_O \cos\omega t \cos\varphi_2 + G_O \sin\omega t \sin\varphi_2 \quad (4)$$

Solving simultaneously:

$$M_O \cos\omega t \cos\varphi = S_O \cos\omega t \cos\varphi_1 + G_o \cos\omega t \cos\varphi_2 \quad (5)$$

$$M_o \sin\omega t \sin\varphi = S_O \sin\omega t \sin\varphi + G_o \sin\omega t \sin\varphi_2 \varphi 2 \quad (6)$$

It comes:

$$M_O \cos\varphi = S_O \cos\varphi_1 + G_o \cos\varphi_2 \quad (7)$$

$$M_o \sin\varphi = S_O \sin\varphi_1 + G_o \sin\varphi_2 \quad (8)$$

Then we calculate the amplitude of the multidimensional trade as follows:

$$M_O^2(cos^2\varphi + sin^2\varphi) = S_O^2(cos^2\varphi_1 + sin^2\varphi_2) + G_O^2(cos^2\varphi_1 + sin^2\varphi_2) + 2S_oG_o(\cos\varphi_1 \cos\varphi_2 + \sin\varphi_1 \sin\varphi_2 \quad (9)$$

$$M_O^2 = S_O^2 + G_O^2 + 2S_OG_O \cos(\varphi_1 - \varphi_2) \quad (10)$$

If the multidimensional trade is horizontal ($\varphi_1 = \varphi_2$)

I have $M = (S_O^2 + G_O^2)$ (11)

In this case, I have a constructive multidimensional trade, because of the multidimensional trade increases.

But, if the multidimensional trade is vertical with different generation's weight **(**$\varphi_1 = \varphi_2 + \pi$), I obtain:

$$M_O^2 = (S_O^2 - G_O^2) \quad (12)$$

Here the multidimensional trade is destructive as it decreases.

Between the two extremes, the multidimensional trade is varying with cos(φ_1- φ_2) or the cosinus of generation's weight difference.

I calculate a generation's weight by dividing member by member of the preceding equations:

$$Tan\varphi = \frac{S_O \sin\varphi_1 + G_O \sin\varphi_2}{S_O \cos\varphi_1 + G_O \cos\varphi_2} \quad (13)$$

Finally, the multidimensional trade expression is :

$$M = S_O^2 + G_O^2 + 2S_O G_O \cos(\varphi_1 - \varphi_2) \cos\left(\omega t - arctan\varphi \frac{S_O \sin\varphi_1 + G_O \sin\varphi_2}{S_O \cos\varphi_1 + G_O \cos\varphi_2}\right) \quad (14)$$

3.2.1 The multidimensional trade interdependencies and growth

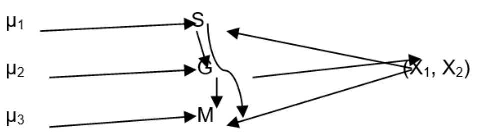
Let's now consider this framework of simultaneous relations:

$$S_{1t} = \beta_{10} + \delta_{11}X_{1t} + \delta_{12}X_{2t} + \mu_{1t} \quad (15)$$

$$G_{2t} = \beta_{20} + \beta_{21}S_{1t} + \delta_{21}X_{1t} + \delta_{22}X_{2t} + \mu_{2t} \quad (16)$$

$$M_{3t} = \beta_{30} + \beta_{31}S_{1t} + \beta_{32}G_{2t} + \delta_{31}X_{1t} + \delta_{32}X_{2t} + \mu_{3t} \quad (17)$$

Because of the interdependencies between the international and intergenerational trade, I postulate the simultaneous equations where, the S's, G's, M's and the X's are respectively, the endogenous and the exogenous variables. I know that trade externalities are such that cov (μ_{1t}, μ_{2t}) = cov(μ_{1t}, μ_{3t}) = cov μ_{2t}, μ_{3t}) =0. As I am in presence of the same period trade externalities in differential equations, I assume that the μ are uncorrelated (the zero contemporaneous correlation):



I state that the condition of a recursive competitive equilibrium or a constant growth rate is set by cov (μ_{1t}, μ_{2t}) = cov (μ_{1t}, μ_{3t}) = cov μ_{2t}, μ_{3t}) =0

When I consider the first equation, we see that it contains only the exogenous variables on the right-side and because of the assumption of the non-correlation with trade externalities μ_1, this equation satisfies the critical assumption of a constant and optimal growth rate.

Next, consider the second equation which contains the endogenous variable S_{1t} as an explanatory variable along with non-stochastic X's. Now the same critical constant growth rate is also satisfied because S_{1t} and μ_{2t} are uncorrelated. Is this so? I answer yes, because, in fact, μ_1 which affects $_{S1t}$ is by assumption uncorrelated with μ_2. In this model, S_{1t} is a predetermined variable insofar as G_{2t} is concerned. In the same reasoning, we argue that the critical constant growth rate is satisfied for the third equation because both S_{1t} and Y_{2t} are uncorrelated with μ_3.

Thus, in this recursive system, the growth rate is constant in each equation separately (Bajona & Kehoe, 2006). Currently, we do not have an interference equation problem in this situation. From the structure of such systems, it is clear that there is no interdependency among the endogenous variables. Thus S_{1t} affects G_{2t}, but G_{2t} does not affect S_{1t}. Similarly, S_{1t} and G_{2t}influence M_{3t} without, in turn, being affected by $M_{3t.}$ We conclude that in such a system, each equation exhibits a unilateral causal dependency and assures to all economies and generations the same and constant optimal growth rate.

3.2.2 The dichotomy between growth and business-cycles

In my theoretical model, the multidimensional trade expression is:

$$M_O^2 = S_O^2 + G_O^2 + 2S_O G_O\, cos(\varphi_1 - \varphi_2) \cos\left(\omega t - arctan\varphi \frac{S_O \sin\varphi_1 + G_O \sin\varphi_2}{S_O \cos\varphi_1 + G_O \cos\varphi_2}\right)$$

This equation expresses the interferences of the two components (international trade and intergenerational trade) of the macro dynamic equilibrium, (Fig. 1). I interpret that equation as a (WTF) which increases in the efficiency of natural resources are obtained at the cost of declines in the efficiency of unnatural resources. Solow growth model based on a constant saving rate implies that the movements in and of the (PPF) cannot occur (Pareto efficiency criterion). In such a model, there is no economic volatility (constant growth rate). When a country or a generation chooses suboptimal initial allocation different from W (disturbance to intergenerational/international (PPF), it is no more possible for this country or generation to reach the equilibrium point which is X on this Graph 1. Since then, the country or generation is engaged in great potential volatility which is varying with the distance separating the effective initial allocation (Wi) to the optimal initial allocation and with the sensitivity of the interdependencies.

To test the above hypothetical arguments we assume the following stochastic interference functions, combining equations 15, 16 and 17 and 1 (See Edgeweblime, 2019):

$$\Delta Y_{O,t}{}^2 = y_{i_o}^2 + y'{}_{i_o}^2 + \frac{1}{\left[\frac{1}{2} + 4\pi^2 j(wij0 + wij)^2\right]} \quad (18)$$

$Y_{it} = \mathrm{AEi(t)\alpha Ni(t)\beta\, X} \overset{\tau}{*} \mathrm{i(t).exp(\varepsilon i, t)}$

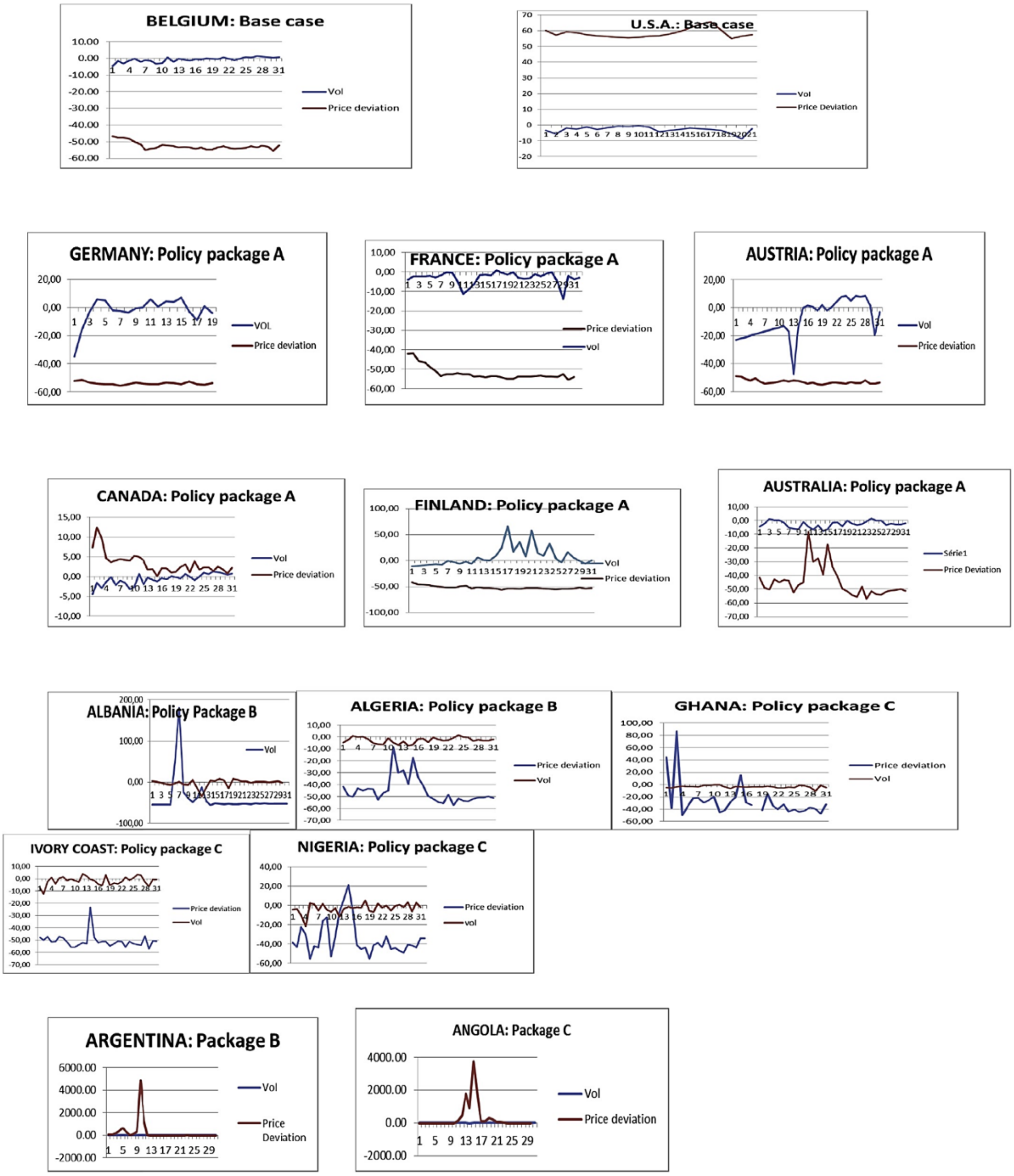
(see equation $y'_{i_o} = \mathrm{E'i(t)\alpha' N'i(t)\beta' \exp(\varepsilon i, t)}$

(see equation 14)

with $wij = \dfrac{\frac{Pj(t)}{Pi(t)}\; Li(t)gij(t)+Lj(t)gji(t)}{Li(t)yi(t)} \qquad i \neq j.$

The logarithm linear regression of equation 74 calculated per worker can be expressed

$\mathrm{Ln}(\frac{Y}{L})\mathrm{i,t} = \ln(A_i + A'_i) + (\alpha_E + \alpha'_E)\ln(\frac{E}{L} + \frac{E'}{L'}) + (\beta_N + \beta'_N)\ln\frac{N}{L} + \frac{N'}{L'}) + [(a_{ij}W_{ij}(t) + a'_{ij}W'_{ij}(t)][Xj(t) + X'j(t)] + \delta''X\, X'i(t)$ (19)



Graph 1. Heckscher –Ohlin trade model

The model, with its great emphasis on theoretical skills, introduces new types of economic agents (the generations) and the importance of optimal choices as the intergenerational and international interdependencies drivers. First, my models enhance the importance of intergenerational choices in growth programs related to economic volatility.

The second important property of these models is that the equilibrium and the stability of the economy are determined on the one hand by the macro dynamic and international interdependencies and on the other hand by the state of international and intergenerational interests or needs, and society's optimal resources allocation.

The third property developed in the present models is the canonical relationship between intergenerational and international equilibrium. The two dimensions are closely linked; it is not possible to have one without the other. All the disequilibria in an economy (unemployment, budget deficits, internal and external disequilibrium and economic volatility) are the result of non-coincidence of intergenerational and international equilibriums. The three properties above are very important in the understanding of the current economic volatility and they provide solutions to problems that affect economies and globalization. The findings of this study may put some light on the process of sustainable development and optimal growth and may also ensure a long run economic stability.

4. EMPIRICAL PLAN, RESULTS, AND DISCUSSION

4.1 Policy Description

In this paper, I consider three policy packages: the package A refers to the countries that have been implementing the sustainable growth strategy for more than fifty years 'early bird'; the package B relates to the countries of the second zone, those experiencing sustainable growth strategy less than fifty years but more than twenty years; the package C refers to the countries that have started sustainable growth strategy recently, less than twenty years ago or not yet, generally the low income countries with HIPC Program. Belgium and the United States of America are considered as the remarkable central-class countries for which price deviation is very low with a low growth volatility, these are the base cases.

4.1.1 The following actions should have an important impact on assumptions A_1&$A0_1$&A_2 - See Edgeweblime (2012)

1. Creating an enabling environment for sustainable human development (SHD)
2. Implementing a National Sustainable development Strategy (NSDS).: the most effective action to reduce volatility or price deviation
3. Promoting community development and participation.

4.1.2 The perfect competition, the best driver to sustainability

This condition is related to a great number of producers and consumers, perfect information, free entry exit, the uniqueness of the product and zero profit. The following actions may lead to these criteria.

5. VALUATION OF GENUINE ENDOGENOUS SHD MICROPROJECTS

5.1 Opportunities Multiplication A Community Emergency NSDS: The Approach and Device

Analysis of sustainable lifestyles regarding the capital, context, opportunities/vulnerability and all institutional structures and processes may affect all the aspects of social life. Current lifestyles contain foreign elements that make people either unable or not creative or dependent on other societies. Avoiding all that is foreign to the community and considering only micro endogenous SHDs projects, consistency is restored lifestyles and individual autonomy. The approach of implementing SHD.

5.2 Selection of SHD Microprojects-Step 1

5.2.1 An endogenous community development: the operational system

The strategy is carried out in three steps: 1) dissemination of the strategy and motivation of the beneficiaries; 2) selection of microprojects SHD and the capabilities that will achieve diffusion of microprojects SHDs; 3) the mobilization of these capabilities in a flexible device, lightweight and efficient.

5.2.2 Technical capacities

A variety of technical capacities will be required for the implementation of microprojects SHD.

5.2.3 Credit

The mastery of organizational skills, participation, management, technical capabilities and the question of financing is one of the most important parts of the strategy.

5.2.4 Capacities mobilization

All skills at regional and national level must be inventoried and used when needed.

5.2.5 The valuation of SHD microprojects

The genius of the approach lies in the enhancement of microprojects that have already succeeded. This means that most of the technical, organizational, management and funding exist in the community.

5.3 Empirical Specifications

Eq. (7) provides an empirical foundation for the modern stochastic endogenous growth theory. It allows us to study, theoretically, the relationship between long-term growth and short-term volatility. Nelson and Plosser 1982; Aghion et al., 2006) show that movements in the Gross National Product (GNP) tend to be permanent. Kydland and Prescott (1982) developed new techniques for analyzing economic volatility, integrating growth and volatility fluctuations. Their research indicates that macroeconomic time series are better characterized as non-stationary integrated processes rather than as stationary processes around a deterministic trend. Our paper's findings support the literature suggesting the ambiguity of this relationship. Although this is dependent upon the structure of the models considered, the assumptions made about the mechanisms generating the endogenous technological change, and the values of the assumed parameters.

5.3.1 Data

A sample of 119 countries was used to study the relationship between growth and economic volatility. This sample contains 25 OECD countries and 94 developing countries, observed between 1980 and 2010. The total number of observations is 3689. The country groupings were chosen because each group had similar intra-group production technologies. Intra-OECD intra-developing country trade considered international trade. Trade between the two groups is regarded as intergenerational trade. This is because the developing countries have the characteristics of developed countries from 100, 200, or more, years ago. All data are collated from the World Development Indicators (WDI). In our framework, international trade exclusively concerns trade between countries with a similar level of development. Hence, $X_i(t)$, which represents the stock of external effects of natural and unnatural resources, defined by the interaction between the natural and unnatural resources, and unnatural resources and the current physical capital, is captured when developed and undeveloped countries are mixed in the same sample. a_{ij}, which determines a country's potential to adopt existing technologies, is also highlighted by the same regression.

Links between sustainable growth and the couple « growth and volatility » are estimated periodically in order to measure the policies' impact on the couple « growth and volatility». Two kinds of coefficients presented in the following matrix are calculated:

- Links between cross-country externalities' trade and the couple « growth and volatility»
- Links between cross-generation externalities' trade and the couple « growth and volatility»

These links are estimated periodically in order to measure the policies' impact on the couple « growth and volatility»

5.4 Evidence of Over-Optimal Multidimensional Trade and Links between Growth and Volatility

5.4.1 Variables description

These three scenarios enable us to determine the relationship between growth and volatility. In these cases, ($a_E$þa0_E), (b_Nb0_N), (a_{ij}þ a'_{ij}), d''_X, ($a_E$þb0_Nþ a_{ij}þ$d'_{(X)}$), (a_E-a0), b_N-b0_N), (a_{ij} - a'_{ij}), -d''_X, and -(a_Eþ b0_N- a_{ij}- d0_X) are all exogenous parameters, whose sign and magnitude are crucial for determining the sign of the relationship between growth and volatility in Eqs. (14), (18) and (19).

We know that $X_i(t)$ includes two scale effects. The first is the stock of natural resources and unnatural external effects, defined by the interaction between the natural and unnatural resources, and the second is that of unnatural resources and the current physical capital. a_{ij} determines a country's potential to adopt existing technologies. The accumulation of unnatural resources in country i is relative to these definitions.

We also know that $X_i(t)$ includes two scale effects. The first is the stock of natural resources and unnatural external effects, defined by the interaction between the natural and unnatural resources, the second is unnatural resources and the current physical capital. a_{ij} determines a country's potential to adopt existing technologies. The accumulation of unnatural resources in country i is relative to these definitions.

Thus, for the general case, where we have international and intergenerational prices leveling out, there is no growth volatility due to the general equilibrium. This general equilibrium means the produced unnatural resources “exported” to the future generation will compensate all the imports (e.g. hoarding natural resources) utilized by the present generation to support growth. In other cases, the world will experiment volatility and the choice of an actualization rate will ensure exports and imports compensation.

The expression ðmi; tÞ is very important in this analysis. It enables us to quantify the uncertainty due to errors in modelling specification or the problems of measure. Its values determine the model validity.

5.4.2 Interactions

Multidimensional trade is balanced by the capability of a country and a generation to adopt technology [(W_{ij}(t)þW'$_{ij}$(t) (Xj(t)þX'j(t))]. This generates positive scale effects on model one's growth, but negative effects on models two and three (see Table 1). In the first case, multidimensional trade is horizontal and constructive, otherwise it would be vertical and destructive. If we ignore the negative scale effects of models two and three, we can argue that the exchange of intergenerational and international goods for technology increases each generation's and country's total factor efficiency and satisfaction during each period (an optimal state, with the intergenerational and international leveling out of the price of goods and factors). However, at the same time, we observe a negative association when exchanging natural resources for unnatural resources through Ln$\frac{E}{L}$ þL$\frac{E}{0}$ ^{0} x Ln($\frac{N}{L}$ þ L$\frac{N}{0}$ ^{0} .

This indicates a country's or a generation's capacity to adopt technology which is an important factor for overall efficiency. The behavior of the variable W_{ij}LnN, confirms this conclusion across the three models. Indeed, there is a positive multidimensional trade scale effect on each country and generation because current goods and services are indirectly exchanged for future unnatural resources along with future goods and services, and vice-versa.

This result confirms, at a high significance level, the fundamental hypothesis of this study. Our hypothesis proposes 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. Indirectly, generations import goods and services that use a high proportion of technically scarce productive factors and a low proportion of technically abundant productive factors and export goods and services that use the reverse proportions of the same productive factors. Thus, positive externalities (unnatural resources) are exchanged against negative externalities (overconsumption of natural resources). A productive factor is technically scarce in a generation if the part of this productive factor imparted to this generation is insufficient to produce as much of these goods and services that it wishes to consume. A productive factor is technically abundant if its proportion existing in this generation is superior to its production needs. This realizes an efficient trade of externalities decoupling thus the relationship between growth and volatility.

5.5 Evidence of Suboptimal Multidimensional Trade and Linkage between Growth and Volatility

Multidimensional trade can be constructive (horizontal), destructive (vertical), or indeterminate (neither horizontal nor vertical). When multidimensional trade is constructive, international and intergenerational trade are in harmony, with (4_1 ¼ 4_2). Alternatively, we have a general equilibrium when the international and intergenerational equilibriums are aligned. The leveling out of prices for international and intergenerational goods and factors are realized simultaneously. In such a world, the over or under consumption of natural resources, by a generation or a country, is integrally compensated by an equivalent measure of unnatural resources. Thus, any aggregate variation, in a generation or a country, will affect other variables in a similar direction in other generations or countries. Under these circumstances, the relationships between growth and volatility are described using three key parameters [($a_E$þb0_Nþ a_{ij}þd0_X), (a_{ij} þ a'_{ij}), andd]. These parameters represent different multidimensional trade scale effects. When these parameters are simultaneously positive, countries may have a choice between technologies with a high-variance and high expected returns, or technologies with a low-variance and low expected returns.

If the multidimensional trade scale effect parameter is negative, countries and generations would not converge towards a steady state. This disturbance should generate cycles of growth and decline and multidimensional trade becomes destructive, as shown above. Waves of over and under consumption of natural resources are experienced. Further, there is poor international and intergenerational compensation between the natural and unnatural resources. In such circumstances, volatility can lead to firms producing at suboptimal levels, leading to lower mean outputs. Ramey and Ramey, (1995) conclude that if lower current outputs affect the accumulation of resources, then growth is adversely affected.

Some multidimensional trade effect parameters can be positive and others negative. In this situation, we have indeterminate trade and the relationship between growth and volatility can be positive or negative. We should refer to the dominant scale effect to decide the indicator of the growth and volatility relationship.

In the present study, the relationship between growth and volatility is positive. This indicates that countries may have a choice between high-variance, high expected return technologies and low-variance, low expected return technologies. As stated above, the parameters (a_Eþ b0_Nþ a_{ij}þ d0_X) and ((a_{ij} þ a'_{ij}) are essential positive, but d is negative. This result means that the future generations should suffer more negative multidimensional trade spillover effects than positive external effects, which they could expect to receive from current generations. The negative relationship between human capital and growth is very instructive. It means human capital contributes more to intergenerational than international trade. Human capital tends to transform multidimensional trade vertically and destructively, indicating that an accumulation of resources is favorable for current generations (developed countries). Intergenerational knowledge and technology barriers (or knowledge and technology barriers between developed and developing countries) harm long-run growth. Although the accumulation of different resources (physical capital, human capital, natural resource endowments, institutional capital, and wealth distribution), generates comparative intergenerational or international trading advantages and gains, it harms global welfare in the long term. This conclusion is a high-level generalization of the Lerner symmetry theorem, which states that a country limiting imports through barriers tends to discourage exports.

Our study also indicates why economic fluctuations are permanent. This is because many barriers disturb the economic convergence towards the desirable steady state. The main cause of economic fluctuations is the succession of different economic regimes (for example, liberal or Keynesian) across the major economies. This instability is underpinned by a lack of economic knowledge and the confusion caused by the wide variety of economic theories. an international and intergenerational leveling out of goods and factors' prices.

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.

In the present study, the relationship between growth and volatility is positive. This indicates that countries may have a choice between high-variance, high expected return technologies and low-variance, low expected return technologies. As stated above, the parameters (a_Eþ b0_Nþ a_{ij}þ d0_X) and ((a_{ij} þ a'_{ij}) are essentially positive, but d is negative. This result means that the future generations should suffer more negative multidimensional trade spillover effects than positive external effects, which they could expect to receive from current generations. The negative relationship between human capital and growth is very instructive. It means human capital contributes more to intergenerational than international trade. Human capital tends to transform multidimensional trade vertically and

Table 1. Multidimensional trade and 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_1+ A'_1	Time invariant factor-0,6581	-0,6581 (-7,21)	0,6567 (7,34)	**1,2584** **(6,27)**	
Ln(E/L+E'/L')	-Log of natural resources Authority per inhabitant (160,6)	**2,356037** **(160,6)**	0,039851 (1,06)	**0,29278** **(2,68)**	**+**
Ln(E/L+E'/L')	Log of « unnatural resources» per inhabitant	2,202217 (239,79)	**0,34942** **(10,36)**	**0,199865** **(9,86)**	**+**
[(W_{ij}(t)þW'$_{ij}$(t)	Unnatural resources	3,50e23	3,57e^{36} (-2,78)	1,12e^{25} (-3,59)	**±**
(Xj(t)þX'j (t))]	Capital per worker	(2,31)	1,70e11 (4,23)	1,03e13 (5,97)	**+**
[Xi (t)þX'i(t)] (1)	Natural resources per worker	8,76e-^{12} (1,99)	4,20e-^{12} (0,91)	2,81e^{12} (-0,55)	**±**
[Xi (t)þX'i(t)] (2)	Royalty and license fees payment	8,55e-^{12} (1,93)	0,7779 (11,0)	0,6919 (8,40)	**±**
[Xi (t)þX'i(t)](3)	Royalty and license fees Receipt	8,43e^{12} (-4,26)	2,80e^{12} (-2,21)	1,43e12 (0,83)	**±**
[Xi (t)þX'i(t)](4)	Human Capital	2,04e12 (1,54)	9,80e12 (5,34)	9,04e12 (4,94)	**±**
Xi (t)þX'i(t)] (5)	Multidimensional trade scale effect	0.3228 (-4,10)	0,021633 (-3,66)	0,00446 (-2,17)	**-**
[[Xi (t)þX'i(t)] (6)	Multidimensional trade ratio	0,3719 (-163,44	0,6581þ (-7,21)þ	0,34942 (239,79)	**+**
W_{ij}LnN)	Interaction between		2,356037± (160,6)		**+**
W_{ij}	Natural and Unnatural resources' trade		2,202217		**-**

Nakamura Nakamura Endogeneity Test the test is done on two steps:

Table 2. Parameters sign and nature of multidimensional trade

	Model 1	Model 2	Model 3	Nature of multidimensional trade
($a_E$þa0$_E$) or (a_E-a_E')	2,356037	0,039851	0,29278	Horizontal
(b_N þ b0$_N$) or ðb_N-b0$_N$);	,202217	0,34942	0,03602	Horizontal
(aijþ a'ij) or (aij - a'ij);	3,50e23	3,57e1136	0,199865	Horizontal and Vertical
(dx1þd0X1) or (dx1-d0X1)	8,76e-^{12}	1,70e	1,12e25	Horizontal
(dx2þd0X2) or (dx2-d0X2)	8,55^{e}-12	4,20e-^{12}0,04297	1,03e13	Horizontal and vertical
(dx3þd0X3) or (dx3-d0X3)	8,43e^{12}	0,7779	2,81e^{12}	Vertical and Horizontal
(dx4þd0X4) or (dx4-d0X4)	2,04e12	2,80e^{12}	0,6919	Horizontal and vertical
(dx5þd0X5) or (dx5-d0X5)	0,3719	0,021633	1,43e12	Vertical
(a_Eþ b0$_N$þ a_{ij}þd'$_{X)}$ or (aEþ b0N- aij-d'X	3,74	2,96e-^{23}	0,00446	Horizontal and vertical
	0,04685		0,00446	Vertical

Table 3. Relationship between mean growth and volatility with Levin-Renelt control variables

Variable	Definition	Coefficient	T- Stats.	Std. Dev.	[95%Conf. Interval] min	[95%Conf.Interval] max
gyVol	Growth volatility	0,45388	3,28	0.138206	0,182999	0,7247602
Gdppccp	-Initial log GDP per capita	31,3275	7,03	4,4538	22,59825	40,05692
Inv	-Average investment Fraction of GDP	1,61e^{11}	1,93	8,30e12	3,23e^{11}	2,08e13
Hc	Initial human capita	0,19918	0,83	0,24047	0,670511	0,2721
gpop	-Average growth of the population Intercept	0,33699	0,52	0,649967	1,6109	0,9369131
Const		92,3378	5,51	16,7647	125,1962	59,4795

destructively, indicating that an accumulation of resources is favorable for current generations (developed countries). Intergenerational knowledge and technology barriers (or knowledge and technology barriers between developed and developing countries) harm long-run growth. Although the accumulation of different resources (physical capital, human capital, natural resource endowments, institutional capital, and wealth distribution), generates comparative intergenerational or international trading advantages and gains, it harms global welfare in the long term. This conclusion is a high-level generalization of the Lerner symmetry theorem, which states that a country limiting imports through barriers tends to discourage exports.

6. CONCLUSIONS, RECOMMENDATIONS AND FUTURE WORK

Our fundamental aim in this paper was to investigate how can the Heckscher –Ohlin trade model (HOM) operate as an optimal tax to generate an efficient educational vector. Thus, the hypothesis was:" The HOM acts as an international hero, imposing an optimal import tax on countries or generations operating within the World Technology Frontier (WTF), and an optimal export tax on countries whose Production Possibilities Frontier (PPF) is above the WTF, in order to ensure an equivalent level of satisfaction for all. *I find, when HOM* imposes an optimal tax, formal sector (industrialized countries or generations) productivity is at its highest, resulting in a low cost of production, and the volume of the informal sector (under-industrialized countries or generations) is at its absolute minimum, with an equilibrium informal sector output at point A on the Graph 1. Economic agents (local authorities), being rational, formalize their activities to take advantage of the low cost of production in the formal sector(industrialized countries or generations) . On the other hand, when the volume of the informal sector tends to increase, and their PPF threatens to fall below the WTF, the HOM imposes an optimal export tax (deprotection) to discourage sub-industrialization. This means, the behavior of local authorities tends to bring all companies in the formal sector whose marginal cost is higher than the market prices, close their doors to enter the informal sector (under-industrialized countries), resulting in an increase in informal sector. The assumptions of the HOS model described here thus appear to be the best tax policy instruments to ensure sustainable international and intergenerational development

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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