MODERN ECONOMIC GROWTH UNDER GEOPOLITICAL TENSIONS, TRANSMISSION OF DISEASES AND CLIMATE CHANGE

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ABSTRACT

The aim of this article is to show-off mutations in the literature of economic growth where development basically, is a process composed of three regimes. The last is the modern growth that reccords paradigm change since it includes dangerous innovations generated by R&D due to high technologial change leading to geopolitical risk coupled with infectious disease, pandemic spread and climate change creating danger and scarcity at all levels. The extended modern growth proposed here, includes international tensions and conflicts similar to those viewed in the past in order to renew economic growth theoretical foundations and establish the new steady state that yields the equilibrium focused on peace any time. An OLG model is used to provide that efficient method reducing uncertainty including Ukraine and Russia war where the forthcoming third war risk is high through the partners intervention.
Keywords : geopolitical risk, economic growth, balanced growth, pandemic spread, infectious disease, forthcoming war
JEL Classification : J13, O11, O33, O40

PRESENTATION OF THE PROBLEM

Recent literature of economics, descibes development like a process of three stages i.e the malthusian trap, the post-malthusian trap and the modern growth where the industrial revolution took place between the last two regimes making demographic transition yields through the work of women, since children procreation and income vary in the opposite direction, thus leaves emerge the notions of quantity and quality of children. More precisely, the unified growth model captures the historical evolution of population,

technology, and output. In the Malthusian regime, technological progress is slow and population growth prevents any sustained rise in income per capita. In a Post-Malthusian regime, technological progress rises and population growth absorbs only part of output growth since a demographic transition reverses the positive relationship between income and population growth, and the economy enters a Modern Growth regime with reduced population growth and sustained income growth. Indeed, the Modern growth is characterized by high technological change level and low technology means low economic level, thus in some circumstances, that means economic backwardness and take place in development economics. However in the beginning of the years 2020s, the transmission of modern infectious disease, epidemics, pandemic, and violence as well as uncertainty on future events like the forthcoming third world war as an impact in the economy particularily trade and labor migration because of geopolitic tensions as well, expressed by economic perturbations which yield worries about diplomatic conflicts happening around the world characterizing macroeconomic outcomes. Since nuclear bombs generated by innovations caused by high tehnological change through R&D exist and are able to eliminate the whole human beings yield to the failure of economic globalization, each countries must be capable to defend herself even if defense authority like Otan conducted by United States around his partners exist. This looks like a new cold war where exist intimidations without concret actions conducted to help cease military disorders so that, the unification of geographical areas of the past is coming back in the market based economy.

Indeed, is that correct to say that, retarded economies transition toward liberal thought based on markets convergence to Modern growth is the best way for the long-run growth to settle ? Or is it a great part of the development process ? Are we going back to the past or to the beginning of someting different ?

Currently, sustainable growth is ruled-out i.e infectious disease like hiv/aids and pandemic like covid-

19 as well as violence, occuring in the world at a high level characterized the rich countries balanced growth path currently, and yields to high goepolitical risk which impact on the human being is a disaster thinking about the war in Ukraine, events which raise passions without nothing to be done by Ukraine countries' partnerships mainly European Union supported by France of Emmanuel Macron and Otan supported by United States of Joe Biden who are the main high personalities involved in the trial.

Despite the fact that, both negociations and sanctions to incite the Russian President to stop the war, remain almost without efficient solution for the geopolitical crisis to slow or to cease. The risk induced may through the partnerships channels, make the nuclear bombs in action and create the third world war risk. Are we victims of our own findings ?. Progressively, all over the world, scarcity is widening making the world back both to the Post Malthusian regime and to the Malthusian regime at the same time in the world. Consequently, the economic development evolution process recently propossed by the literature needs to be clarified, since currently, it looks like an incomplete story with lacking puzzles where democracy respect as well as sustainability (i.e pandemic) are absent of the world countries relationships i.e economic globalization Of course globalization, is a part of international exchanges and the engine of growth as noticed Ricardo's comparative advantage slowed by the current international disaster making geographical zones closed to everything like economy, finance, labour mobility or immigation, asylium seekers (displaced persons) are back in the economic literature but no more from the South to the North as usually observed, but inside Europe currently. Figure1 presents the literature finding on the process of economic development

Figure1 : The basic Economic Development Process

Figure1 above show-off, the current process of economic development according to the literature (Galor and Weil, 2000). However, modern growth currently includes geopolitic tensions i.e various military and diplomatic conflicts are holding in the world. How to generate the balanced growth path in that context ? Equivalently how to generate the inverted U-sharpe curve ?

This article uses the findings of several authors such as Caldara and Iacoviello (2022) index of geopolitical risk called, « GPR » highligting geopolitic events from 1985 until today (figure3) where the GPR increases the probability of economic disaster and predicts lower investment and unemployment. Geoplolitical risk is defined as the threat, realization and escalation of adverse events associated with wars, terrorism and any tensions among states and political actors that affects the peaceful course of international relations.

The following figure2 displays the GPR index from 1900 to 1985 and highlights tensions in the world since the years 1990s. Empirical models of geopolitical risk focused on the period 1985 to 2019 show-off a shock to geopolitical risk inducing persistent declines in investment, employment and stock prices. Moreover, higher values of GPR index are associated with higher probability of economic disasters, lower expected GDP and higher downside risks to GDP growth. Figure3 highlights the basic GPR constructed originally from 1900 and the new one departure from 1985 until 2020 based on searches of the historical archives of the *Chicago Tribune, the New-York Times* and *the Washigton Post*

Figure2 : Historical GPR index from January 1900 through December 2020

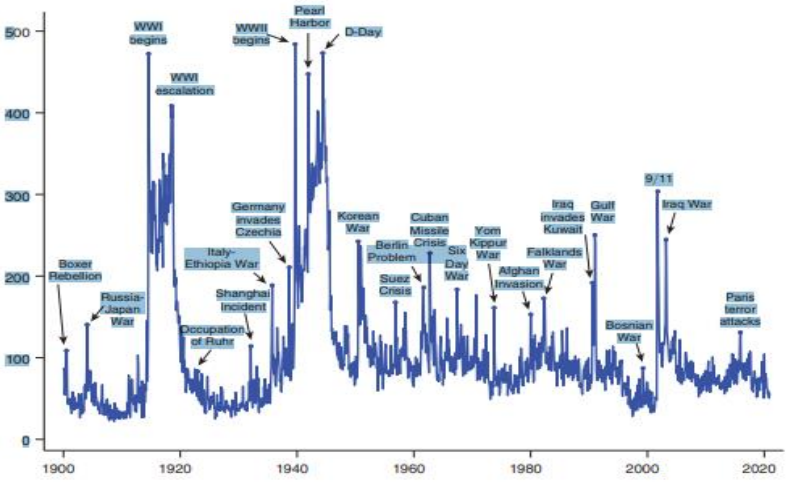


FIGURE 3. HISTORICAL GPR INDEX FROM 1900

Notes: Historical GPR Index from January 1900 through December 2020. Index is normalized to 100 throughout the 1900–2019 period.

Figure3 is the new GPR constructed by Caldara and Iacoviello (2022) in order to highligt geopolitical tensions occuring in the world since 1985 that continue with Russia and Ukraine.

The following figure4 highlights threats and acts in geopolitic aspect constructed using the *New-York Time* since 1900 to highlight intensity of news about adverse political events. The two GPR indices share similar long-run trends and display a very high correlation of 0.86 sharing very similar spikes during the world wars and the wake of the Korean war, the Gulf war and September the 11. Figure6 plots country specific GPR indices for selected countries where most of the countries share the same exposure to common geopolitical events like the two world wars, the Gulf war and Irak war. After the world war 2, the United Kingdom was involved in several international crises like the dispute with Egypt for the Canal of Suez, the war against Argentina for control over the Falkland Islands. Germany faced a major crisis that culminated in the construction of the Berlin Wall in 1961. Japan, Russia and China were opposed in regional

wars in the first half of the twentieth contury. Mexico and Korea were each embroiled in two major wars were United States was involved. The following figures 5 and 6 display the summaries of the international tensions.

Figure3 : Geopolitical risk dating back to 1985s

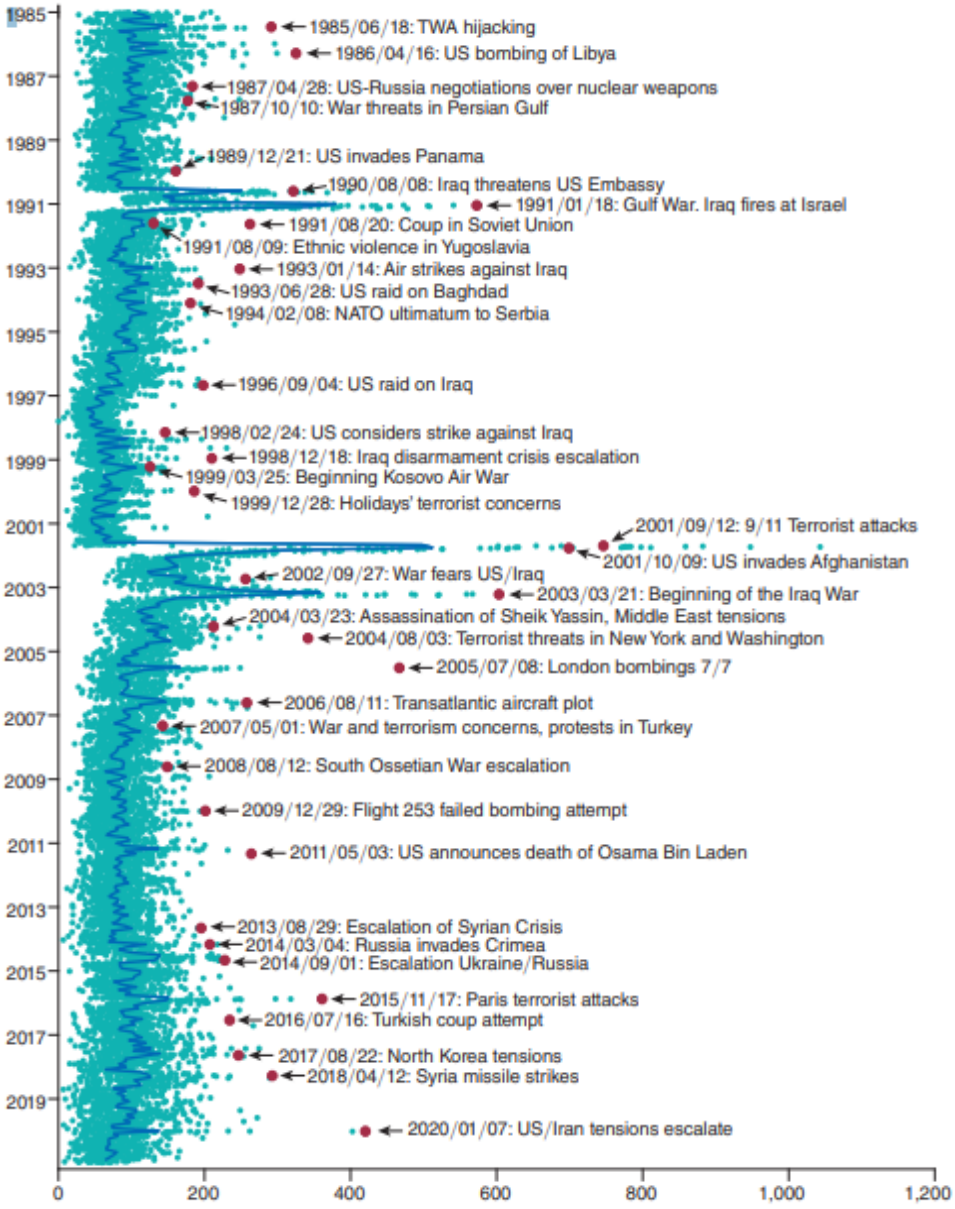


Figure4 : Geopolitical threats (GPR threats) and Geopolitical acts (GPR acts)

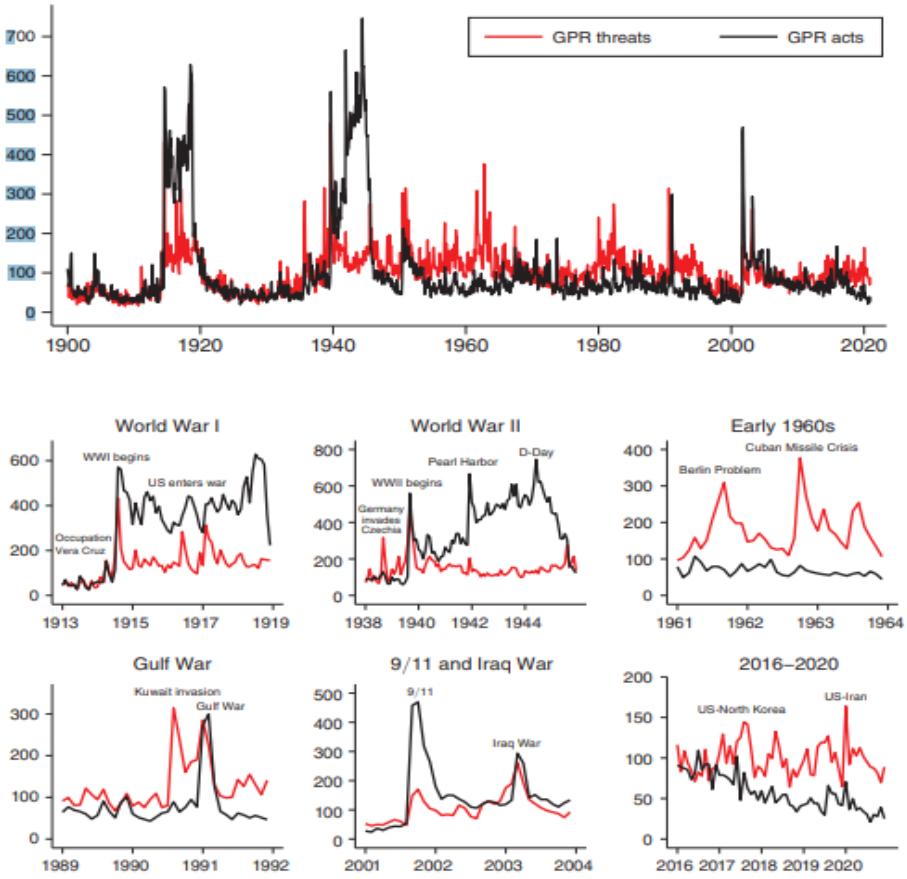


FIGURE 4. GEOPOLITICAL THREATS AND GEOPOLITICAL ACTS

Notes: Geopolitical threats (GPT) and the geopolitical acts (GPA) indices. The GPT index is constructed by searching articles in categories 1 to 5 in Table 1. The GPA index is constructed by searching articles in categories 6 to 8 in Table 1. Both indices are normalized to 100 in the 1900–2019 period.

Figure5 : the narrative GPR Index

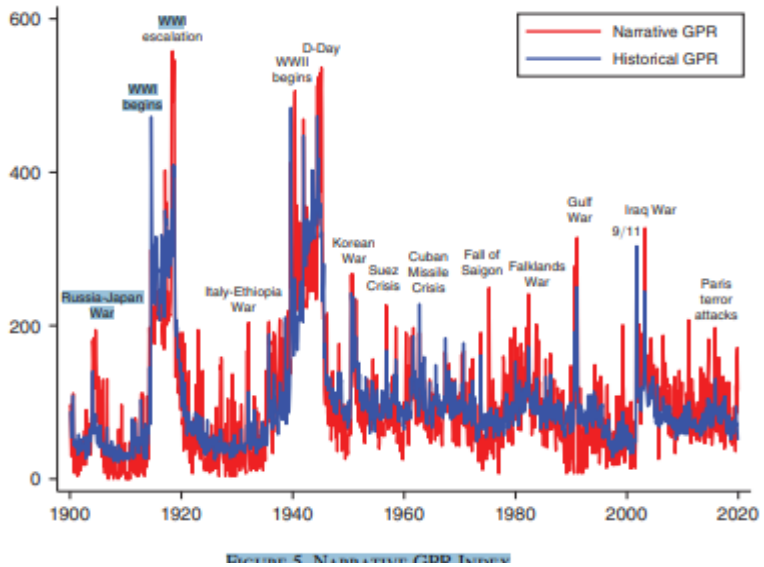


Figure6 highlights each country specific GPR index and captures risk posed by or involved in the country in question and are comparisons in the concern of the economy, deaths, uncertainty of market volatility based on options of the Standard and Poor's 100 stock index. Three attacks periods can be noticed, the Gulf war hold around 1990-1991 and after in 2001 with september the 11.

Figure6 : Country Specific Geopolitic Risk

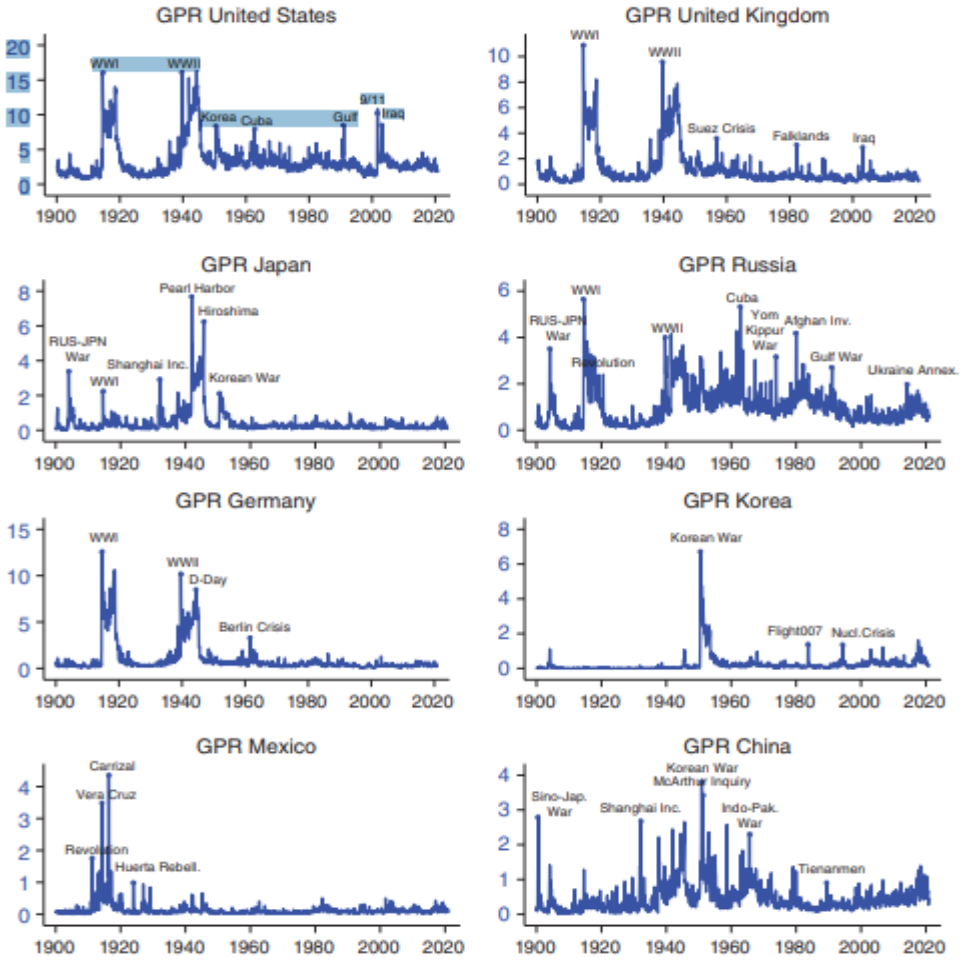


FIGURE 6. COUNTRY-SPECIFIC GEOPOLITICAL RISK

Figure7 : Comparisons with military spendings news and war deaths

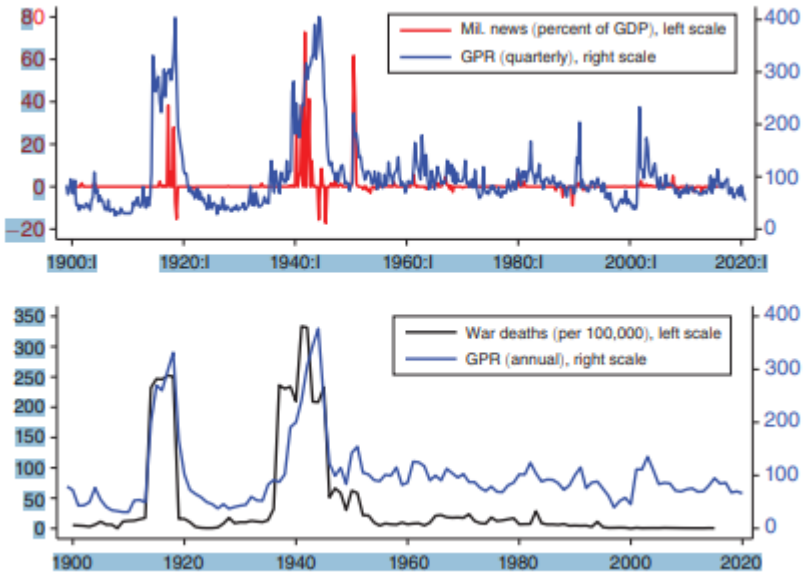


FIGURE 7. COMPARISONS WITH MILITARY SPENDING NEWS AND WAR DEATHS

Figure8 : Comparison with financial and economic uncertainty measures

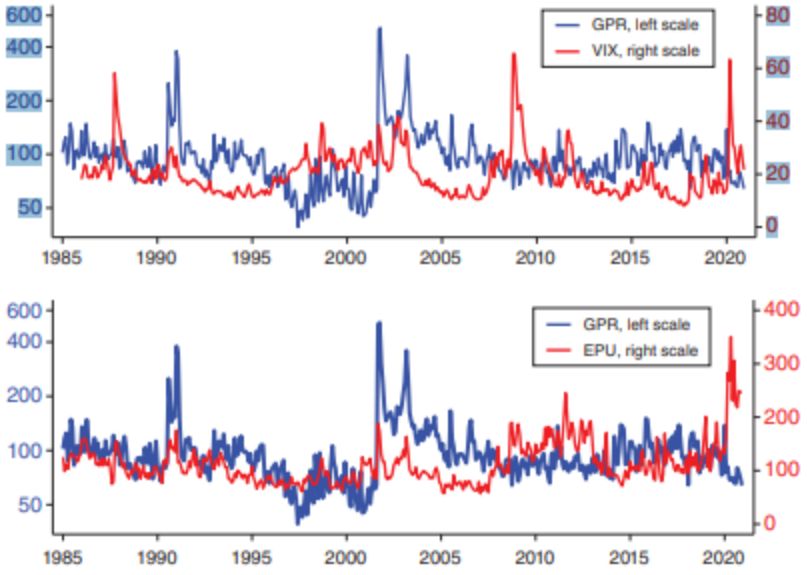
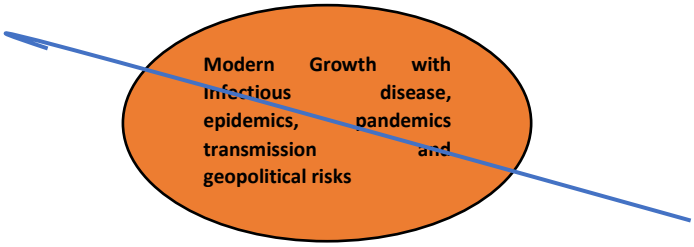


FIGURE 8. COMPARISON WITH FINANCIAL AND ECONOMIC UNCERTAINTY MEASURES

Figure8 compares the GPR index with financial volatility (VIX) as measured by the Chicago board options exchange's volatility index with economic policy uncertainty index (EPU) constructed by Baker, Bloom and Davis (2016). We present now table1 where are highlited the query for the GPR index and after we display an another figure which studies the impact of the increased geopolitic risk, the way macroeconomic variables are affected through shocks that capture threats. In panelA of table1, the contribution to the index is the percent of articles in each category satisfying the condition for inclusion in the GPR index, as a share of all articles satisfying that condition. In panelB the truncation character « * » denotes a search including all possible endings of a world i.e threatening. Table2 lists the largest shocks to the GPR index and its components in the 1900-2019 sample. For this tables, the shocks are constructed as the residuals of a regression of the level of the relevant monthly index against its first three lags. Consequently, the research question addressed by this article is to bring a novel view of the process of economic development where it means no more a process but something composed of several aspects such a geopolitical tensions in the globalized economy added with infectious disease, pandemic and climate change in order to clarify what means population, technological change and output interactions for long-run sustainable growth to settle again. Indeed, currently, the process of economic development looks like figure9 below. Economic development is a block of negative outcomes and no more a process endowed of a movement

Figure9 : the Extended Modern economic growth i.e under gropolitical tensions, infectious disease, pandemic and climate change



The 3rd regime called modern growth includes geopolitical tensions, infectious disease and pandemic which travel around the world, the whole under climate change action as displays by figure9 just above.

Modern growth is in the literature, the regime where settled high technological change with positive effect that yields economic globalization i.e market based economy transition of the poorest countries toward liberal economics. Economies in transition before are actually, facing the disillusion of negative aspects of technological change when too high, thus raise reflections on the desire to acquire that levels, which unfortunatly is, the whole world new deal. Since nuclear bombs able to eliminate the whole world can be used, then the economic process is entering inside the possible 3rd world war where among the other extreme regimes, exist the pandemics since the years 1980s i.e hiv/aids and corona virus, spread all over the whole world through connections added to geopoloitic threats and the scarcity consequences because of the non possibility of the trade comparative advantage to fully play like before. The past world instability and debate are thus, back in the whole world with negative shocks because of democracy non respect and non capitalism settlement everywhere yet and creates several crisis i.e pandemic, scarcity and the

third war risk. The world is non sustainaible and democracy is not unified all over the world in politics.

Therefore, the aim of this article is to raise discussions on how to re-establish the inverted U-shape curve for liberal economy to hold i.e democracy and capitalism. However, the keys both for growth sustainability and pandemic absence is the finding of the threshold ensuring the world stability without violence and attacks of other countries for the pandemic not to spread more. Thus, we are looking for a kind of synthesis of the three new regimes in one as a synthesis of the components evocated above.

The following table1 shows answers to questions and measurements of geopolitical risks

Table1 : Search Query for the GPR Index

TABLE 1—SEARCH QUERY FOR THE GPR INDEX

Category	Search query	Peak (month)	Contribution to index percent: Full sample	1900–1959	1960–2019
Panel A. Search categories and search queries					
Threats					
1. War threats	War_words N/2 Threat_words	Germany invades Czech. (September 1938)	13.5	17.9	9.2
2. Peace threats	Peace_words N/2 Peace_disruption_words	Iran crisis of 1946 (April 1946)	3.5	4.3	2.7
3. Military buildup	Military_words AND buildup_words	Cuban Missile Crisis (October 1962)	23.5	21.3	25.8
4. Nuclear threats	Nuclear_bigrams AND Threat_words	Nuclear ban negotiations (August 1963)	10.1	4.2	16.0
5. Terrorist threats	Terrorism_words N/2 Threat_words	9/11 (October 2001)	2.7	0.3	5.0
Acts					
6. Beginning of war	War_words N/2 War_begin_words	WWII begins (September 1939)	18.8	26.8	10.7
7. Escalation of war	Actors_words N/2 Actors_fight_words	D-Day (June 1944)	19.6	23.9	15.3
8. Terrorist acts	Terrorism_words N/2 Terrorism_act_words	9/11 (September 2001)	8.3	1.3	15.2

Panel B. Search words Topic sets	Phrases
War_words	**war OR conflict** OR hostilities OR revolution* OR insurrection OR uprising OR revolt OR coup OR geopolitical
Peace_words	**peace** OR truce OR armistice OR treaty OR parley
Military_words	**military OR troops** OR missile* OR "arms" OR weapon* OR bomb* OR warhead*
Nuclear_bigrams	**"nuclear war*"** OR "atomic war*" OR "nuclear missile*" OR "nuclear bomb*" **OR** "atomic bomb*" OR "h-bomb*" OR "hydrogen bomb*" OR "nuclear test" OR "nuclear weapon*"
Terrorism_words	**terror*** OR guerrilla* OR hostage*
Actor_words	**allie* OR enem* OR insurgen*** OR foe* OR army OR navy OR aerial OR troops OR rebels

Threat/act sets	Phrases
Threat_words	**threat* OR warn* OR fear* OR risk* OR concern*** OR danger* OR doubt* OR crisis OR troubl* OR disput* OR tension* OR imminen* OR inevitable OR footing OR menace* OR brink OR scare OR peril*
Peace_disruption_words	**threat*** OR menace* OR reject* OR peril* OR boycott* OR disrupt*
Buildup_words	**buildup* OR build-up* OR sanction*** OR blockad* OR embargo OR quarantine OR ultimatum OR mobiliz*
War_begin_words	**begin* OR start* OR declar*** OR begun OR began OR outbreak OR "broke out" OR breakout OR proclamation OR launch*
Actor_fight_words	**advance* OR attack* OR strike*** OR drive* OR shell* OR offensive OR invasion OR invad* OR clash* OR raid* OR launch*
Terrorism_act_words	**attack** OR act OR bomb* OR kill* OR strike* OR hijack*

Panel C. Excluded words	
Exclusion words	movie* OR film* OR museum* OR anniversar* OR obituar* OR memorial* OR arts

Source : the GPR index built in 1900

The following table2 classifies countries' risks in geopolitical aspect since 1900 (geopolitical events

TABLE 2—LARGEST GEOPOLITICAL SHOCKS SINCE 1900

Month	Rank	GPR	Shock	Event
Panel A. Shocks to the GPR index				
1914:4	15	145.2	84.5	Occupation of Vera Cruz
1914:8	1	472.3	341.5	WWI begins
1916:6	14	318.3	93.2	WWI escalation
1917:2	6	350.2	141.9	US severs Germany relations
1938:9	11	210.7	109.9	Germany occupies Czechia
1939:9	2	484.2	318.6	WWII begins
1941:12	3	447.5	245.7	Pearl Harbor
1944:6	12	473.2	107.9	D-Day
1950:7	5	242.4	143.5	Korean War
1962:10	8	228.1	121.2	Cuban Missile Crisis
1973:10	13	161.1	94.3	Yom Kippur War
1990:8	9	191.9	115.5	Iraq invades Kuwait
1991:1	7	250.4	126.4	Gulf War
2001:9	4	289.9	238.2	9/11
2003:3	10	244.6	110.2	Iraq War
Month	Rank	GPR threats	Shock	Event
Panel B. Shocks to the threats component of the GPR index				
1914:8	1	432.6	279.2	WWI begins
1938:9	5	316.1	217.1	Germany occupies Czechia
1939:9	2	480.0	246.8	WWII begins
1962:10	3	376.6	234.0	Cuban Missile Crisis
1990:8	4	314.1	225.7	Iraq invades Kuwait
Month	Rank	GPR acts	Shock	Event
Panel C. Shocks to the acts component of the GPR index				
1914:8	2	571.5	456.9	WWI begins
1939:9	1	560.0	463.0	WWII begins
1941:12	4	665.7	391.5	Pearl Harbor
1991:1	5	273.1	196.9	Gulf War
2001:9	3	457.5	403.4	9/11

Notes: The table lists the largest shocks to the GPR index (and its components) in the 1900–2019 sample. For this table, the shocks are constructed as the residuals of a regression of the level of the relevant monthly index against its first three lags.

Table3 below presents geopolitical risks and economic disasters

TABLE 3—GEOPOLITICAL RISK AND ECONOMIC DISASTERS

	Disaster (1)	Disaster (2)	Disaster (3)	Disaster (4)	Disaster (5)	Onset (6)	Ending (7)
GDP growth *t*-1	−0.0071	−0.0062	−0.0056	−0.0065	−0.0056	−0.0009	0.0012
	(0.0030)	(0.0030)	(0.0030)	(0.0032)	(0.0026)	(0.0010)	(0.0010)
GPR	0.1753	0.1144	0.0337		0.1001	0.0180	−0.0175
	(0.0223)	(0.0241)	(0.0469)		(0.0236)	(0.0237)	(0.0094)
Country GPR		0.0940	0.0842		0.0794	0.0664	−0.0090
		(0.0160)	(0.0170)		(0.0175)	(0.0295)	(0.0105)
Dummy WWI/WWII			0.3328				
			(0.1761)				
GPR spikes				0.1692			
				(0.0246)			
Country GPR spikes				0.0821			
				(0.0122)			
Dummy pre-1946					0.2437		
					(0.0490)		
Dummy 1946–1972					0.1152		
					(0.0467)		
Constant	0.2309	0.2289	0.1947	0.1762	0.1112	0.0401	0.1180
	(0.0252)	(0.0273)	(0.0341)	(0.0302)	(0.0320)	(0.0185)	(0.0130)
Observations	3,056	3,056	3,056	3,056	3,056	2,447	609
R^2	0.20	0.20	0.21	0.18	0.26	0.13	0.02
Countries	26	26	26	26	26	26	26
Country fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes

In the following, we present an OLG discrete time model of the world crisis in section2 inside which, are highlighted all the components of the new modern growth theory as stipulated in the presentation of the dilemma done above. Section3 displays preliminary discussion on that can be noticed. Section4 highlights results, specifically how to raise the balanced growth path i.e how to locate the steady state in the globalized world. Section5 studies the dynamical system of the extended modern growth theory built, then the conclusion is provided in section6.

THE EXTENDED MODERN GROWTH THEORY

The Geopolitical Risk, The Pandemic, Infectious Disease and Climate Change

Modern growth is described by the geopolitical risk able to yield to a disaster, $D_{i,t}$ which is composed of the variables, *NB* i.e nuclear bombs existence, the *GDP* or the wealth of the nation and the *PVC* which gathered pandemic, infectious disease and climate reheating where growth is measured by the *GDP*, the country is indexed by $i\epsilon\mathbb{N}$ and the whole is written such as a Cobb-Douglas function i.e

$$D_{i,t} = A_{t,i}(NB_t)^{\alpha i}(PVC_t)^{\beta i}(GDP_t)^{\mu i} \quad (1)$$

Where, $\alpha i+\beta i+\mu i=1$ and A_{it} is technological change at time, t for a given country indexed by $i\epsilon\mathbb{N}$. When technological change is high, then its rate, $g_{ti}=(A_{t+1i}-A_{ti})/A_{ti}$ of country, i, at time, t is also high and can reach very high level specifically, when the country is able to produce nuclear bombs, then the growth rate converges toward 1. Otherwise it fluctuates between 0 and less than 1. Each country's geopolitical risk exposition can be expressed by

$$D_{it}/GDP_t = d_{it} = A_{it}(nb_t)^{\alpha i}(pvc_t)^{\beta i} \quad (2)$$

Where, $nb_t = NB_t/GDP_t$ and $pvc_t=PVC_t/GDP_t$ are the normalized variables per-country

Equation (2) effects depends on his neighborhoods i.e his geographical location. Since it is a function defined on a convex compact set, d_{it} is includes inside a ball due to the fact that it admits neighborhoods expressed by the set, U. According to the topological theory, there exist an other set, V including the set, U such that, $U\cap V$ is non empty, meaning that, labor mobilty as well as pandemic can move from one country to the other since exist among them both open sets, thus also in touch with other abroad countries. Restricting the theory to two countries, then assuming a sequences of geopolitical risks $\{d_{it}\}_i$ departures from country i to country, j at time, t such that it admits a limit, d_i* then, the outcomes depend on the power degree of the

geopolitical risk such that, it it is strong enough, then it yields pandemic spreads due to population threat and mobility abroad or to more peaceful places in or outside the country. Otherwise, if political tensions created by *i* on *j* are too strong, such that the country, *j* can't resist to d_i* power, then many issues are open such that assylium seekers existence, economics and humanity disasters and the country converges to the Malthusian trap viewed in the literature caused by scarcity in a general way and death occurrences consequences, sustainability is ruled-out. Modern growth described earlier is extended and includes negative shocks. The economy is in recession and may go back to the Post Malthusian regime and may be kept by the Malthusian trap. Generalizing the problem to *M* countries, several things may happen depending on the world economic context. In the case of globalization, scarcity generalization caused by geopolitical risks and threats, transmission of pandemic as well as diseases, then the world economy face both the Malthusian and the Post Malthusian regimes depending to the place tensions' degrees hold, development becomes a puzzle and no more a process. If there is not a positive cooperation among different countries groups, then the third war can emerge making the rest of the countries be involved and then, at least, *M+1* countries are in war with several views i.e some shares the same thought and some others not. According to the history, the end of the war depends on the elimination of the dominator if made weak enough through partnerships, then the war can cease since diplomacy fail to re-establish the optimality of the well-being function.

The Production

In order to establish a separation among two countries, it must exist at least one variable, $z_{ij}=(x_i, y_j)$ which doesn't belong to them such that, by the separating hyperplan theorem, the both countries *i* and *j* can be separated by a generalized linear function also called an hyperplan, Δ_H^{ij} such that, $\Delta_H^{ij}=\Sigma_{i\geq 0}\Sigma_{j\geq 0}(x_i y_j)$

Production measured by *GDP* is the output obtained through the use of physical capital stock, K_{ti}, human capital, H_{it} and simple labor, L_{it} expressed such that

$Y_{i,t} = (K_{ti})^{\alpha i}(B_{ti}H_{ti})^{bi}(L_t)^{di}$ *where* $ai+bi+di=1$ (3)

Where, B_{it} is the technology used to enhance human capital productivity in the production sector acting such that, if the products or the ouput are high-tech, then the country is developed, otherwise it is not and may not have achieved its development frontier yet, depending on the distance with the globalized market. Exchanges among countries hold through international trade and both infectious disease and pandemics travel from one place to another. In contrast, climate change acts all over the world naturally not the pandemic on which controls are possibles and then per-efficiency production function is expressed by equation (4) i.e

$y_{it}=(k_{ti})^{\alpha i}(h_{ti})^{bi}$ (4)

Where $y_{it}=Y_{it}/L_{it}$, $k_{ti}=K_t/L_t$ and $h_{ti}=B_{ti}H_t/L_t$

There exist a threshold, y^* where $y<y^*$ means that, the country's technological change is not high enough to make them produce a nuclear bomb, otherwise, if $y>y^*$ then, the country produce bombs and can raise geopolitical threats to other world countries according to some ambitions it has.

Let the whole world be symbolized by, $\Omega=(w_1 , w_2 , \ldots w_N ,..)$, then lauching a bomb from somewhere, yields a risk for the sequences of countries inhabitants to converge toward nobody left i.e $\{w_i\}_{i\geq 0} \rightarrow w\approx 0$ called the malthusian regime

Optimization of the production function yields the wage rate income of the skilled, w_{ti}^H ,the unskilled wage rate income, w_{ti}^L and the interest rate, R_{ti} such that,

$w_{ti}^H = biq_{ti}^{bi-1}p_{ti}^{di}$

$w_{ti}^L = diq_{ti}^{bi}p_{ti}^{bi}$

$R_{ti} = aiq_{ti}^{bi}p_{ti}^{di}$

Where, $q_{ti}=(B_{ti}H_{ti})/K_{ti}$ is per-capita quality (engineers) and $p_{ti}=L_{ti}/K_{ti}$ is per-capita quantity (routine tasks)

The Utility Optimization

In an overlapping generation world where the agent live over an infinite discrete time, the preferences of members of generation *t* in country *i* are defined such that

$u^{ti}=(c_{ti})^{\delta}(\tau^{H}e_{t+1i}m_{ti}w_{ti}{}^{H})^{\gamma}(\tau^{L}m_{ti}w_{ti}{}^{L})^{1-\delta-\gamma}\}$ (5)

Where c_{ti} is intertemporal consumption

Population grows at a rate, $m_{ti}=m_{ti}{}^{H}+m_{ti}{}^{L}$ and each agent give birth to children (where in conformity to the literature, we assume, $m_{ti}{}^{H}<m_{ti}{}^{L}$ and uses his income both on consumption and children rearing, where we assume the unskilled to expend for quantity, τ^{L} and the skilled on quality, τ^{H} and education, e_{t+1i} thus their respective intertemporel budget constraints are expressed such that,

$$w_{ti}{}^{H}q_{ti}\tau^{H}m_{ti}{}^{H}\,e_{t+1i}+c_{ti}\leq w_{ti}{}^{H}q_{ti}$$

and

$$w_{ti}{}^{L}p_{ti}\tau^{L}m_{ti}{}^{L}+c_{ti}\leq w_{ti}{}^{L}p_{ti}$$

Where e_{t+1i} is education, then, the optimization problem can be written such that

$$Max\{\ u^{ti}=(c_{ti})^{\delta}(\tau^{H}e_{t+1i}m_{ti}{}^{H}\,w_{ti}{}^{H})^{\gamma}(\tau^{L}m_{ti}{}^{L}\,w_{ti}{}^{L})^{1-\delta-\gamma}\ \}$$

Subject to

$$w_{ti}{}^{H}q_{ti}\tau^{H}m_{ti}{}^{H}\,e_{t+1i}+c_{ti}\leq w_{ti}{}^{H}q_{ti}$$

$$w_{ti}{}^{L}p_{ti}\tau^{L}m_{ti}{}^{L}+c_{ti}\leq w_{ti}{}^{L}p_{ti}$$

$$m_{ti}\geq 0 \text{ and } e_{t+1}\geq 0$$

Utility optimization yields,

$e_{t+1}{}^{*}=q_{t}/w_{t}{}^{H}\tau^{H}$ (6)

$m_{t}{}^{L}{}^{*}=(1-\delta-\gamma/\lambda_{2})^{1/\gamma+\delta}[(c_{t}\tau^{H}q_{t})^{\gamma/\gamma+\delta}]/\tau^{L}w_{t}{}^{L}(p_{t})^{1/\gamma+\delta}$ (7)

THE PRELIMINARY DISCUSSIONS

Recalling that, geopolitical tensions is composed of innovations negative effects in use, as well as pandemics coupled with infectious disease and climate change, expressed by equation (2) i.e $d_{it}=A_{it}(nb_{t})^{\alpha i}(pvc_{t})^{\beta i}$

Where are included nuclear bombs, $(nb)_{t}$ and pandemic as well as infectious travelling diseases and climate change viewed also everywhere in the whole world, $(pvc)_{t}$ the first component is caused by high technological change, a by product of education, e_{t+1} and sustainability absence yields deaths, assylium seekers,

scarcity as well as geopolitical tensions impact on the population, since the attacked countries' population is moving for some other places. Sustainabity absence is also expressed by both soil and air degradation, as well as deaths caused by military attacks or by disease, thus yield to economic regression. This aspect joins the Malthusian trap, whereas, partners outside of the conflicts also suffer from scarcity in agriculture or food and raw materials used as intermediary inputs. Then exist also some other countries which face the post Malthusian problem at the same time. We need to look at the lives preservations or sustainable growth expressed by the inverted U-shape curve due to Kuznets (1957) first in environmental economy and be careful that, innovations provided by high-tech efficiency of the R&D be used in good actions for the post malthusian trap, to join modern growth which is no more restricted because it is composed of others negative components listed above, then the world economy will be good and expect the Ricardo law of comparative advantage in trade to play and leave emerge the balanced growth path all over the world economy where only the unicity will then be looked for and establish Pareto optimality since the policy is more profitable than decentalized equilibrium.

Definition1 : the economy is characterized by, $(d_{it}, e_{t+1}, m_{it}^{L}, A_{it})$ i.e of geopolitical tensions, d_{it} education or human capital accumulation, e_{t+1} population, m_{it}^{L} and technology, A_{it} variables et time, t for a country indexed by i such that their expressions are given like following :
$d_{it} = A_{it}\,(nb_t)^{\alpha i}\,(pvc_t)^{\beta i}$ expresses the economic disaster
$e_{t+1}^{*} = q_t / w_t^{H} \tau^{H}$ expresses education or human capital accumulation at high level endowed by educated agents and their children
$m_t^{L*} = ((1-\delta-\gamma)p_t / \lambda_2)^{1/\gamma+\delta}[(c_t \tau^{H} q_t)^{\gamma/\gamma+\delta}]/\tau^{L} w_t^{L}$ expresses population size without elites i.e the quantity i.e agents working on routine tasks which represents the higher part of the population
$A_{it} = \mathbb{\Gamma}(g_{it}, e_{it+1})$ is knowledge function which is convex in its growth rate, g_{it} i.e knowledge and concave in

human capital accumulation, e_{it+1} . Innovations emerge according to those three elements i.e techology depends on the growth rate measured by the GDP and human capital measured by the years of scolarisation (Lucas, 1988)

Indeed, since definition1 yields, $d_{it}=A_{it}\Gamma(g_{it}\ , q_t/w_t^H\tau^H)(nb_t)^{\alpha i}(pvc_t\ )^{\beta i}$ then the average per-capita disasters yield, $d_{it}/m_{ti}^L=d_t=A_{it}\Gamma(g_{it}\ , q_t/w_t^H\tau^H)(nb_t)^{\alpha i}(pvc_t\ )^{\beta i}$ is that what we call now « the extended modern growth theory »

THE RESULTS

Proposition1 : *the general equilibrium, (e* , m*) exist*
Proof : innovations provided by technological change is expected to occur between two periods of the agents' lives since it results from a decline in the number of children, m_{ti}^L and an increase in their quality, e_{t+1i} in the literature, therefore, since, the first is strictly convex set and the second is strictly concave set, the general equilibrium, (e^* ,m^*) exist, as a limit of the sequences of variables, $\{e_{t+1i}\ , m_{ti}^L\}_{t\geq 0, i>0}$. Following Galor and Weil (2000), there exist expenditures for children, θ^L for the unskilled labor children and, θ^H for the skilled children, then we have, $\theta^L+\theta^H e_{t+1i}$ that yields, $\theta^L m_{ti}^L+\theta^H m_t^H e_{t+1i}$ which belongs in a compact set such that, there exist a linear function f i.e, $f(\theta^L m_{ti}^L+\theta^H m_t^H e_{t+1i})=f(\theta^L m_{ti}^L)+f(\theta^H m_t^H e_{t+1i})$ and since the variables inside are independent, derivating the function yields, to the existence of a sequences, $\{e_{t+1i}\ , m_{ti}^L\}_{t\geq 0, i>0}$ if the countries are taken together, indeed, the sequences admits a limit, (e^* ,m^*) where, e^* and m^* are the average values of the whole countries

Lemma1 : *according to proposition1, if per-country equilibrium in tensions, $\{d_{it}/m_{ti}^L\}_{t\geq 0, i>0}$ converge to the average level, d* then, the equilibrium is expressed by, (e*; m*, d*)*

Proof : given, $d_{ti}=A_{it}\Gamma(g_{it}\ , q_t/w_t^H\tau^H)(nb_t)^{\alpha i}(pvc_t)^{\beta i}$ due to no nuclear bomb launch risk, then, both pandemics

and infectious diseases increase. Otherwise, they converge to a stable equilibrium i.e remain constant whereas, climate reheating degradations are properly corrected, therefore, $d_{ti}=A_{it}\mathbb{\Gamma}(g_{it}\ ,\ q_t/w_t^H\tau^H)(nb_t)^{\alpha i}(pvc_t)^{\beta i}=A_{it}\ \mathbb{\Gamma}(g_{it}\ ,\ q_t/w_t^H\tau^H)\rightarrow d^*$ which is a locus where (e^*,m^*) are reached, then the equilibrium is expressed by, (e^*,m^*,d^*)

Assumption1 : *the disaster is both a linear function, $d(e,m)=d(e)+d(m)$ that can spread all over the whole world countries or if it stays in only one sigle country, then it is a fixed point i.e $d(e)=e$ and $d(m)=m$*

Lemma2 : *according to lemma1, the extended equilibrium is locally stable*

Proof : human capital and knowledge are the essential components of the economic growth, thus can be assimilated with modern growth evocated in the literature. Indeed, the disaster can be minimized if $\partial d_{ti}/\partial e_{t+1i}<0,\ \partial {d_{ti}}^2/\partial^2 e_{t+1i}>0,$ meaning that, a minimum exist and it is a fixed point, since, $d^*(e^*)=e^*$ exist through diplomatic negociation and knowledge in general and can is reached by some countries and not by some others. Similarly, lives can be preserved if $\partial d_{ti}/\partial m_i^*>0,\ \partial {d_{ti}}^2/\partial^2 m_i^*<0,$ meaning that, a maximum exist and is a fixed point, $d(m^*)=m^*$ thus can also be reached by some other existing countries in the world. Therefore, in absence of disaster, the multiple equilibria sequences, $\{e_i,m_i\}_{t\geq 0}\rightarrow\{e^*,m^*\}$ such that, d be a linear function i.e the transposition of the disaster problem yields, $d^i\{e_i,m_i\}_{t\geq 0,i>0}\rightarrow d\{e^*,m^*\}=d(e^*)+d(m^*)$ and since, $d^i\{e_i,m_i\}_{t\geq 0})_{i>0}=(d^i\{e_i,\}+(d^i\{m_i\})_{t\geq 0,i>0}$ is a linear sequences, then $d^i\{e_i,\}\cap d^i\{m_i\}_{t\geq 0}\neq\emptyset$ is a linear sequences, thus, the equilibrium is locally stable. Extending the assertion to the whole world, we have, $d(e^*)\cap d(m^*)\neq\emptyset$ is equivalent to $(e^*+m^*)\neq\emptyset$ at the limit, then, the general equilibrium, (d^*,e^*,m^*) is globally stable.

Assumption2 : there exist a world threshold, d^* such that,
If geopolitical tensions, $d_t < d^*$, the economy is located inside the modern growth regime, since the globalized economy is without conflicts but still pandemics and infectious disease only to work on. Otherwise,
If $d_t \geq d^*$ then, the economy is located at the post-malthusian regime there are threats in the world countries about both finance, economy, sustainable growth and uncertainty such that, there exists countries in that situation. Finally,
If $d_t \approx d^* = Max\{d_{ti}\}_{t\geq 0, i>0}$ then, nuclear bombs have been already launched to some places located on earth so that, the death sequences converges toward its maximum, the economy is kept in the malthusian trap

Definition2 : the equilibrium sequences defined by the vector, $(d_{ti}, e_{ti}, m_{ti}^{L}, A_{ti})_{t\geq 0, i>0}$ reaches its steady state when all the variables grow at the same constant rate, g_i on the space at any time, such that,
$d_{t+1i}/d_{ti} = e_{t+1i}/e_{ti} = m_{t+1i}^{L}/m_{ti}^{L} = A_{it+1}/A_{it} = g_i$
Where g_i is the average extended modern growth rate of a given country

Proposition3 : by definition2, the above sequences vector converges to the unique equilibrium, (d^*, e^*, m^*, A^*)
Proof : taking two countries neighborhood i.e x is the neighborhood of i then, *first,* there exist an open set, U such that, the ball, $B(i, x_i) \subset U \subset R$ then, there exist another set, $V \subset R$ of country, j which possess a neighborhood, x_j such that, $B(j, x_j) \subset V$. Therefore, if the geopolitical tension is high such that, country j, is the stronger, then, j attack i and it yields, $U \rightarrow V$ and without intervention, we may have, an equivlency among them such that, $U \approx V$ is the unification which yields to negative results such that, disease spread, deaths, assylum seekers emergence and economic regression. *Second,* if the non agressor country, i keeps stronger and have strongest partners than he is, then tension increases such that, nuclear bomb

seems to be a solution to the eradication of the problem of invasion of the weaker country. If the nuclear bomb is used because partners are willing to help and are also stronger, then there is disaster spread and conflicts increase. If nuclear bomb is used whatever by whom, it extended the conflicts to other countries and worsen the situation such that, death converge toward the highest level also caused by high speed of the pandemic spread. The economic disaster, yields deaths and human disapearance at a great scale i.e inside the set *R* symbolizing the whole world, then the equilibrium can't exist. *Third*, if solution is found without conflicts and tensions, then the multiple equilibria sequences, admits a limit which because of the compacity of the set in which belong the countries, the limit is globally stable i.e unique

THE DYNAMICAL SYSTEM

According to equations (2), (6) and (7) as well as the hypothesis of the growth rate given by knowledge, the dynamical system of the extended modern growth moves such that

$$d_{t+1i}=A_{it}(nb_t)^{\alpha i}(pvc_t)^{\beta i}\, d_{ti}$$

$$e_{t+1i}=(q_t/w_t^H\tau^H)e_t$$

$$m_{t+1i}^L=((1-\delta-\gamma)p_t/\lambda_2)^{1/\gamma+\delta}[(c_t\tau^H q_t)^{\gamma/\gamma+\delta}]/\tau^L w_t^L)m_t^L$$

$$A_{it+1}/A_{it}=g\{(e_{t+1i}-e_{ti})/e_{ti}\}$$

Where d_{i0} , e_{i0} , m_{i0}^L , A_{i0} are historically given

Since the extended modern growth theory is characterized by geopolitical tensions risk, knowledge or education and population grow in such a way that, technological change depends on knowledge, according to the literature of economic growth, then it can be find multiple equilibria corresponding to the sequences variables which belong to each country or countries' groups in the world.

Proposition4 : the equilibrium in geopolitical risk and growth sustainability, (g_A^*, g^{e*}) exist and is stable

Proof : the above equations system can be written such that,
$(d_{t+1i}/d_{ti})/(e_{t+1i}/e_{ti})=(w_t{}^H \tau^H/q_t)A_{it}(nb_t)^{\alpha i}(pvc_t)^{\beta i}=g_A$
Using the first and the second equations of the system yields geopolitical disaster risk. In conrast, growth sustainability expresses such that,
$[(A_{it+1}-A_{it})/(e_{t+1i}-e_{ti}/e_{ti})](m_{t+1}{}^L/m_{t+1}{}^L)$
$=[\tau_t w_t{}^L/(c_t \tau^H q_t)^{\gamma/\gamma+\delta}]((1-\delta-\gamma)p_t/\lambda_2)^{1/\gamma+\delta}=g^e$ emerges

Proposition5 : the sequences of the world globalized equilibria's sequences limits, $\{g^*_i\}_{i>0}$ converge toward a general equilibrium without geopolitical tensions and disease free, g^* such that, $\{g_i^*\}_{i>0} \rightarrow g^*=(1/2)(g_A^*+g^{e*})$ or the modern growth
Proof : according to proposition4, the large number law, yields to the existence of the middle of the two growth rates serial, $g^*=(1/2)(g_A^*+g^{e*})$ which is a limit of the growth rates sequences, $\{g_i^*\}$ that exist in each country such that, $g_i^*=(1/2)(g_{Ai}^*+g^{ei*})$

CONCLUSION

This article aim was the modelling of the current geopolitical tension associated with pandemics, infectious disease and climate change which together make the whole world economy regresses and rules-out sustainable growth expressed by the inverted U-shape in the literature of growth applied to environment. The target of the article was not to provide results through the conduction of a reflection on the current danger faced by the whole world after having proved the positive effects of modern growth as well as time taken and affords done to achieve modern growth which is facing troubles so that it legitimates this article in asking innovations, yes, but what for ?

REFERENCES

Bloom, D., Kuhn, M. and Prettner, K, 2022, Modern Infectious Disease, Macroeconomic Impacts and Policy Responses, *Journal of Economic Literature,* 60 (1), 85-131

Caldara, D. and Iacoviello, M., 2022, Measuring Geopolitic Risk, *American Economic Review*, 112(4), 1194-1225

Galor, O. and Weil, D., 2000, Population, Technology and Growth, from the Malthusan Stagnation to the Demographic Transition and Beyond, *American Economic Review,* 90 (4), 86-164

Loubaki, D. , 2013, HIV/ AIDS in Pregnancy Process and Endogenous life Fluctuation in Least Developed Economics, *International Journal of Economic and Development Sustainability,* 1, 52-70

Loubaki, D. , 2013, HIV/ AIDS and Transmission Risk from Mother to Child during the Pregnancy Process in SSA, *Applied Mathematics Journal*, 3(4), 132-145

Loubaki, D., 2020, Corona Virus and Economic Growth, *Journal of Multidisciplinary Engineering Science and Technology,* 7 (9), 12676-12681

Loubaki, D., 2021, The Covid-19 Pandemic and Stochastic Growth, Implications for Developed, Developing and Emerging Economies, *European Scientific Journal*, 17 (21), 204-238

Loubaki, D., 2012, On the Brain Drain Reduction in Poorest Developing Countries, *Journal of Economic Development,* 37 (3), 71-101