Sustainability thoughts 127: Pareto optimality under the sustainability eye: Is the traditional pareto efficient bundle the second most undesirable bundle on the pareto optimality sustainability line? If yes, why?

Lucio Muñoz*

* Independent qualitative comparative researcher/consultant, Vancouver, BC, Canada.

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Abstract: It can be said that sustainability is positively related to cost internalization, the more cost internalization the higher the level of sustainability. On the other hand, it can be said that cost externalization is negatively related to market responsibility, the more cost externalization the higher the level of market irresponsibility. We know that sustainability is positively related to market responsibility, the more responsible the market, the higher the level of sustainability. And we know that cost externalization is positively related to pareto optimality as the existence of costs that can be externalized create pareto improvements dynamics across markets that stop only when there is no more cost to externalize leading to the lowest price possible that clears that market at the pareto optimal point at that market. As cost externalization is negatively related to market responsibility and therefore, to sustainability, then sustainability trends are negatively related to pareto optimality trends. Hence there is a link point by point between the sustainability line and the pareto optimality line that can be expressed in terms of increasing cost externalization and in terms of increasing cost internalization, leading to model distortion and expansion and to model correction and contraction, respectively. In other words, under the sustainability eye different pareto optimal points are linked to specific levels of sustainability; and these levels of sustainability could change depending on the direction of cost externalization or cost internalization from being fully responsible pareto points to being fully irresponsible ones. And this raises interesting questions such as how cost externalization affects pareto optimality points across markets? How cost internalization affects pareto optimality points across markets? How the pareto optimality sustainability line across markets looks like when externalizing costs and when internalizing costs? Is the traditional pareto efficient bundle the second most undesirable bundle on the pareto optimality sustainability line? If yes, why? The goal of this paper is to provide answers to the questions indicated above.

Keywords: Sustainability, cost internalization, market responsibility, cost externalization, pareto optimality, production frontier, social indifference curve, market price line. pareto improvement, pareto optimal sustainability line

Introduction

a) The sustainability line

It can be said that there are different levels of market sustainability possible, a situation summarized by the sustainability rightgram in Figure 1 below:

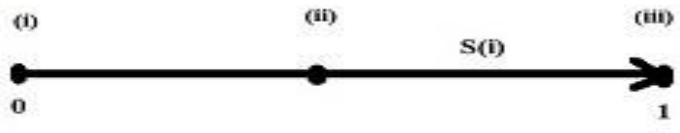

Figure 1 The sustainability line(Si)

Figure 1 above simply tells as the following about the sustainability line[S(i)]: 1) sustainability increases from left to right from no sustainability to full sustainability; and therefore, 2) at point (i) there is full unsustainability[S(i) = 0], at point (ii) there is partial sustainability[$0 \leq S(i) \leq 1$], and at point (iii) there is full sustainability[S(i) = 1]. Notice that there can be different types of partial sustainability like one component only sustainability (e.g. the traditional market) or two components only sustainability (e.g., the green market). How the nature of the sustainability line

above is linked to paradigm shift dynamics and to different levels of sustainability through the sustainability inverse gram has been recently pointed out (Muñoz 2019).

b) The sustainability and cost internalization right gram

It can be said that cost internalization is positively related to increasing sustainability as it leads to the shifting of lower level sustainability markets to higher level sustainability markets, a movement towards sustainability, a situation indicated in Figure 2 below:

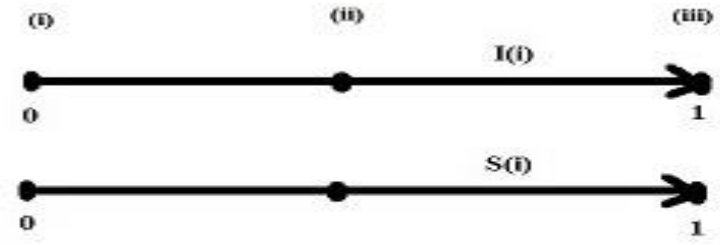

Figure 2 The sustainability and cost internalization rightgram

The sustainability [S(i)] and cost internalization[I(i)] right gram in Figure 2 above indicates the following: 1) Sustainability and cost internalization flow in the same direction linked point by point; and therefore; 2) at point (i) there is no cost internalization so there is full unsustainability, at point (ii) there is partial cost internalization so there is partial sustainability, and at point (iii) there is full cost internalization so there is full sustainability. Notice that there can be different types of partial cost internalization that leads to partial sustainability like one component only cost internalization(e.g. the red socialism market) or two components only cost internalization(e.g., the red market). It has been pointed out for example that full environmental cost internalization leads to the shift from traditional market to green markets (Muñoz 2016a)

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c) Market responsibility and cost externalization Inverse gram

It can be said also that cost externalization is negatively related to increasing market responsibility as it leads to the shifting of higher level responsibility markets to lower level responsibility markets, a movement towards unsustainability, a situation depicted in Figure 3 below:

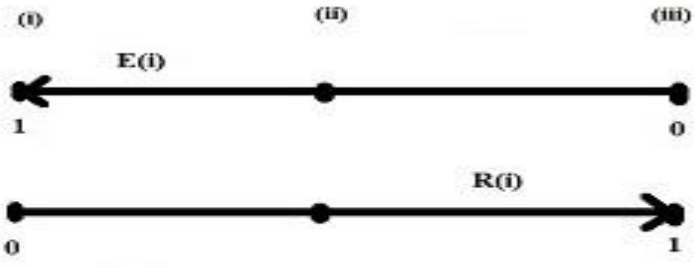

Figure 3 The market responsibility and cost externalization inversegram

The market responsibility[R(i)] and cost externalization[E(i] inverse gram in Figure 3 above indicates the following: 1) Market responsibility and cost externalization flow in the opposite direction linked point by point; and therefore; 2) at point (i) there is full cost externalization so there is full market irresponsibility, at point (ii) there is partial cost externalization so there is partial market responsibility, and at point (iii) there is no cost externalization so there is full market responsibility. See that there can be different types of partial cost externalization that lead to partial market responsibility like one component only cost externalization(e.g. the socio-environmental market) or two components only cost externalization(e.g., the environmental market). The link between development models and responsibility has been shared in detail recently (Muñoz 2016b).

d) Linking sustainability and cost externalization

As cost internalization is positively related to increasing sustainability, then cost externalization must be negatively related to increasing sustainability, a situation shown in Figure 4 below through matching the sustainability and cost internalization right gram and the market responsibility and cost externalization inverse gram point by point:

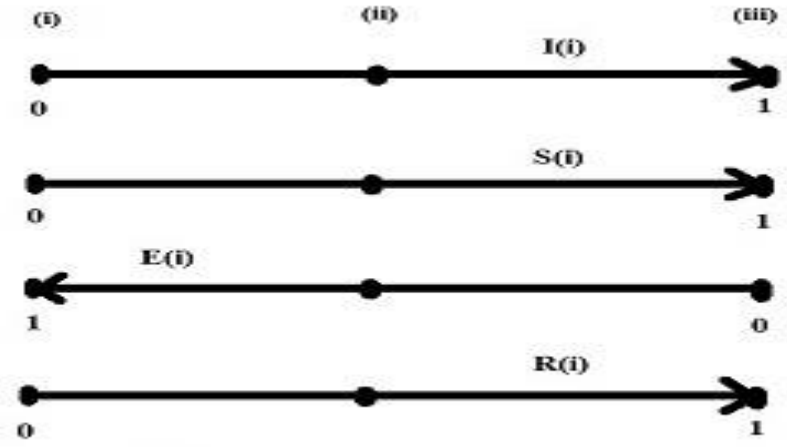

Figure 4 Linking sustainability and cost externalization

We can appreciate in Figure 4 above that increasing sustainability[S(i)] is negatively related to increasing cost externalization[E(i)]. We can extract the following relevant aspects by linking the different trends point by point: 1) at point (i) there is no cost internalization because there is full cost externalization; and therefore there is full unsustainability as there is full market irresponsibility; 2) at point (ii) there is partial cost internalization so there is partial sustainability; and therefore, there is partial cost externalization leading to partial market responsibility too; and 3) at point (iii) we have full cost internalization and no cost externalization; and therefore, we have full sustainability and full market responsibility. The structure of the perfect sustainability market that results from having no cost externalization and having full cost internalization has been recently highlighted (Muñoz 2016c).

e) Linking the sustainability line with the pareto optimality line

Cost externalization is positively related to pareto optimality trends across markets as it creates pareto improvement conditions that drives markets to other optimality points where there are no longer pareto improvement possible; and therefore, sustainability trends are negatively related to pareto optimality trends as it is negatively related to cost externalization trends, a situation that can be appreciated in Figure 5 below:

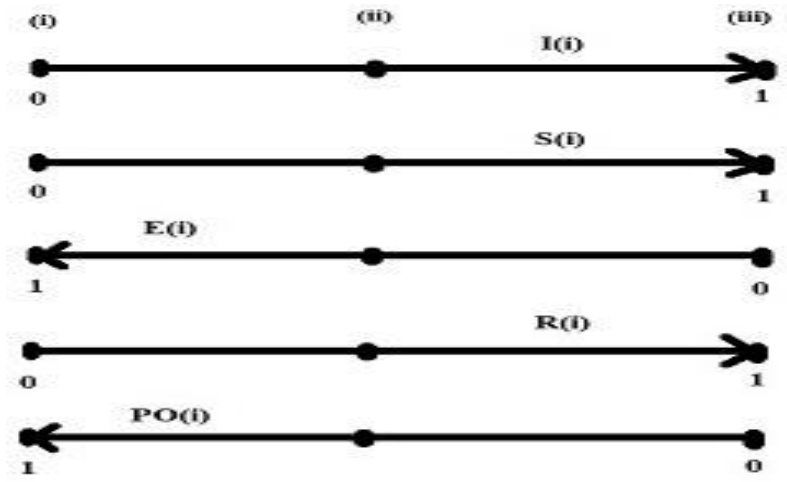

Figure 5 Linking sustainability trends and pareto optimality trends

Notice that we added a pareto optimality trend leftgram[PO(i)] at the bottom of Figure 4 to link it to sustainability trends[S(i)]; and their trends go in opposite direction as they are negatively related. We can say the following about pareto optimality in Figure 5 above: 1) at point (i) pareto optimality disintegrates into full unsustainability as full cost externalization leads to producing and consuming at no cost driving production and consumption into the ground and the market collapses; 2) at point (ii) there is partial pareto optimality or partial pareto efficiency as at that point there is partial cost externalization or partial cost internalization; and therefore, there is partial sustainability; and 3) at point (iii) there is full pareto optimality or full pareto efficiency as at that point there is no cost externalization as there is full cost internalization; and therefore, there is full sustainability.

Hence, increasing cost externalization trends lead to lower levels of optimality efficiency, and therefore, to more unsustainable production and consumption bundles. In other words, we can see in Figure 5 above that the pareto optimality trend goes from full market responsibility at point (iii) to partial market responsibility at point (ii) to full irresponsibility at point (i) as cost externalization increases. See that the traditional market based pareto optimality point is in Figure 5 above a partial pareto efficient point as it operates under partial cost externalization type II as social and environmental costs are externalized, a two components externalization model. If we look at Figure 5 from the point of view of increasing internalization, development goes from unsustainability to partial sustainability to full sustainability, a trend consistent with the idea that development is moving towards sustainability in different waves(Muñoz 2016d).

Therefore, as indicated above there is a link point by point between the sustainability line and the pareto optimality line that can be expressed in terms of increasing cost externalization and in terms of increasing cost internalization, leading to model distortion and expansion and to model correction and contraction, respectively. In other words, under the sustainability eye different pareto optimal points are linked to specific levels of sustainability; and these levels of sustainability can change depending on the direction of cost externalization trends or cost internalization trends from being fully responsible pareto points to being fully irresponsible ones.

The Brundtland Commission(WCED 1987) called for finding ways of moving away from business as usual in terms of fixing the traditional development model in order to deal with social and environmental issues related to economic activity; and the 2012 Rio +20 conference(UNCSD 2012a; UNCSD 2012b) directed us towards green market thinking to substitute traditional market thinking as the way forward to address the environmental crisis, a decision supported even before and after the conference by stakeholders now interested in pursuing a more environmentally friendly development model(UNCSD 2011; OECD 2011; UNDESA 2012; WB 2012; OECD 2012; OECD 2014; IISD and IIED 2014; OECD 2015a; OECD 2015b; UN 2015a; UN 2015b; UN 2016), and this way forward to fix the traditional market and shift it to green markets is linked to the type of pareto optimality dynamics shared in this paper as the green market is a type I cost externalization market or a type II cost internalization market that results when the traditional market is corrected to account for the environmental cost of production, yet nothing written to my knowledge about this link so far. Hence, there is a need to understand how green pareto optimality and traditional pareto optimality can be linked through sustainability thinking. And this need raises interesting questions such as how cost externalization affects pareto optimality points across markets? How cost internalization affects pareto optimality points across markets? How the pareto optimality sustainability line across markets looks like when externalizing costs and when internalizing costs? Is the traditional pareto efficient bundle the most undesirable bundle on the pareto optimality sustainability line? If yes, why? The goal of this paper is to provide answers to the questions indicated above.

Goals of this paper

1) To show that when there is full cost internalization we create a world under sustainability based pareto optimality; 2) To highlight that partially externalizing production costs leads to the collapse of the sustainability production frontier as pareto improvement conditions are created and production and consumption migrates to specific one component only or two component only pareto optimality points; 3) To stress that under full cost externalization the sustainability production frontier collapses as pareto improvement conditions are created; and then production and consumptions migrate towards full unsustainability, where over production and over consumption leads to market collapse; 4) to point out the characteristics of the pareto optimality sustainability line and its implications when it is either increasing or decreasing; and 5) to use the information above to provide answers to the questions being addressed in this article.

Methodology

a) The terminology used in this paper is introduced; b) Operational concepts, models and tables are shared; c) The structure of sustainability based pareto optimality that results from full cost internalization is highlighted; d) The structure of partial pareto optimality points created when the sustainability based production frontier collapses due to the pareto improvement situations driven by partial cost externalization type I is pointed out; e) The structure of partial pareto optimality points created when the sustainability based production frontier collapses due to the pareto improvement situations driven by partial cost externalization type II is given; f) The structure of an unsustainable pareto optimality point when the sustainability based production frontier collapses due to pareto improvement situations driven by full cost externalization is stressed; g) The nature of the pareto optimality sustainability line is discussed; h) The implications of an increasing pareto optimality sustainability line are indicated; i) The implications of a decreasing pareto optimality sustainability line are given; and j) Some food for thoughts and relevant conclusions are listed

Terminology

A = Active social component	a = Passive social component
B = Active economic component	b = Passive economic component
C = Active environmental component	c = Passive environmental component
R = Product R	Ri = Production and consumption level Ri
Q = Product Q	Qi = Production and consumption level Qi
PF = Production frontier	PFi = Production frontier "i"
PL = Price line	PLi = Price line "i"
SIC = Social indifference curve	SICi = Social indifference curve "i"
KM = Red socialism market	KMP = Red socialism market price
ENM = Environmental market	ENMP = Environmental market price
TM = Traditional market	TMP = Traditional market price
SENM = Socio-environmental market	SENMP = Socio-environmental market price
RM = Red market	RMP = Red market price
GM = Green market	GMP = Green market price
S = Sustainability market	SP = Sustainability market price
EM = Environmental margin	SM = Social margin
ECM = Economic margin	i = Profit

Operational concepts, models and tables

A) Operational concepts

1) Red socialism market, the society only market.
2) Red socialism market price, the price that reflects only the social cost of production.
3) The traditional market, the economy only market.
4) The traditional market price, the general market economic only price or the price that covers the cost of production at profit(TMP = ECM + i = P) or zero profit(TMP = ECM = P).
5) The environmental market, the environment only market.
6) The environmental market price, the price that reflects only the environmental cost of production.
7) The socio-environmental market, the society and environment only market.
8) The socio-environmental market price, the price that reflects the social and environmental costs of production.
9) The red market, the society and economy only market.
10) The red market price, the price that reflects the social and economic costs of production.
11) The green market, the economy and environment only market.
12) The green market price, the price that reflects both the economic and the environmental cost of production or the price that covers the cost of environmentally friendly production.
13) The sustainability market, the society, economy and environment market.
14) The sustainability market price, the price that reflects the social, economic, and environmental costs of

production.
15) The economic margin, to cover the economic cost of production.
16) The environmental margin, to cover the extra cost of making business environmentally friendly.
17) The social margin, to cover the extra cost of making business socially friendly.
18) Full costing, all costs are reflected in the pricing mechanism of the market.
19) Partial costing, not all costs are reflected in the pricing mechanism of the market.
20) No costing, all costs are not reflected in the pricing mechanism of the market.
21) Full responsibility, when a market uses full costing.
22) Partial responsibility, when a market uses partial costing.
23) Full irresponsibility, when a market uses no costing.
24) Cost externalization, the leaving out of the pricing mechanism of the market relevant costs associated with production.
26) Social cost externalization, the leaving out of the pricing mechanism of the market the social costs associated with production.
27) Environmental cost externalization, the leaving out of the pricing mechanism of the market the environmental costs associated with production.
28) Cost externalization assumption neutrality, the assumption that production has minimal or no cost impact on external factors to a market model.
29) Fully independent development choices, when we have individual development choices unrelated to each other or pure choices such as society only(A), economy only(B), and environment only(C). In this world only fully independent development choices exist so the set = {A, B, C}. This is the world of the Arrow Impossibility theory and theorem.
30) Partially codependent development choices, when we have mixed/paired development choices such as socio-economy(AB), socio-environment(AC), and eco-economy(BC). In this universe only codependent development choices exist so the set = {AB, AC, BC}. This is outside the normal world of the Arrow Impossibility theory and theorem.
31) Fully codependent development choices, when all development choices are mixed together such as the socio-economy-environment(ABC) model. In this paradigm only fully codependent development choices exist so the set = {ABC}. This is outside the world of the Arrow Impossibility theory and theorem.
32) Full cost externalization, all costs associated with production are not reflected in the pricing mechanism of the market.
33) Partial cost externalization, some costs associated with production are not reflected in the pricing mechanism of the market.
34) No cost externalization, all costs associated with production are reflected in the pricing mechanism of the market.
35) Full cost internalization, all costs associated with production are reflected in the pricing mechanism of the market.
36) Partial cost internalization, some costs associated with production are reflected in the pricing mechanism of the market.
37) No cost internalization, all costs associated with production are not reflected in the pricing mechanism of the market.
38) Externalities, factors assumed exogenous to a model
39) Full externality assumption, only one component is the endogenous factor in the model; the others are exogenous factors.
40) Partial externality assumption, not all factors are endogenous factors at the same time in the model.
41) No externality assumption, all factors are endogenous factors at the same time in the model.
42) Economic externality, the economic costs associated with production not reflected in the pricing mechanism of the market.
43) Social externality, the social cost associated with production not reflected in the pricing mechanism of the market.
44) Environmental externality, the environmental cost associated with production not reflected in the pricing mechanism of the market.
45) Profit, the incentive to encourage economic activity
46) Full cost price, a price that reflects all costs associated with production.
47) Some cost price, a price that reflects only some costs associated with production.

48) No cost price, a price that does not reflect any cost associated with production.
49) Traditional Pareto optimal, the levels of production and consumption determined by the traditional market price.
50) Green pareto optimal, the levels of green production and green consumption determined by the green market price.
51) Red market based pareto optimal, the levels of production and consumption determined by the red market price.
52) Socio-environmental based pareto optimal, the levels of production and consumption determined by the socio-environmental market price.
53) Red socialism based pareto optimal, the levels of production and consumption determined by the red socialism market price.
54) Environmental market based pareto optimal, the levels of production and consumption determined by the environmental market price.
55) Sustainability based pareto optimal, the levels of production and consumption determined by the sustainability market price.

B) Operational models

i) The development variability model
If we have a system with three components, society(A), the economy(B) and the environment(C), the development variability model(D) can be stated as:

1) D = A + B + C + AB + AC + BC + ABC

Expression 1) above simple says that there is development when one or two or all components at the same time are in active or dominant form. We can also see in expression 1) above, going from left to right, that i) there can be different types of one component only based development or deep development models(A, B, C); ii) there can be different types of two components only based development or partial partnership based models(AB, AC, BC); and iii) there can be one type of all component based development(ABC) or full partnership based model. In other words, we can see in expression 1) above three things; i) that going from left to right, component inclusion increases; ii) that going from right to left, component exclusion increases; and that 7 different types of development(Di) are possible.

ii) The anti-development model

If none of the three components, A, B and C mentioned above are in active form or dominant form then we have the anti-development model(d), where passivity or no clear dominance leads to a free for all full unsustainability:

2) d = abc = full unsustainability model(USM)

Notice that in expression 2 all components, a, b, c, are in passive or dominated form

iii) The development model in terms of market structures

If we add the passive components to each of the dominant structures in the development variability model(D) above, we transform it into development market structure(DM) with all possible individual market structures as follows:

3) DM = Abc + aBc + abC + ABc + AbC + aBC + ABC
And the anti development market is:

4) dM = abc = USM, where USM = the unsustainable market
Notice that Abc = the red socialism market = KM
aBc = the traditional market = TM
abC = the environmental market = ENM
ABc = the red market = RM

AbC = the socio-environmental market = SENM
aBC = the green market = GM
ABC = the sustainability market = S

Based on the information above, expression 3) above can be restated in terms of the names of the markets associated with each market structure as follows:

5) DM = KM + TM + ENV + RM + SENM + GM + S

If we look at expression 1) and compare it with expression 5) we can see the following: a) that under independent choice assumptions three forms of development are possible(A, B, C); and therefore, 3 types of markets(KM, TM, ENM); b) that under partial codependent choice assumptions three forms of development are possible(AB, AC, BC); and therefore, 3 types of markets(RM, SENM, GM); c) that under full codependent assumption only one form of development is possible(ABC); and hence, only one type of market is possible(S); and d) if we assume that only the independent economic choice matters as the perfect traditional market indicates then only one type of development is possible(B) as well as only one type of market(TM), and hence in this case, the traditional market(TM) drives development.

iii) The development model in terms of market price structures

The price structure of each market reflects only the cost margin or the sum of cost margins associated with each component in each specific market in active form or dominant form, the society(A) reflects a social margin(SM), the economy(B) reflects an economic margin plus profits(ECM + i = P), and the environment(C) reflects an environmental margin(EM); and if we apply this thought then to the market price for each market present in expression 5 above associated with the active components in expression 1) above we arrive to the following development market prices(DMP):

6) DMP = (KMP = SM) + (TMP = P) + (ENMP = EM) + (RMP = SM + P) + (SENMP = SM + EM) + (GMP = EM + P) + (SP = SM + EM + P)

And the price structure of the anti-development model

7) dMP = USMP = 0 = free

Where USMP = the unsustainability market price with a zero cost margin

Notice that ideas related to how market pricing and cost externalization are linked(Muñoz 2020) and related to how market prices can be derived from the sustainability market price(Muñoz 2015e) have been recently stressed in detail.

C) Operational table

If we assume that EM > SM > P > 0 = free price, then all models, markets and prices presented above can be organized in terms of the highest market price to the lowest market price as well as in terms of type of cost externalization and type of cost internalization under each market is operating as shown in Table 1 below:

Table 1

Development Type	Market Structure	Price Structure	Type of Externalization	Type of Internalization
D1 = ABC	S = ABC	SP = SM + GM + P	None	Full
D2 = AC	SENM = AbC	SENMP = SM + EM	Type I	Type II
D3 = BC	GM = aBC	GMP = EM + P	Type I	Type II

D4 = AB	RM = ABc	RMP = SM + P	Type I	Type II
D5 = C	ENM = abC	ENMP = EM	Type II	Type I
D6 = A	KM = Abc	KMP = SM	Type II	Type I
D7 = B	TM = aBc	TMP = P	Type II	Type I
D8 = dM	USM = abc	USMP = 0 = free	Full	none

We can see in Table 1 above that SP > SENMP > GMP > RMP > ENMP > KMP > TMP > USMP, this and the other information in Table 1 is used below to place the position of production frontiers and indifference curves and optimality points of markets with respect to other markets or to drive markets to the right or to the left depending on whether we are externalizing costs or we are internalizing costs.

Pareto optimality type 1: The case of no cost externalization

The situation where all costs, social(A), economic(B), and environmental costs(C), are internalized in the pricing mechanism at the same time in the production and consumption of bundles R and Q leads to the sustainability based pareto optimality point as indicated in Figure 6 below:

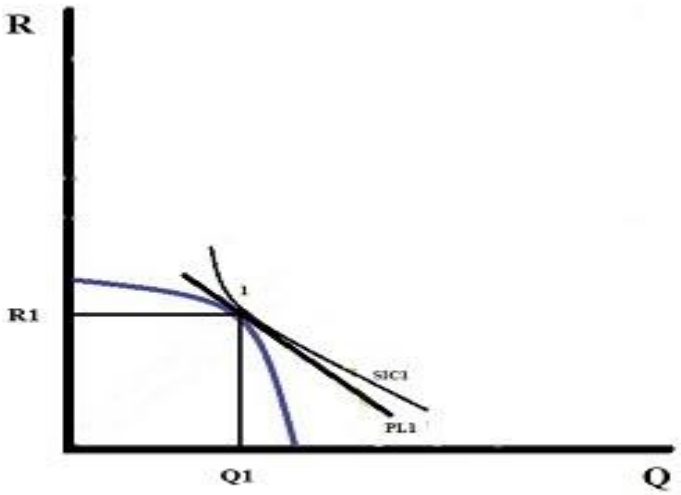

Figure 6 Sustainability based pareto optimality There is no cost externalization here as there is full cost internalization

Figure 6 above tells us the following about the sustainability based pareto optimality point at point 1: i) At this point the slope of the sustainability production frontier, of the sustainability price line PL1 and the sustainability indifference curve SSC1 is the same; and ii) sustainability producers and sustainability consumers produce and consume bundles R1 and Q1. We can also see in Figure 6 above the following: i) producing and consuming below point 1 is not optimal, producing and consuming at point 1 is optimal; and ii) producing and consuming beyond point 1 is not possible because those bundles fall outside the sustainability based production frontier. Therefore, in Figure 6 above there is no cost externalization. Notice that if there are technological advances and innovations that reduce any of the three costs, social, economic. and environmental costs of production or reduces any combination of them will lead to a lower sustainability price, then the sustainability production frontier will expand leading the higher production and consumption at lower sustainability prices or if there are events leading to increases in the social, economic, and environmental cost of production or increasing in any combination of them this would lead to a higher sustainability price, then the production frontier will contract and we will produce and consume less at a higher sustainability price. And finally, it can be said that the sustainability based pareto optimal point is a full pareto optimality point as no cost internalization takes place.

Pareto optimality type 2: The case of partial cost externalization type I

The situation where only one cost of three costs, social(A), economic(B), and environmental(C) costs, is externalized or two costs only are internalized in the pricing mechanism in the production and consumption of bundles R and Q leads to the collapse of the sustainability based pareto optimality point at point 1, migrating to the right to new markets with lower price than sustainability pareto optimality price, leading to more production in consumption in those new markets than in the sustainability market as indicated in Figure 7 below:

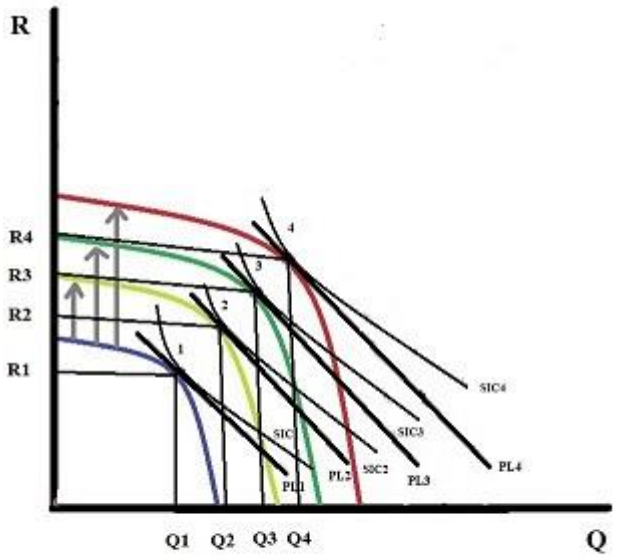

Figure 7 Pareto optimality under partial cost externalization type I Only one market cost is externalized leading to two component only type of markets such as the socio-environmental market, the green market and the red market

As indicated in the operational Table 1, the market prices when externalizing only one type of cost or when internalizing only 2 types of costs leads to the markets at point 2, 3, and 4 in Figure 3 above. Notice that production frontiers and indifference curves are ordered in Figure 7 above from the highest market price to the lowest SP > SENMP > GMP > RMP; and hence the production frontier will migrate from sustainability based pareto optimality point at point 1 to those markets following the signal of those specific market prices as detailed in Figure 7 above. Hence, at point 1 we have the sustainability market(S), at point 2 we have the socio-environmental market(SENM), at point 3 we have the green market(GM), and at point 4 we have the red market(RM).

Figure 7 above helps to highlight the impact of cost externalization type I on the migration to the right of optimality point 1: i) the sustainability production frontier collapses when externalizing economic costs is fine as indicated by the arrow from production frontier 1 to 2; and moves from point 1 to point 2, the optimal socio-environmental market optimality point; ii) the sustainability production frontier collapses when externalizing social costs is fine as indicated by arrow from production frontier 1 to 3; and moves from point 1 to point 3, the optimal green market or eco-economic market optimality point; and iii) the sustainability production frontier collapses when externalizing environmental costs is fine as indicated by arrow from production frontier 1 to 4; and moves from point 1 to point 4, the optimal socio-economic or red market optimality point. Notice in Figure 7 above that now production and consumption after point 1 is possible because cost externalization type I creates pareto improvement situations in each market to the right of point 1 that leads to production frontier expansion that stop at their respective optimal points at point 2, 3, and 4 . And this process leads to consumption bundles to the right of point 1, but non-of those bundles is consistent with sustainability based pareto optimality as they have externality gaps or sustainability gaps embedded in them. We can see also in Figure 7 above that production and consumption increases as cost externalization is allowed; and the markets with higher costs have higher prices and therefore, lower production and consumption, which is the reason why Q1 < Q2 < Q3 < Q4 and R1 < R2 < R3 < R4. In other words, the higher the market price, the lower the production and consumption quantity; and the lower the market price, the higher the production and consumption quantity. And therefore, the structures in

Figure 7 above are the result of externalization type I, where only one of three costs is externalized, creating pareto improvement dynamics that lead to the migration of the sustainability based pareto optimality point to the optimality point of the other markets.

Notice that if there are technological advance and innovations that reduce the socio-environmental costs or eco-economic costs or the socio-economic costs of production in each of those markets they will lead to lower prices in those markets, then production frontier of those markets will expand leading to higher production and consumption at lower market prices or if there are events leading to increases in the socio-environmental cost or eco-economic cost or socio-economic cost of production in those markets, then there will be an increase in prices in those markets and in that case the production frontier of each market will contract and we will produce and consume less at a higher market price. And finally, it can be stressed that because of partial cost externalization type I, partial partnership based markets are partial type I pareto optimality based markets, including the green market.

Pareto optimality type 3: the case of partial cost externalization type II

The situation where two costs, social(A), economic(B), and environmental(C) costs, are externalized or only one cost is internalized in the pricing mechanism in the production and consumption of bundles R and Q leads to the collapse of the sustainability based pareto optimality point at point 1, migrating to the right to the new markets with lower price than sustainability pareto optimality point 1 as indicated in Figure 8 below:

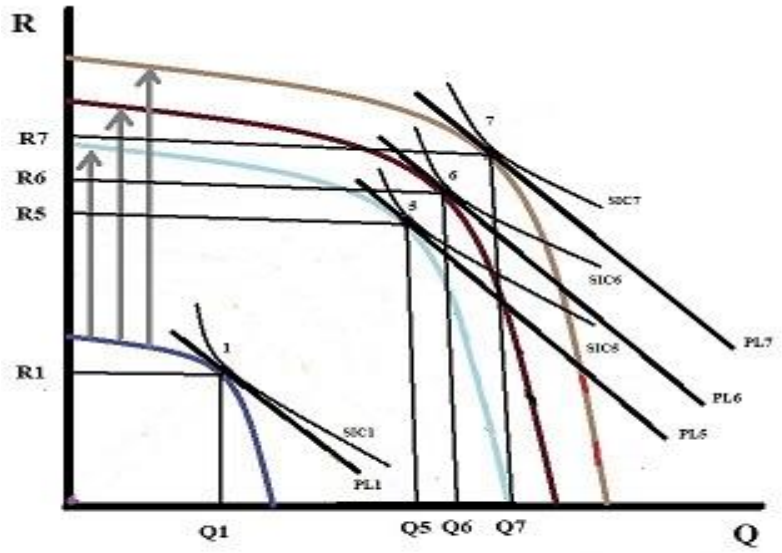

Figure 8 Pareto optimality under partial cost externalization type II Only two market costs are externalized leading to one component only type markets such as the deep ecology, red socialism, and the traditional market

Again as indicated in the operational table, the market prices when externalizing two costs or internalizing only 1 type of cost out of three types of costs it leads to lower prices and therefore, it leads to increases in production and consumption such as in point 5, 6, and 7. Notice that the production frontiers in Figure 8 above are placed from left to right from the highest price to the lowest price as SP > ENMP > KMP > TMP; and the production frontier will expand from sustainability based pareto optimality point 1 to those new markets following the signal of those specific market prices as detailed in Figure 8 above. Hence, at point 1 we have the sustainability market(S), at point 5 we have the environmental market(ENM), at point 6 we have the red socialism market(KM), and at point 7 we have the traditional market(TM).

Figure 8 above helps to see the impact of cost externalization type II on the migration to the right of optimality point 1: i) the sustainability production frontier collapses when externalizing social and economic costs is fine; and moves from point 1 to point 5 as indicated by the arrow from the production frontier 1 to 5, the optimal environmental market optimality point; ii) the sustainability production frontier collapses when externalizing

environmental and economic costs is fine as indicated by the arrow from the production frontier 1 to 6; and moves from point 1 to point 6, the optimal red socialism market optimality point; and iii) the sustainability production frontier collapses when externalizing social and environmental costs is fine as indicated by the arrow from the production frontier 1 to 7 and moves from point 1 to point 7, the optimal economic or traditional market optimality point. Notice in Figure 8 above that now production and consumption after point 1 is possible because of cost externalization type II creates pareto improvement situations that lead to increasing production and consumption until it reaches point 5, 6 and 7 respectively, which leads to consumption bundles to the right of point 1, but non-of those bundles is consistent with sustainability based pareto optimality as they have externality gaps or sustainability gaps embedded in them.

We can also see in Figure 8 above that production and consumption increases as cost externalization is allowed , which leads to lower prices than the sustainability price(SP). Lower market prices encourage increase production and consumption in those markets; and again those lower market prices are the reason why Q1 < Q5 < Q6 < Q7 and R1 < R5 < R6 < R7. In other words, the higher the market price, the lower the production and consumption quantity; and the lower the market price, the higher the production and consumption quantity. And therefore, the structures in Figure 8 above are the result of cost externalization type II, where two out of three costs are externalized, creating pareto improvement dynamics that lead to the migration of the sustainability based pareto optimality point 1 to the optimality point of markets at point 5, 6 and 7, where point 5 for example has a higher market price than for example point 7.

Notice that if there are technological advances and innovations that reduce the environmental cost or the social cost or the economic cost of production in each of those markets that would lead to lower market prices in those markets, then production frontier of those markets will expand leading to higher production and consumption at lower market prices or if there are events leading to increases in the environmental cost or social cost or economic cost of production in those markets then this would lead to price increases in those markets, and the production frontier of each of those markets will contract as a result of that and we will produce and consume less at a higher market price. And finally, it can be stressed that because of partial cost externalization type II, deep model type based markets are partial type II pareto optimality based markets, including the traditional market(TM).

Pareto optimality type 4: The case of full cost externalization

The situation where all costs, social(A), economic(B), and environmental(C) costs, are externalized or no cost is internalized in the pricing mechanism at the same time in the production and consumption of bundles R and Q leads to the sustainability based pareto optimality point collapsing and moving right towards full unsustainability as indicated in Figure 9 below:

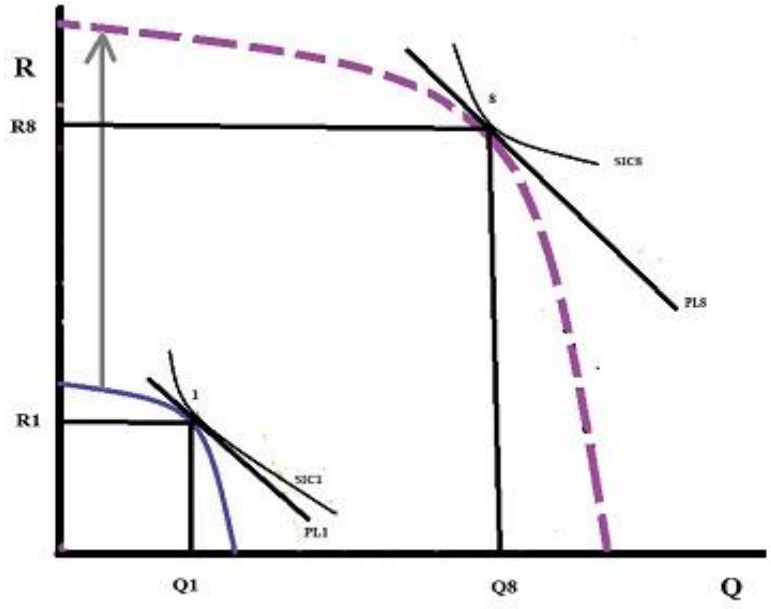

Figure 9 Pareto optimality at full cost externalization: full unsustainability

We can see in Figure 9 above that full cost externalization or no cost internalization leads to the collapse of sustainability based pareto optimality at point 1 since SP > USMP = 0; migrating towards point 8 due to the pareto improvement situations created by full externalization as indicated by the arrow from point 1 to point 8. Notice that the production frontier at point 8 breaks at one point as in the long term production and consumption levels at point 8 collapse due to the over production and over consumption generated by producing and consuming at free prices(MP8 = USMP= 0 = free), degrading social, economic and environmental assets until production and consumption is not longer viable or possible and the market collapses as indicated by the broken production frontier at point 8 in Figure 9 above. We can also use Figure 9 above to point out clearly that at point 1 we have full sustainability and at point 8 we have full unsustainability. And finally, it can be pointed out that because of full cost externalization, pareto optimality breaks down on the way from full sustainability to full unsustainability.

The pareto optimality sustainability line

If we link all the pareto optimality point from Figure 6 to Figure 9 above; and place them in the same plane we can appreciate the structure of the pareto optimality sustainability line across markets, as shown in Figure 10 below:

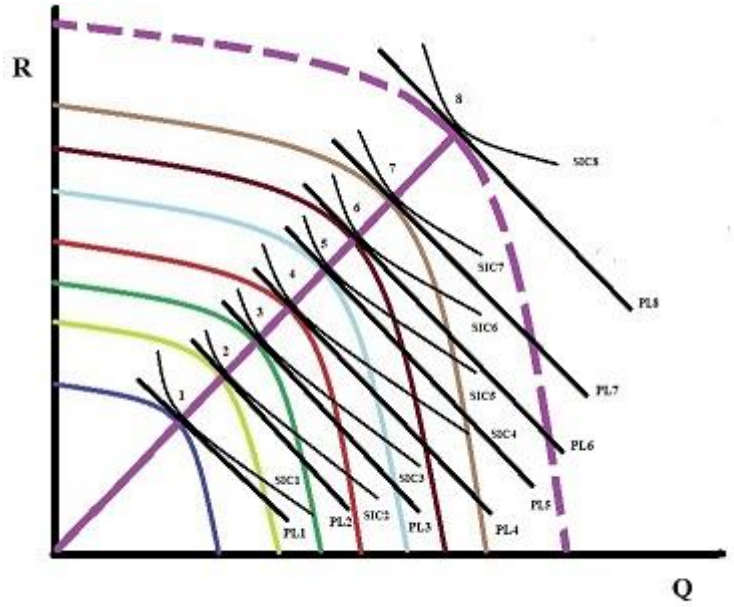

Figure 10 The pareto optimality sustainability line links the pareto optimal ponts of all possible markets

We can see in Figure 10 above that the pareto optimality sustainability line connects all optimality points from the sustainability based pareto optimality point at point 1 to the fully unsustainable point at point 8. The following can be highlighted based on Figure 10 above from the sustainability point of view: i) The most undesirable optimality point on the pareto optimality sustainability line is point 8 as there the market collapses under full unsustainability and it is the furthest point from full sustainability at point 1; ii) The second most undesirable point on the line is the traditional market and its traditional optimality point at point 7 as it is the second point on the line furthest from the sustainability based pareto optimality point 1, and notice also that this point 7 is where production and consumption that is sustainable is the highest on the pareto optimality sustainability line, which means more social and environmental pollution is created at that point 7 on the pareto optimal sustainability line compared to any other market to its left; and iii) the most desirable point on the pareto optimality sustainability line is point 1, where production and consumption is socially and environmentally and economy friendly at the same time.

The increasing pareto optimality sustainability line

When cost externalization is the driving force, then the more cost externalization takes place the further away we move from the sustainability based pareto optimality point 1, a move to the right from highest to lower sustainability levels all the way to full unsustainability as indicated in Figure 11 below:

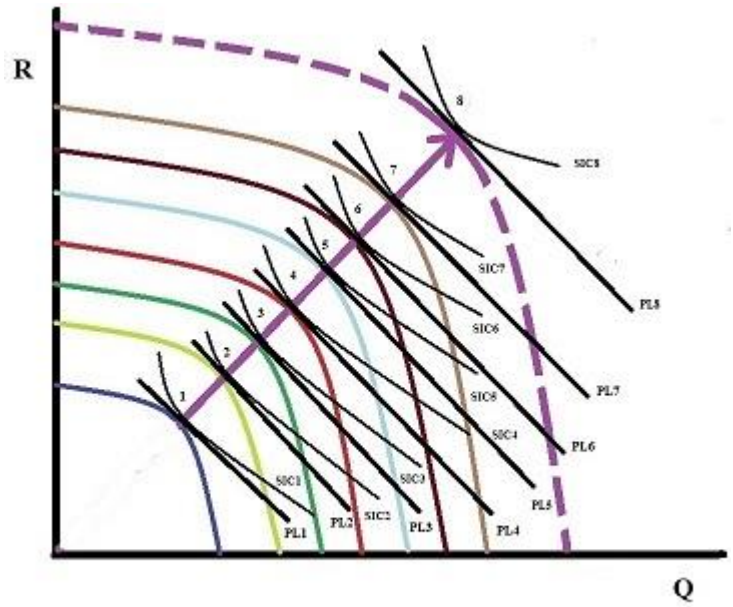

Figure 11 The increasing pareto optimality sustainabilityline
As externalitazation increases the level of sustainability decreases until it reaches full unsustainability status at point 8

We can appreciate in Figure 11 above that as cost externalization increases from left to right the production frontiers migrate to the right towards full unsustainability; and away from the sustainability based pareto optimality point 1 indicating that sustainability trends are inversely related to pareto optimality trends across markets as the furthest to the right we are from sustainability pareto optimality the lower the level of sustainability. Another way of looking at Figure 11 above is from the point of view of market price distortions, the further away from sustainability we are the more distorted the price clearing that market is as there is higher externalization cost there, which means the following: i) At point 1, there are no market distortions as full costing takes place(the sustainability market); ii) from point 2 to point 4 we have different types of distorted markets created by type I cost externalization as only one cost is externalized(the socio-environmental market, the green market, and the red market); iii) from point 5 to 7 we have different types of distorted markets created by type II cost externalization as two costs are externalized(the environmental market, the red socialism market and the traditional market); and iv) at point 8 we have a fully distorted market created by full externalization, the fully unsustainable market as no cost is internalized in this market. In short, Figure 11 above summarizes the trip from full sustainability to full unsustainability as cost externalization goes from no externalization all the way to full externalization, which highlights the increasing nature of the pareto optimality sustainability line under cost externalization. In other words, increasing cost externalization trends can be seen as market distortions creating pareto improvement trends that expand production frontiers towards more and more unsustainable production and consumption bundles as cost externalization increases.

The decreasing pareto optimality sustainability line

When cost internalization is the driving force, then the more cost internalization takes place the further away we move from full unsustainability, a move to the left from the highest to lower unsustainability levels all the way to full sustainability as indicated in Figure 12 below:

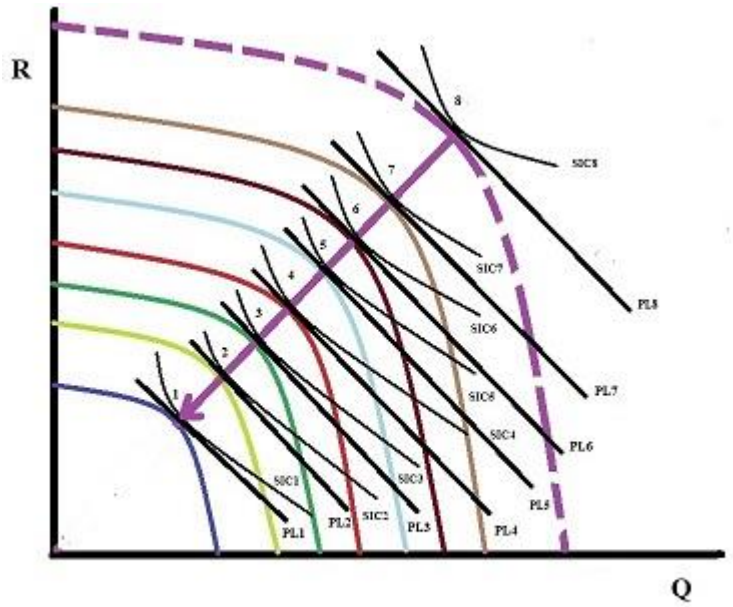

Figure 12 The decreasing pareto optimality sustainability line
As cost internalization increases sustainabilitylevels increase until it reaches the full sustainability status at the optimal point 1

We can see in Figure 12 above that as cost internalization increases from right to left the production frontiers of all markets contract and migrate to the left towards full sustainability; and away from the unsustainability based pareto optimality point 8, indicating again that sustainability trends are inversely related to pareto optimality trends as the furthest to the left we are from unsustainability pareto optimality at point 8 the higher the level of sustainability. Another way of looking at Figure 12 above is from the point of view of market price corrections, the further away from unsustainability we are the less distorted the price clearing that market is as there is higher cost internalization there, which means the following: i) At point 8, there is a full market distortion as no costing takes place so then the unsustainability market price is zero(MP8 = USMP = 0 = free); ii) from point 7 to point 5 we have different types of distorted markets created by type I cost internalization as only one cost is internalized, internalizing one specific cost means correcting the full unsustainability price(MP8 = USMP = 0) through the accounting of one specific cost in each market price(the traditional market[TMP = MP8 + P = P] as it reflects only economic costs), (the red socialism market[KMP = MP8 + SM = SM] as it reflects only social costs), and (the environmental market[ENMP = MP8 + EM = EM]) as it reflects only environmental costs); iii) from point 4 to 2 we have different types of distorted markets created by type II cost internalization as two cost are internalized in the pricing mechanism of each market(the red market[RMP = MP8 + SM + P = SM + P] as social and economic costs are accounted for), (the green market[GMP = MP8 + EM + P = EM + P] as environmental and economic costs are accounted for), and (the socio-environmental market[SENMP = MP8 + EM + SM = EM + SM) as environmental and social costs are accounted for); and iv) at point 1 we have the full sustainability market as all costs are internalized or accounted for[SP = MP8 + SM + EM + P = SM + EM + P]. In short, Figure 12 above summarizes the trip from full unsustainability to full sustainability as cost internalization goes from no internalization all the way to full internalization, which highlights the decreasing nature of the pareto optimality sustainability line under cost internalization. In other words, cost internalization trends can be seen as market corrections trends that contract pareto improvement conditions leading to production frontiers contracting towards more and more sustainable production and consumption bundles as cost internalization increases.

Food for thoughts

1) Is the choice structure in sustainability markets and traditional markets the same? I think no, what do you think?; 2) Can traditional production and consumption bundles be found in green markets? I think no, what do you think?; and 3) Are cost externalization trends positively related to the concept of exclusion? I think, yes, what do you think?

Conclusions

a) It was shown that full costing leads to sustainability based pareto optimality; b) It was highlighted that under cost externalization type I the sustainability based production frontier breaks and migrates towards different types of partnership based production frontiers, namely the socio-environmental market, the green market, and the red market; c) It was stressed that under cost externalization type II the sustainability production frontier breaks and moves towards different type of deep thinking markets, namely the environmental market, the red socialism market and the traditional market; d) It was pointed out that under full cost externalization the sustainability production frontier breaks and travels towards full unsustainability base markets; e) It was indicated that if we connect all the pareto optimality points in all possible markets we generate a pareto optimality sustainability line; f) It was conveyed that an increasing pareto sustainability optimality line means that cost externalization trends are driving production and consumption bundles away from the sustainability based pareto optimal bundle as the market distortions they create fuel increasing production and consumption trends to the right of the line to the point that at full cost externalization markets collapse under full unsustainability; g) It was indicated that a decreasing pareto optimality line means that cost internalization trends are driving production and consumption bundles closer to the sustainability based pareto optimality bundle as the correction of existing distortions leads to decreasing production and consumption trends to the left of the line to the point that at full cost internalization markets thrive under full sustainability; and h) Over all the negative relation between sustainability trends and pareto optimality trends across markets from fully sustainable ones to fully unsustainable ones was indicated as well as the fact that traditional pareto optimality is the second pareto point the furthest from sustainability based pareto optimality bundle on the pareto optimality sustainability line; and therefore, it is the second most undesirable pareto point on that line.

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