RATIONAL PRINCIPLES OF ECONOMICS AND THEIR APPLICATIONS: A LEGACY FROM SCIENCE

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Abstract

New approach to study economies is adopted in the paper. The change in prices is assumed solely by variation in demands or supplies. Cause of such variations is quantified. Efforts behind changes in demand, supply and prices are characterized as 'potential'. The potential stems from different kind of resources and is utilized for trade or production; quantification of such utilization is done. We also have explored rules about flow of potential in economy. The laws can be used to study evolution of economies. A set of goods & services, population and initial prices can be considered as the economy for study. In addition to conventional parameters, we get a new state determining parameter for economy defined as ecomperature. Ecomperature mimics temperature from physics. Resources flow from sections of higher ecomperature to that of lower ecomperature to attain uniformity in ecomperatures. Some aspects of possible applications of the theory are discussed. The paper isn't about interdisciplinary analogies or similarities, but it is about the foundative reasoning behind the scientific mechanisms.

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1. Introduction

Great thinkers such as Newton, Clausius, Gibbs, Kelvin et cetera have instituted a set of logical thinkings about the cause-effect links; not only in physical sciences but in any sense wherever change of information exists. What these people have instituted is though seems to be just physics, actually is a discipline of rational modeling. If developed & applied in rightful manner, legacy of these people in science will be very useful in economics & commerce.

Scope for applications of rationalism or mathematics to social sciences including economics is being explored continuously with different perspectives. Oldest to my knowledge, there is a bunch of essays on application of mathematics to moral sciences [1] is published in 1881. There is a long tradition in economics of considering analogies between economic and physical systems [2]. There are efforts about application of physics laws to economics identified to be Econophysics, recent article serial [3, 4] provides a good review of such work over the decades. The work about intersection of economics & physics is superstitious so far: not concerning core mechanisms and applied by blind faith in laws of physics instead of concerning the logical reasoning behind the laws. Mainstream economists have generally been unimpressed by this work [5]. Unlike the related prior literature, subject of this paper is about rational/logical reasoning behind the laws & mechanisms of science (i.e. not about analogies, similarities or statistical techniques). Thus we would expect new tools for analysis of economies.

It is big debate that whether economics is a science or art. It seems to be science as it runs with the cause-effect links; but it is hard to be proven as science as it lacks the causal & rational modeling. Core characteristic of science is possibility of experiment with its mechanisms. In this paper, we would explore the ‘science’ behind economics. If such discussions are taken forward by economists, in near future we might strengthen the doctrine of experimental economics.

There are two exclusive parts of this paper. One (sections 2-3) is about foundations and principles discussing mechanisms in the economies, and other (section 4) is about applications discussing fruitful adoptions of the principles to practical economies.

2. The Legacy from Mechanics

Modern world has legacy of rational thinking due to Newton. Newton's three laws of mechanical motion can be generalized for general motions.

2.1. Newton's first legacy to economics

Basically, Newton's first law of motion implies that there is no change unless there is rational cause to cause the change. The change concerned in dynamics is of position of an object. Economics concerns change in price of an object; and there should be no change in price unless there is change in corresponding demand or supply. For ease of account let us define a quantity.

Definition 1: The difference between supply of a good and demand of the good in the economy is defined as Flow of the good in the economy.

Other exclusive price influencing parameters if any may be included in definition of flow, but for now we believe to include just the demand and supply. Economy has trivial definition, we will specify it soon. Also, the word good in this article implies to include class of goods and services.

As there are specific demands & supplies at specific instant, the flow is variable for each good or service changing with time. Let's signify flow by F, demand by D & supply by S. Then for each good ν,

$$F_\nu = S_\nu - D_\nu \qquad (1)$$

The subscript ν implies the preceding variable regarding the good ν.

Change in price should be caused by change in the flow. Let's call the empirical quantity which causes change in flow by action as impact. Then in terms of impact I, we can state the first principle of economics as (let P to denote price)

Principle 1: There is no change in price P_ν of a good ν unless an external unbalanced impact I acts on the good or service.

The terms external & unbalanced are important for accurate accounting of the impact.

2.2. Newton's second legacy to economics

Newton's second law of motion characterizes the quantity which causes change according to the first law. According to the general mathematical sense, impact I should be directly proportional to the rate of change it causes.

$$\text{i.e. } I_v = m_v \frac{dF_v}{dt} \qquad (2)$$

The proportionality constant m_v should be exclusive for the good and should mimic inertia i.e. higher the m_v, harder to change price or flow of ν. In this concern, quantitative need of the good by purchasers reflects inertia. For instance, there is lesser tendency for change in bread prices than that for prices of cars; one Rupee change in bread prices is harder than thousands Rupees change in car prices. Before proceeding, we should define the quantitative need.

Definition 2: Quantitative need q_v of a good ν is the number of its units required by a typical purchaser in unit time.

Technically the time unit used in this definition should be same as unit of time in other formulations.

We can simply identify m to be kq

$$\text{i.e. } m_v = k.q_v \qquad (3)$$

Where k is some universal constant and q_v is quantitative need of ν.

Hence by this substitution, (2) becomes

$$I_v = k.q_v \frac{dF_v}{dt} \qquad (4)$$

Now we can state the second legacy by Newton as follow.

Principle 2: The impact acting on a good ν is equal to quantitative need of ν (i.e. q_v) times the time rate of change in flow of ν (i.e. F_v) caused by the impact, all multiplied by k.

From the principle 2 (same as (4) mathematically), we can define unit of the impact as follow.

Unit of Impact: Quantity of impact that causes change in flow of $\frac{1}{k.q_v}$ units in unit time is defined as one Smith (Sm).

One Sm is equivalent to impact that causes change in flow of $\frac{1}{k}$ units of the good having unit quantitative need in unit time

In the principles, time t should be synchronized with progress of transactions. Primarily, the time should be counted in units of (numbers of) transaction happening. But assuming uniform natural progress of transactions or any sort of regression, time can be identified in unit of popular terms like hours, months, quarters and years.

2.3. Newton's third legacy to economics

It is easy to prove from (4) that in absence of external impact, the $q_v.F_v$ product should be conserved. Assuming no external impact in the economy, for every impact, there is equal & opposite counter impact.

i.e. $\sum I = 0$ (5)

Principle 3: Whenever an impact acts on a good from surrounding, there is exact opposite counter-impact on the surroundings.

2.4. The Economic Potential

According to the principle 1, the impact causes price change. Taking this mechanism forward, it can be realized that the product of impact and the price change caused by the impact characterizes efforts behind the change. In different words, we can characterize a property capable to generate an impact and to cause price change due to the impact. This property can be identified to be potential in economics: capacity to generate an impact causing a price change.

Hence we define the economic potential as

$V = I.\, dP$ (6)

Where dP is change in price caused by impact I.

Unit of Potential: Quantity of the potential changed due to changing price by unit currency by impact of unit Sm is defined as one Marx (Mx).

The potential is true account of the efforts or resources involved behind any economic change. It is counterpart of energy in physics. Note that unit of potential i.e. Mx depends on currency unlike the unit of impact Sm.

Certain potential should be consumed in any economic activity, as an economic activity leads to changes in either demands or supplies or prices of goods.

3. Legacy from Thermodynamics

3.1. Economies under Study

We can identify a closed economy under study be 'Economy', and the universal economy be 'Global Economy'. Set of specific population, goods and initial prices of the goods, along with the physical-virtual boundaries can be defined as economy for study. The complement of an economy in global economy can be defined as 'Surrounding' of the economy. We can also configure boundary between economy and its surrounding. If many economies are considered simultaneously, then definition of the surrounding economy can be adopted as appropriate: complement of all the economies or complements with respect the economies.

An economy is characterized by a population, the specific goods existing there, and transactions about the goods among the population proceeding with time. Thus we can configure the flow of each good in it. We can also define quantitative need of each good among the population i.e. q_v. From the principle 2 we can determine impact acting on a good by knowing variation its flow and as k is universal constant. Further, we can make sum of all the impacts in economy. From the principle 3 we know that if an impact acts on a good, then there is exact opposite impact on surrounding so that the sum is zero. Hence an economy can be thought to be isolated if sum of all impacts within it is zero. The nonzero sum means existence of unbalanced impact what is possible only if there is possibility of transactions between the economy and its surrounding. The positive sum implies that the unbalanced impact (i.e. sum) should act on the surrounding by the economy. Conversely, there should be unbalanced impact on the economy from its surrounding if the sum is negative. In this way we get interaction of economy with its surrounding economy. We now know what an external impact on economy would mean.

For the isolated economy, from (4) we get an interesting principle. In the case I=0, equation (4) implies conservation of the product $q_\nu.F_\nu$. For each good ν in the economy we can obtain q_ν & F_ν and thereby their product. We can sum over ν in the economy. This product seems an important property of the economy. It is in fact counterpart of momentum in physics. Thus let's call it economic momentum.

Definition 3: The product of quantitative need with the flow summed over all the goods in an economy is defined as Economic Momentum of the economy.

i.e. Economic Momentum = $\sum_\nu q_\nu.F_\nu$ (7)

Note that single good itself along with the population can be considered as a (sub) economy. Thus we should call the neat product $q_\nu.F_\nu$ be economic momentum of ν.

Now we should state the important deduction from principle 2.

Principle 4: Economic momentum of an economy is conserved in absence of external impact.

This principle implies that for isolated economy, change in economic momentum of a good should cause change in economic momentum of other goods. As q_ν wouldn't vary, there should be change in flow of the goods. That is, change in flow of a good should cause change in flow of other goods, provided that they aren't isolated from each other. Quantitative changes can be obtained by equating $\sum q_\nu.F_\nu$ before and the $\sum q_\nu.F_\nu$ after. This principle can be more exploited by considering parts isolated within the economy at specific moment.

3.2 Configuration of the Economy

The economic potential V is true account of efforts behind any change in economy. Basically change in economy is manifested by change in prices or that in flow. Certain potential consumed in certain change should remain accumulated in the changed state, and same potential should be released on reverse change. The potential stems from resources. A resource when acquired, gives to the owner an ability to change flow and prices of certain goods. In other words, utilization of resources leads to ability of transactions, and transactions cause some potential (due to simultaneous change in flow & price of the good).

Definition 4: The property which gives ability of doing indefinite number of transactions by its utilization along with other such properties to its owner is defined as Resource.

Thus land, real estate, labor, capital, rentable things, entrepreneurship, knowledge, natural creatures etc. are examples of resources. Such resources basically offer ability to change flow of goods in economies, thereby price change is also caused while doing transaction. In simple words, certain potential can be extracted by utilization of the resources. We can configure the resources in terms of potential i.e. the resources can be counted in terms of Mx. Resources can be used for production. We have to carefully concern the production.

Definition 5: An activity by people in an economy which leads to generation of new units of goods for consumers is defined as production.

Production stems from utilization of potential, thus it can be measured in units of potential. Production can be quantified in units of Mx by using (4).

We shouldn't regard trade or credit to be production due to obvious reasons. But trade and credit activities do lead to change in flow and prices of goods. Before getting confused, let us define a characteristic which should include non-productive activities like trading and crediting.

Definition 6: Potential contained within an economy excluding potential due to production in the economy and potential due to external impacts in the economy is defined as Internal Potential of the economy.

From definitions 5 & 6 we can deduce another principle for variations in economies. If some quantity of resources is delivered to an economy, then it would be used for increase in production of goods and services. The fraction which isn't used for production should cause increase in the internal potential of economy. This would be fifth principle of economics

Principle 5: Change in internal potential of an economy is equal to external resources delivered to the economy minus production in the economy.

Denoting resources by R, production by W and internal potential of the economy by H all counted in terms of Mx, principle 5 can be expressed as follow

$$dH = dR - dW \quad (8)$$

Where, d stands for differential change in the quantities.

Change in production i.e. dW in an economy can be calculated by using (4) & (6). If a specific good ν is produced in quantity of X_ν units, then there will be increase in supply of ν by X_ν. Putting this in (1) we get $dF_\nu = X_\nu$. This substitution in (4) gives the impact due to the production. The goods produced have no price unless sold. Thus there is total value addition, the price increase caused due to production impact is equal to the ex production price. Assume the ex production price of the good be P^0_ν, then the economic potential consumed in the production (or the production in terms of Mx) can be obtained by multiplying the impact by P^0_ν.

$$\text{i.e. } W = k\sum_\nu q_\nu \frac{dX_\nu}{dt} P^0_\nu \quad (9)$$

(9) is quantification of the production of the goods in economy. It can be obtained by summing the production over all the goods and all the production houses. It is better to define production house

Definition 7: An entity in economy which generates new units of goods by utilizing different types of essential resources in strategic manner is defined as production house.

Not only factories, but all sort of service stations, modification-repackaging stations, consultation counters etc. are included as production houses. Excluding traders, all the business houses normally fall in definition of production house. Production house should essentially generate new units of goods; thus trading firms aren't eligible as production houses.

As suggested before, the economic activities in an economy that are manifested by changes in flow & prices without production of new units of goods should increase internal potential of the economy. We now proceed to quantify economic potential involved in such non production activities.

Trade of a good can be thought as switching between manufacturers and consumers. Every transaction of trade causes change in price of the good (that is addition to ex production price) and also affects flow of the good by purchasing or selling the goods. Potential involved

when a trader purchases a good from producer is already accounted in similar form of (9). The internal potential of economy would be potential in addition to such potential, which is caused due to trading. That means we should account for transactions when traders sell the goods.

A microstate or microeconomy state can be thought to be a set of specific population purchasing certain goods at specific price from the sellers. People purchasing a good at same prices in an economy, is example of microstate. Population of economy infers the economics through different goods having different prices. A good purchased at fixed price by some people is the smallest consolidated example of the economy. We should call such set be microstate i.e. microstate should essentially have a good, fixed price of the good, and certain population for the transaction. Some people buying notebook at $3 define a microstate; while other people buying same notebook at $3.1 define (& belong to) other microstate. Whole economy can be thought to be consisting of the microstates as building blocks.

Some sort of resources is involved behind trade. By knowing trading parameters for specific trader like quantity traded, value addition etc. we can quantify potential involved in the trade. The consumer prices P_ν in any economy are always more than ex production prices P^0_ν. Potential involved in such price increase is the internal potential. If population δn_j is purchasing good ν for time dt, then change in flow of ν due to transactions by this population should be

$$dF= q_\nu . \delta n_j .dt \qquad (10)$$

(10) is evident from fact that demand of a good is multiple of its quantitative need, concerned population & time span of the need. Using (4) & (10) we get the impact generated due to transactions by the δn_j people

$$I_\nu = k.q_\nu^2 . \delta n_j \qquad (11)$$

This impact is caused by resources behind the trade. Price change caused by the impact is the incremental price of ν for which traders convince the consumers. Denote $P_\nu - P^0_\nu$ for δn_j population by $\delta P_{\nu j}$. Multiple of the impact and the price change quantifies resources involved in the trade

$$\text{i.e. } dR= k.q_\nu^2 . \delta n_j . \delta P_{\nu j} \qquad (12)$$

This relation implies that potential involved in trading is directly related to the population purchasing the good at same price. We are referring set of the good having same price for some population as the microstate. (12) has microstate defining parameters relating to potential involved in the transactions. Thus the product $\delta n_j.\delta P_{vj}$ can be referred as a state determining property of the microstate. Let us define the product to be ecomperature (E).

i.e. $\delta n_j. \delta P_{vj} = E_{v,\delta P}$ (13)

Suffix δP in $E_{v,\delta P}$ is used to distinguish the microstate of population δn_j having specific price P_v. Several microstates can be combined to consider larger states; then E can be simply added (provided the microstates are of same good ν). Soon we will explore how to calculate E when the microstates are added generally. Here for same good, summing over all the prices & populations, and noting that total potential should be sum of potentials due to the fractions, we get ecomperature of the good as a whole in the economy. That is if all microstates about a good ν are thought to be combined as single state.

$$E_v = \sum_{\delta P} E_{v,\delta P} \quad (14)$$

Where $E_{v,}$ is ecomperature of ν while $E_{v,dP}$ are ecomperatures of the microstates. E_v characterizes state of the good by implying the price deviation among population and the potential involved in the deviation. E_v is analogous to temperature in physics. Every economic entity such as goods, services or their collections have certain E. Additivity of resources behind the E is key to calculate E for different collections (similar to, additivity of heat behind temperature is key to calculate resultant temperatures).

Using above relations we get relation between R (resources delivered to good ν in economy) and E (ecomperature of the ν in economy) for the state of the good ν as

$R_v = k.q_v^2.E_v$ (15)

We can take this further to know state of whole economy. There are many goods in economy, let χ be total number of goods in the economy. q_v & E_v being quantitative need & ecomperature of individual good ν. Total potential should be sum of individual potentials, thus resources/potential consumed in the state of economy would be

$$R = k\sum_{v} q_v^{\,2} E_v \tag{16}$$

We can find average quantitative need q over the goods in economy as

$$q = \frac{\sum_{v} q_v}{\chi} \tag{17}$$

If we regard E to be ecomperature of the economy, then as (15),

$$R = kq^2 E \tag{18}$$

Substituting for q & R, we get

$$E = \frac{\chi^2 \sum_{v} q_v^{\,2} E_v}{\left(\sum_{v} q_v\right)^2} \tag{19}$$

The potential (18) is changed when resource R is delivered in the economy. We are concerning trade and not production by considering prices incremental to ex production prices. Hence the potentials calculated by (15) & (18) belong to internal potential of the economy.

By considering an economy where certain resources dR are delivered without causing production, we get the internal potential dependency on E. By using this dependency, we get general form of principle by substituting it in (8):

$$dR = kq^2.dE + dW \tag{20}$$

That is, resources should cause either change in ecomperature or production in the economy. E is state determining property which accounts internal potential of the economy. (20) is more clear expression of principle 5.

3.3. Flow of Resources

3.3.1 Direction of the flow

There must be natural direction for flow of the resources. Consider certain amount of resource ΔR is transferred from an economy A having ecomperature E_A to another economy B having ecomperature E_B, without causing production changes (i.e dW=0). Then the ratio ΔR/E can be a guide for evolution. Generally E_A & E_B are unequal. Thus $\Delta R/E_A$ & $\Delta R/E_B$ too are unequal i.e. their sum (with sign) will be not zero. In other words, net ΔR/E in the system will either always increase or always decrease. Let's define the ratio property as econtropy L

$$\text{i.e. } dL=\frac{\Delta R}{E} \tag{21}$$

Recognize that in (21) d & Δ are used according to mathematical concern of the exact-inexact differential relationship.

As R is quantified in units of potential, it should flow from higher potential to lower. Also as ecomperature is directly proportional to potential, we conclude that ΔR should flow from E_A to E_B if E_A is higher than E_B. Thus econtropy loss from A is $\Delta R/E_A$ while econtropy gain by B is $\Delta R/E_B$ and as E_A is higher than E_B, $\Delta R/E_A < \Delta R/E_B$ thus there is a net gain in the combined econtropy. Hence we get the general rule that econtropy of economy should always increase. But our conclusion might mislead as we ignored case of $E_A = E_B$. In this case, total econtropy change is zero i.e. net entropy is constant. Thus the concluding rule is that- entropy of an economy can always increase or remain constant.

$$\text{i.e. } dL=\frac{\Delta R}{E}\geq 0 \tag{22}$$

This rule can be used for identification of direction of flow of resources. Here we get the principle about this. The resources flow in economy leading to no decrease in net econtropy.

Principle 6: Economy evolves with time such that change in econtropy is always non-negative.

Concept of econtropy (21) should be used while accounting for internal potential of economy. In the case where no change in production and ecomperature occurs, (21) suggests that resources should be consumed in change in econtropy. Thus using this possibility, we get most general expression of the principle 5.

$$E.dL = k.q^2.dE + dW \quad (23)$$

Where all the properties q, E, L, dR & dW are quantified for economy as a whole.

3.3.2. Equilibrium in economy

Reading state of an economy is now straightforward. The state would change by flow of resources, changes in prices, production, internal potential etc. We can fix such parameters be state defining parameters for economy; they are ecomperature, econtropy, population, number of goods etc. When any of such parameter changes, we should regard it to be change in state of the economy. We would call such state of economy as a whole be macrostate; this is state of macroeconomy. Also, we already have defined microstate be identification of specific population purchasing specific a good at specific (same) price. Due to possible permutations of varied goods, utilities, capabilities, traders & consumers there are uncountably many microstates in any economy. It is difficult to account each microstate individually, but there would be correspondence between collective evolution of the microstates and the macrostate of economy.

Tendency of consumers is to obtain the goods at lowest possible price, while tendency of traders is to sell the goods at maximum possible price. Hence taking the population and its spatial distribution into account, there is always maximization of the microstates. Economy proceeds such that the combinations of good-price-sale are maximized due to tendencies of consumers and traders. This fact leads to a golden rule: macrostate of the economy should evolve such that it has maximum number of microstates. This rule is much similar to principle 6 as it determines time evolution of economy. Econtropy is an abstract parameter; mechanism of microstate maximization can be adopted to interpret it well. Without loss of generality, we can identify econtropy of the economy (macrostate) with number of microstates existing in it.

Identifying econtropy of the economy with number of microstates in it would lead to arithmetical difficulties. Number of microstates in an economy formed by combining several is multiple of the numbers of microstates in individual economies. Such multiplicative property is a huge hectic for analysis leading to excessive difficulties in calculation. Unlike other additive properties, multiplicative property dominates numerical values. Simple solution to this concern is to identify the econtropy with logarithm of number of microstates instead of the number itself. Logarithm then makes it an additive property as needed. Thus let’s assume

$$L = k'.\log N \qquad (24)$$

Where k' is a general constant and N is number of microstates existing in the economy having econtropy L.

If an economy with microstates N_A is added to other one with microstates N_B, the combined economy has microstates N_AN_B. And due to (24), the econtropy should be sum of that of individuals because of the fact $\log(N_AN_B) = \log N_A + \log N_B$. Here, by addition we mean the economies to be in economic contact.

Definition 8: When people belonging to an economy get capability of doing transactions with people from other economy, then those economies are defined to be in economic contact.

When an economy say A with N_A microstates is added to other economy B having microstates N_B, then the resultant maximum number of N_AN_B isn't reached instantly. Upon the economic contact, people (i.e. consumers & traders) approach, negotiate and make relationships (i.e. transactions). Each newer relationship leads to a newer microstate, such increase in microstates proceeds with time after the economic contact. Let the number of microstates at an instant after facilitation of the economic contact be N, ultimately it should get equaled to N_AN_B but this equality isn't attained directly. Instead there is gradual increase in N till it achieves the limit of N_AN_B. Resources (i.e. potential) flow between A & B while increase in the microstates. Resources flow between the economies until- the increase in microstates due to gain of ecomperature of an economy is higher than decrease in that due to decrease in ecomperature of other. The resources stop to flow when entropy L reaches at maxima; this is the case when $d(\log N_AN_B) = 0$. If there is just the resource exchange and not any production, resource loss by an economy is equal to resource gain by other i.e. $\Delta R_A = -\Delta R_B$. Using this equality along with (21) & (24), we get

$$d(\log N_1N_2) = \frac{\Delta R}{k'}\left(\frac{1}{E_1} - \frac{1}{E_2}\right) \qquad (25)$$

$d(\log N_1N_2) = 0$ is possible in case of $E_1 = E_2$ only. Thus the equilibrium occurs when ecomperature of both the sub-economies are equalized. Alternatively, number of microstates is maximized when both ecomperature are equalized. Reversed resource flow is possible only after

the ecomperatures are equalized. This implies that resources flow from higher ecomperature to lower ecomperature, and the equilibrium occurs when ecomperature of all components becomes same.

Several sections of any economy can be considered as individual economies having certain ecomperatures. Equality of all the ecomperatures manifests equilibrium; change in ecomperature of any section would disturb the equilibrium. Then resources flow across to equalize the ecompreture of the fractions those are in economic contact. This is similar to thermal equilibrium of physical objects, all parts of the object have same temperature otherwise heat flows across the parts in thermal contact. Thus we get a new form of principle 6: resources flow from parts of higher ecomperature to that of lower ecomperature to attain uniformity in ecomperatures.

4. Applications of the theory to practical economies

We have explored much theoretical foundations enough to start applications to practical economies according to this new perspective.

4.1. Measuring Ecomperatures

We have discovered few theoretical principles about the economies. Now we should proceed to adopt these principles practically. To configure the economy we have tools of census, sampling and indirect data. Through all these tools we get sufficient information to configure the economy. By knowing prices experienced by the population, we get ecomperature of the economic section. For each good ν we should define P^0_ν what is ex production price of ν. It can be averaged over the production houses or can be calculated on basis of resources involved for production of ν or any indirect method can be used for defining it.

We should obtain data of prices P_ν among population about each good. Thus we will have specific population δn_j experiencing price $P_{\nu j}$. We can calculate ecomperature of the good in economy as

$$E_\nu = \sum_j \delta n_j \left(P_{\nu,j} - P^0_\nu \right) \tag{26}$$

Then by calculating E_ν for all the goods, with (19) one can calculate ecomperature of the economy. But gathering such huge data might be undesired task. In order to avoid this, we can exploit sampling and the law of large numbers. Through sampling we can obtain mean price $\overline{P}_\nu$ for each good. For sufficiently larger sample, following equality holds true

$$E_\nu = n\left(\overline{P}_\nu - P^0{}_\nu\right) \tag{27}$$

Hence for each good and for each subsection of the economy, we can obtain ecomperatures. Knowing population n, sampled mean price of a good $\overline{P}_\nu$, and ex production price of the good $P^0{}_\nu$ are the simple requirement for getting ecomperature of the economic systems.

Ecomperature defines state of the economy. Increase in E can be manifested by increase in prices, increase in population, increase in goods (introduction of newer goods & services) or increase in quantitative need of some goods.

4.2. Remarks on Quantitative Need

At all the instances the quantitative need q_ν comes as a multiple. Thus in order to make simpler application, q_ν can be concluded to be number or units of ν needed by an individual in a year (instead of that in unit time). Even with the larger time unit consideration for q_ν, it mimics the inertia. If we see seriously, changing time consideration in definition of q_ν should change value of k, as kq_ν is the property which mimics ultimate inertia.

Some goods such as house, personal vehicle, capital machinery etc. are needed at very lower numbers/units by individuals. The q_ν of such goods can be obtained by dividing the total units needed throughout a life by typical lifetime of individual. Several goods have deviation in q_ν among different individuals, while some have exact values of q_ν. For fixing q_ν for different goods in an economy, well knowledge of prior data in the economy and of statistical methods is required. A central authority or a responsible body should fix values of different q_νs in the economy.

Value of q_ν is almost constant in long run; but we can't generalize q_ν to be constant over time. Basically q_ν varies in the period when ν is newly introduced or under technological

evolution. For instance, we have witnessed change in quantitative needs of kerosene, photography services, phones, legal services, carry bags etc. Value of q_v is constant for most of the goods, it may vary for very few goods; further, it doesn't vary within a year for almost all of those few. Thus it is good strategy to regard q_v be constant for all the goods and reviews its value annually. There is scope for substitution of q_v as function of time or of other independent variable (like purchasing power index, technology adoption index etc.). But that is not necessary at such introductory stage; in future that separate scope can be explored when we get enough data and primary studies.

There is scope that q may vary beyond boundary of the economy, as the authority may not consider external concerns while defining q values for the economy. But the principle 4 provides guidance for the cases when there are changes in q or F in proper study.

4.3. Flow of Resources in the Economy

End of section 3.3.2 concludes that potential/resources should flow from sections of higher ecomperature to those with lower ecomperature in order to equalize the ecomperatures. Models mimicking heat transfer mechanism in physics can be developed in economies. We can define and identify specifically what sort of the entities lie between different sections of economy facilitating economic contact. Then we can configure the characteristic properties of the entities mimicking coefficients of conduction, or resistance. At this state I expect linear relationship between rate of potential flow and the ecomperature drop; but rigorous studies will reveal the fact well. Knowledge of the relationship between potential flow and ecomperature drop will be of great help to predict future prices in the sections of economy in economic contact. At later stages, we would construct a handbook about the resistance and coefficients of different entities facilitating economic contact. Ecomperature is directly dependent on population and prices (& the goods) in the sections of the economy. Thus changes in population and prices can be assessed/expected through ecomperature dynamics.

If to be compared with physics, then production mimics work done and trade mimics thermal (internal) energy. Thus economist can proceed to explore counterpart of theories of engines and work extraction with respect to specific resource source and resource sink.

In physics, there are two types of contacts causing flow of energy viz. thermal contact and mechanical contact (i.e. collision). The law of conservation of momentum guides for the later case. Our theory has explored exactly similar foundative principles. The former case is clear as manifested through equilibrium of ecomperatures. For later case we should identify smallest section of the economy such that there is no external impact, then sum of q_vF_v should be conserved i.e. change in flow of a good should cause the unbalanced change in flow of other goods.

4.4. Economy under Study

Like the thermodynamic laws are applicable to various types of thermodynamic systems considered for the study, the principles explored in this manuscript can be used. The six principles are general and are valid for any technical consideration as the economy. A well defined economy is to be identified where the principles can be applied; such economy may look strange, but the principles are valid there. Such exploration with applications of the principles to various system economies will lead to knowledge of newer mechanisms in economics.

It is often hard to absolutely configure the economy we expect. The fraction we fail to configure or parameterize properly for the study doesn't get included in definition of the economy. This would be typical case while considering economies having dominantly geographical boundaries. There many of any of goods, purchasers, traders & mechanisms are missed while the configuration which leads to exclusion of corresponding transactions from the economy. That is, such transactions technically included in definition of surrounding of the economy. But this surrounding is different from the typical surrounding we expect. One may define this to be black economy with respect to the study. Then exchange of resources, production and population with the black economy and that with surrounding economy might be accounted separately. We may explore parameters of the 'engines' operating between the economy & black economy.

4.5. Potential Retained by individuals

Persons or institutions those take decisions and perform economic activities (i.e. trade, sell and purchase), acquire potential or consume potential. By acting as labor, entrepreneur, capitalist, landlord etc. it acquires potential. When it acts as purchaser, consumes pre-acquired

potential. We can calculate the acquired potentials by knowing that labor & entrepreneurship are resources generated by the individual, ownership of land & rental estate is solely to the individual, and capital is generated by retained potential of the individual which too has sole ownership.

It is clear from definition of the flow in different equations that the seller gains potential while purchaser looses, as result of the transaction.

4.5.1. Labor

For labor, resource consumed is the persons own without any liability. Thus potential retained by labor (V_l) is equal to the potential it gets through routine (labor derived) transaction. For calculating potential gain by the labor we have to concern its salary. Let's denote salary by s. Further, we can classify labor in different types based on the skills or intelligence involved. The authority which defines q values for the economy, can also define q values for different such types of labor. By knowing requirement of a specialized labor and details of the firms which require such labor, the quantitative need of the labor (q_l) can be quantified. Value of q_l is quantitative need of the type of labor by single employer; in fact it is to be averaged over employers in the economy.

Thus by (4) & (6) we get

$$V_l = k.q_l.\frac{ds}{dt} \tag{28}$$

Here, ds/dt means salary per unit time. Salaries can be known on monthly or yearly basis and easily turned with respect to the time units. Here all the earnings like allowances, incentives etc. to be included in definition of s. It is possible to apply the theory by considering the specific labor as the economy where we may treat the allowances & incentives different from salary, but it will need our tools to be advanced a lot. For now we should proceed with gross assumptions.

By substituting s as function of time, time variation of V_l can be obtained. Fraction of such V_l is spent by the individual labor when it purchases something.

4.5.2. Landlord or Renter

In similar fashion, using (4) & (6) we get the potential retained by a landlord or renter (V_r).

$$V_r = k.q_r.x_r \frac{dr}{dt} + k.q_r.\frac{d\left(x_s.P_s\right)}{dt} - k.q_r.\frac{d\left(x_p P_p\right)}{dt} \tag{29}$$

Where x_r is units of land (or rental property) rented, r is rent per unit time obtained by the individual and q_r is quantitative need of the land (or the type of rental property). For defining q_r for the economy, different classes of lands and rental things can be identified and specific values can be defined for specifically. Of course, averaging over the individuals in economy for q values is an approach. x_s is number of units of the land (or rental estate) sold, P_s is selling price of the x_s units, x_p is the units purchased and P_p is the purchasing price for those units.

Hence we get the economic potential retained through all the transactions by landlord in certain time.

4.5.3. *Capitalists*

In very same manner, accounting for potential gain minus potential loss, we would get potential retained by capitalists (V_c) in the economy.

$$V_c = k\sum_s \left(q_{I_s} \left(\frac{d\,Re_s - dI_s}{dt} \right) + q_{int_s} \frac{d(int_s)}{dt} \right) \tag{30}$$

Where, s runs sectorwise (e.g. food, pharmaceutical, building, chemical etc.) among the economy. We can estimate need of investment anticipated in each sector and can also know total number of firms lacking optimum capital in that sector.

Thus,

$$q_{I_s} = \frac{\text{Investment need anticipated in sector s}}{\text{No. of firms in sector s needing investment}} \tag{31}$$

I_s is investment the capitalist doing in sector s, Re_s is repayment received by the capitalist from prior investments in sector s. The anticipation about the interests can be obtained as

$$q_{int_s} = \frac{\text{No. of investments done in sector s}}{\text{No. of capitalists in sector s}} \tag{32}$$

Here, number of investments means firmwise counting. Also, while calculating any q we regard the counting in overall economy. The int_s implies monetary interest received by the capitalist on prior investments in sector s.

Hence (30) gives economic potential retained by capitalists in certain time.

4.5.4. Entrepreneur/Businessman

Potential acquired is equal to that gained (by selling finished products & byproducts) minus that lost (by purchasing raw material, paying rent, interest, wages etc.). Thus considering all the accounting constraints on the entrepreneur we get potential retained by an entrepreneur (V_e) in the economy as

$$V_e = k\left(\sum_j q_j \frac{dj}{dt} P_j - \sum_i q_i \frac{di}{dt} P_i - x_r q_r \frac{dr}{dt} - \sum_k x_{lk} q_{lk} \frac{ds_k}{dt} - q_{int} \frac{d\,int}{dt} \right) \tag{33}$$

Here i runs over raw materials P_i implies cost paid of i; j runs over products & byproducts P_j is selling price of j; i and j in differentials are respective quantities or number of units purchased or sold. *k* runs over different kinds of labor x_{lk} is units of the kind of labor employed, q_{lk} is quantitative need for the kind of labor in the economy, s_k is salary for the kind of labor. The accumulated funds and capital can also be included in similar expressions, but I have excluded it considering for continuous potential acquired by entrepreneur in time dt.

4.6. Domestic Potential of the Economy

We can sum up the acquired potential of all the individuals in the economy and can define the sum as domestic potential gain of the economy. One concern is that the set of all the individuals in the economy may not be same as the economy under study. The domestic potential gain shouldn't mean the potential change in whole economy. But we can indeed identify the set of individuals be a significant subset of the economy. The gained potential should flow or be consumed from this subset to rest of the economy. The domestic potential gain is nothing but the change in internal potential if no part of it is consumed by the individuals. We can use principle

5 about such accounting. The increase/change in internal potential should be either transferred to other subset of the economy or to the surrounding (or to black economy), or it would dissipate in the economy. As internal potential is directly proportional to E, the dissipation should lead to increase in E of the economy. A just sum of the individual acquired potentials doesn't mean increase in internal potential, because soon significant portions of the acquired potentials are consumed for purchasing the goods. Thus there wouldn't be straightforward increase in ecomperature of economy. The domestic potential gain and change in internal potential of economy are different things, though they should be exploited for dependency.

The domestic potential gain is a better parameter to assess productivities in economies rather than conventional domestic products (or incomes). The products are obtained in units of currencies while the potential is obtained in units of Sm-currency i.e. Mx which is a true account of resources utilized behind the activities. Adopting scheme of domestic potential instead of domestic product would additionally facilitate different systematic studies about the economy according to the theory we just explored.

We can define the potential terms by treating credit as a good. Different classes of credit can be identified based on sectors, terms etc. Quantitative need for each class of credit might be treated constant or it can be substituted as function of time; initially it is better to treat it as annual constant like other q values. Sum of credit generated in the economy can be defined as domestic liable potential. Ratio of the liable potential to economic potential (gain) is a good parameter to assess safety of the economy. As banking and financial sector is well organized and regulated, data about liable potential can be obtained with higher specificity like that in current year, that accumulated in the economy, that is risked etc. Comparison of such specific credit data with domestic potential gain provides much data to study. The potential due to risked or abandoned credit is loss to economy, and this potential should be deducted from internal potential of economy according to principle 5.

4.7 Tax Concerns

The domestic potential gain is obviously parameter in economy to analyze, decide taxation. Taxes are collected in currency, and currency due to prices & earnings comes as just

multiple to other quantities like q, F & k. Thus tax can be directly accounted on the potential as fraction or percent.

Potential consumed by a purchaser leads to gain of potential to the seller and a fraction to government. Thus while accounting for potential gain by an individual, we have to just subtract as much fraction as the applicable tax. The remaining part is retained by the individual while the subtracted tax fraction is acquired by the government. Such tax deduced potential gain offers a true parameter for productivity in the economy.

5. Conclusion

In this paper we have explored rational principles of economics. By rational principles, we mean the mechanisms with continuous cause-effect links. The philosophical doctrine of physics is based on strong rational foundations, similar foundations for economics are discussed here.

Basically we concerned to account for changes in prices, and accounted changes in demand or supply as sole causes for changes in prices. A characteristic of each good which determines extent of price variation due to equivalent changes in flow does role of inertia; we got quantitative need along with a universal constant k as the inertia against price change.

We also searched for a quantity which would account all the efforts behind economic activity. We argued it to be capability change flow in specific amount that further has capability to change price in specific amount. We defined this to be economic potential. The potential can be extracted through resources and can be used for trade or production what is principle 5. Further we got ecomperature to be a state determining property for whole economy which quantifies internal potential i.e. potential due to trading. We also defined microstates in the economy and found that natural tendency is towards maximization of microstates. Thereby we got an important rule that an economy evolves to get in ecomperature equilibrium i.e. to attain same ecomperature for all its sections. And economic potential flows from sections of higher ecomperature to those of lower ecomperature.

Thus all the 6 principle collectively make essential & sufficient foundation to discuss such new doctrine in economics. Different sets of population, goods and initial prices, along with

the boundary identified can be considered as the economy under study, and the principles can be applied there to conclude fruitful results. It is exactly like thermodynamics and mechanics where we consider different systems under study and extract conclusion trough the foundative laws.

To start, I have discussed applications of the principles in section 4. There is vast possibility of studies with specific economies and the conclusions. Substitution of F or q (or P) as time dependent functions can provide a different toolbag for economists.

The approach to economics discussed here makes economics a causal and generalized study. It has potential to clearly claim economics be science as it has general principles with well defined constraints, further making experimental provision for the general treasure possible.

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