

CONSTRUCTAL LAW AND SCIENTIFIC DISCOVERIES

Companion Paper to the Presentation
to the 14th CLC 2024: “Constructal
Law and Resolving the Medicine
Crises in Romania”

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Reconciling the Constructal Law with Scientific Discoveries

ABSTRACT

The Constructal Law as formulated by Adrian Bejan needs to be customized to accommodate this large category of special type of flow systems the Man – Man flow systems.

For a finite Man – Man flow system to persist in time (to live) it must evolve optimally such as to ease and increase access to what flows.

And the Corollary to the Constructal Law for Man – Man flow systems is:

For a finite Man – Man flow systems to evolve optimally an equilibrium problem must be resolved to involve both DEMAND – SUPPLY functions and the unit transfer cost between markets.

All equilibrium problems are solving a minimization problem and a maximization problem. In this case the minimization problem is minimizing cost of the (commercial) operation and the maximization problem is maximizing (commercial) revenue. Optimal solution is a saddle point solution with a minimal cost and maximum benefit. For the commercial Man – Man systems the optimal solution consists of Optimal Prices and the dual variable Optimal trade flows. This is a nontrivial proposition as the dominant approach to Man – Man (commercial) systems is the one sided, engineering approach. Either prices or quantities are optimized allowing the dual variable to float randomly generating global market resistance valued at \$150 trillion as per economist Nomi Prins estimations.

INTRODUCTION

ECONOMICS IS PHYSICS.

Quote from Adrian Bejan’s article “Energy theory of periodic economic growth”: ‘

„Scientists from both sides of the divide have tried to find the connection between economics, physics, ecology and sustainability, therefore it is useful to take a look at ideas that were tried”.

Below an idea that has been tried successfully, is a physical mechanism built into our finitely converging algorithm of the OGP technology (Optimal Global Pricing) which is resolving optimally the economic transactional phenomenon and in particular resolving the commercial transaction problem at the micro-economic level. The problem is from (9) in references, solved previously by an infinite converging algorithm.

The formulation of the geometric programming problem representing the market modeling is shown below in Fig1.,2. We have here the Input network graph view and output network graph view of optimal solutions for commercial transactions.

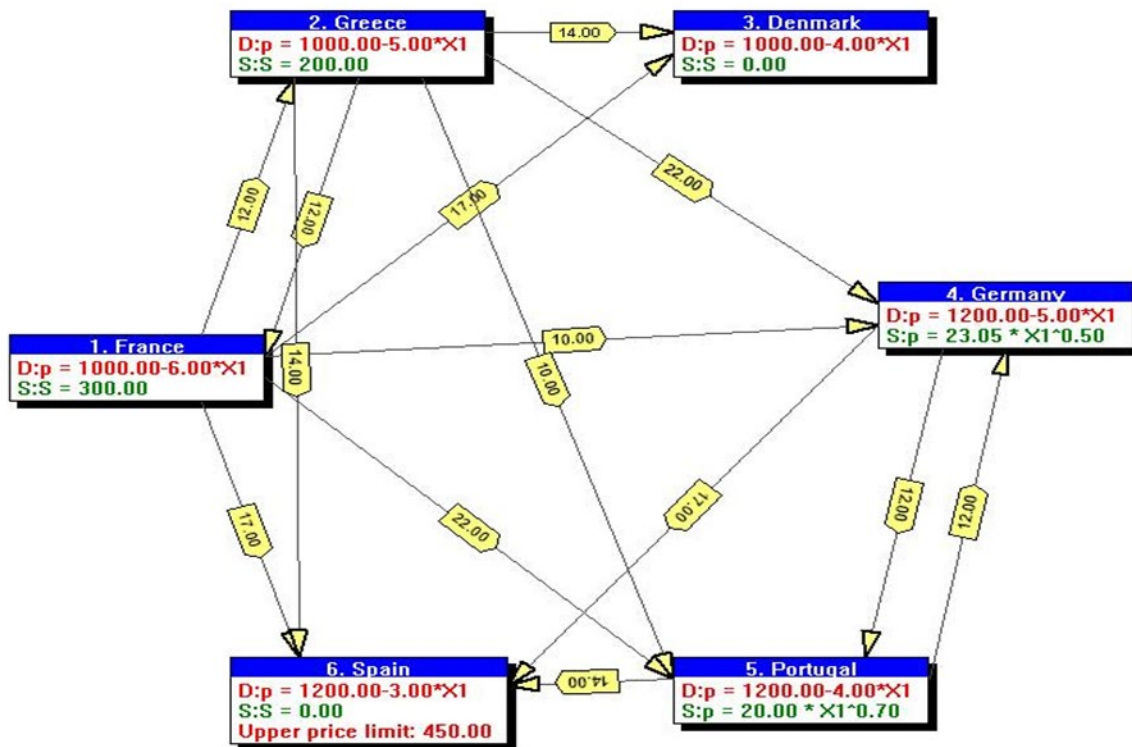


Fig 1.

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We have production units for this particular medicine in Germany and Portugal, warehouse amounts in France and Greece. In Spain we have an upper price limit imposed by regulators. Denmark is a pure consuming market. Demand functions for all markets and unite transfer cost for all possible trade routes are also represented in the input network graph. Unit transfer cost is represented in the yellow tags of the directed arc routes.



Fig 2.

Optimal solution: optimal prices and optimal trade flows. Optimal supply, optimal demand, optimal consumption are derived from optimal prices and optimal trade flows. The optimal trade flows are represented by directed arcs – the optimal route, from source to consumer plus the optimal amounts to be shipped which are represented in the yellow tags. Notice that there are no loops allowed, i.e. trade routs initiated and ending in the same market.

This OGP technology solving the problem above has been derived from our research at NCSU. We specialized the equilibrium of electrical circuits to resolve the economic equilibrium problem.

Currents in electrical circuits are trade flows in economic circuits and voltage in electrical circuits are price differentials between markets in economic circuits.

The physical process applied to economic circuits is located in our finitely converging algorithm with two types of iterations: Minor and Major. In the minor iterations the algorithm is differentiating prices between markets to attain maximum local revenue as per demand-supply functions. If the markets would be independent of each other the sum of local maxima would equal the global maximum. Markets are however not independent. They communicate with each other via the available trade

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routes and unit transfer costs. In the Major iterations the algorithm is harmonizing prices such as to avoid losses to market arbitrage. The resultant global maximum is greater than the sum of the local maxima because the arbitrage losses are prevented.

Notice that optimal supply plus import is always at least equal or exceeds optimal demand which serves to protect the optimal prices from being eroded. Optimal trade flows meet the requirements of the demand functions and also supplement the protection of optimal prices by occupying the trade routes that otherwise would be exploited by parallel traders. Optimal prices protect optimal trade flows as there are no more arbitrage profit margins taking left in the system. The values of the dual variables price and flow, that is Optimal prices and optimal trade flows are the necessary and sufficient condition for a commercial (transactional) operation to be effective and to 'persist in time'. Parallel trade or resistance to flow is therefore replaced by increased access to what flows. All revenue of this commercial transaction is benefitting the producer and consumer, i.e. is easing, increasing the access to what flows. This physical mechanism is endowing the commercial economic (transactional) system with 'persistence in time'. Optimal commercial systems are persistent in time, will live.

PAPER

Scientific discoveries on both sides of the divide, physical sciences and economics, happened in the past 50 years therefore it makes it worthwhile revisiting the formulation of the Constructal Law.

ECONOMICS

From the classical economics of Adam Smith with his 'invisible hand', to the Austrian Economics of Ludwig Von Mises who advocates a *laissez-faire* economy and affirms "Government is the only institution that can take a valuable commodity like paper, and make it worthless by applying ink." To the neoclassical economists like John Maynard Keynes and Milton Friedman (Nobel 1976) who correctly claim that prices (the cost of the transaction) are determined by the interplay of the market demand – supply however, mistakenly affirm that economies can be managed by fiscal and / or monetary policies; To the Nobel laureates in economics of these days, like David Card (Nobel 2021) with his empirical economics. As per David Card "Most old-fashioned economists are very theoretical, but these days, a large fraction of economics is really very nuts-and-bolts". This assertion means that economics is grounded in physics and we in economics, physics and operations research were aware of this since the late 70th. And John Nash (Nobel 1994) with his equilibrium model. The algebraic method of calculating the Nash equilibrium involves solving a system of equations addressing both demand and supply when solving economics problems. This is the same concept we have in the Peterson – Scurtu economic equilibrium model from the early 80th. The general equilibrium problem derived by Peterson from the equilibrium of electrical circuits and the economic equilibrium problem of Peterson – Scurtu are grounding economics in physics. This is the same finding of Adrian Bejan coming from thermodynamics:

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‘Economics is Physics’. Coming to the same conclusion via electrical engineering and thermodynamics is reassuring and asserting unequivocally that economics is physics. The Constructal Law is the crowning of all of this evolutionary history in economics as the Constructal Law is explicitly summing up how evolution is happening. The latest economic science is in fact closing an evolutionary cycle started in the late 18th century by Adam Smith with his ‘Invisible Hand’ driving the economy. The only difference between Adam Smith and today’s economists is that we now know what this ‘invisible hand’ is. This invisible hand is in fact the laws of physics and we now have a better understanding of what laws of physics pertain to what economic activity. Indeed, scientists from both sides of the divide have persevered and came to a better understanding of the connections between the physical sciences and economics.

From our own research:

- Laws of elasticity in physics govern economic cycles of a market economy at the macro-economic level (Reference (1) studies performed at REI – ASE Bucharest in the early and late 70th with some notable results).
- Laws of the equilibrium of electrical circuits govern all commercial activity, in fact all human transactional activity, at the micro-economic level (all new research of Peterson and All and latest economic Nobel laureates.)

MEET OUR TEAM



Elmor L. Peterson

Mathematical modeling of economic and / or complex engineering systems



Mircea Scurtu

Peterson’s Ph.D student
 Founder of OGT, 36 years in the pharmaceutical industry



Mihnea Emanuel Galca

Software Engineer, Politehnica Institute Bucharest



Barry Goodwin

William Neal Reynolds Distinguished Professor
 NCSU Expertise: Agric Marketing, Prices, Markets and Policy, Applied Econ, International Trade

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The economics of our team is in line with the economics of the recent Nobel Laureates David Card and John Nash. Our economics is 'NUTS AND BOLTS' and it also is 'EQUILIBRIUM'. Optimizing Man – Man flow systems is in line with the empirical research of David Card and equilibrium research of John Nash. Optimizing Man – Man flow systems is the key to recovering the \$150 trillion in resistance i.e. in wasted resources on the global markets and converting them into ease and increase to what flows. This would be the active participation of humanity in the natural phenomenon of globalization of the planet.

The OGP (Optimal Global Pricing) technology from OGT (Optimal Global Technologies) is the business application of the finitely converging algorithm that is solving the Economic Equilibrium Problem with exact numerical and optimal solutions for both Prices and Trade Flows. Among the multiple application the OGP technology are:

- resolving bottle necks when launching new products
 - resolving resistance to flow in global markets
 - resolving the medicine crises in low priced markets
 - evaluating inter-regional and inter-temporal competition,
 - evaluating alternative trade and tariff arrangements,
 - evaluating policies combining different levels of quotas, tariffs, export taxes, exchange rates,
 - simulating producing and consuming markets with various levels of minimum reserve requirements,
 - processing cost, retail markup margins, minimum prices and supporting other pricing and trade flows related activities.
- THIS IS THE SCIENTIFIC DISCOVERY that we want to fit into the Constructal Law.

PHYSICAL SCIENCES

Operations Research is the science of systems.

By an increasing degree of complexity these systems are:

- Machine – Machine systems
- Man – Machine systems
- Man – Man systems.

Constructal Law as formulated by Adrian Bejan:

For a finite size flow system (not infinitesimal, one particle, or sub particle) to persist in time (to Live) it must evolve with freedom such that it provides easier and greater access to what flows.

applies immediately to Machine – Machine, and to Man – Machine systems and in general to exact sciences.

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This fits well with Adrian's understanding of optimization widely known and accepted in engineering:

(page 68 Freedom and Evolution book) "Optimization is not mathematics. It is not the operation...This operation is finding the extremum of the function, the hilltop or the valley bottom, and nothing more. It has nothing to do with choosing between two or three concrete options that are useful and available, with the objective of making your own life better".

For Man – Man systems the Constructal Law needs to be more specific. Need to explicit what 'evolve with freedom' means. Man – Man systems are economic systems, including all commercial and in general all transactional systems of humans.

The understanding of optimization evolved in time to be more comprehensive.

In the history of Geometric Programming Peterson is stating:

"Fifty Years of Geometric Programming

An **Evolutionary** odyssey from

The **Optimal Design of *Individual* Components of Systems**

To

The **Optimal Design of *Entire* Extra-large-scale and Multi-scale Systems**

-- Including **Numerical Simulations** of their **Deterministic** or **Stochastic Behavior** --"

Transactional activity means transitioning a value from the source to the end user / consumer at a cost. And the value can be anything to make life better like goods, services, knowledge, science, art, religion. And the forces governing human transactions are the forces and the laws of demand – supply based in the socio - human factor.

Optimization **is** mathematics and the mathematical discovery resides with Clarence M. Zener (1961), Zener being the first to coin the term 'Geometric Programming', Richard Daffin 1967 and his Ph.D student Elmor L. Peterson. This new understanding of optimization is encapsulated in the Generalized Equilibrium Model of the three above. The applicability of this optimization in economics has been elucidated by Peterson and his Ph.D student Mircea Scurtu in 1983.

A quote from Adrian Bejan's book 'The Physics of Life' page 228:

"In physics, resistance is a concept from electricity (voltage divided by current), which was adopted subsequently in various fields of physics – fluid of mechanics, heat transfer, pedestrian, and animal movement".

These concepts from electricity / physics have also been adopted in many other fields including economics. Dr. Elmor L. Peterson and his collaborators have derived the general equilibrium model from the equilibrium of electric circuits. This general equilibrium model has been widely used in applications such as

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- simulation of heavy-hydrogen fusion and of note is that Americans have recently realized a controlled heavy-hydrogen fusion;
- Climate simulation and weather prediction with appropriate scientific laws that have been digitized;
- Cosmic simulation of the evolution of our universe with appropriate scientific laws that have been digitized;
- game theory;
- simulation of macro-economic equilibrium on monotone-network models of price-sensitive supply and demand;
- optimization of Obama's universal health care with appropriate physiological and empirically determined health-care laws.

Nothing short of this understanding of Optimization will do for Man – Man systems.

Optimization of Man – Man systems **IS** choosing between two or three concrete options in accordance with the interests of humans participating in these systems which are cooperative, competitive, adversarial or everything in between for the specific purpose of making their life better. A producer of a medicine is investing on average \$2.6 billion in R&D for each new medicine and is interested in getting paid for his efforts and paid as soon as possible as the patent life of the new molecule will expire in a few short years. The distributor of the medicine is interested in getting his fair share of the business somewhere around 10% – 15%. In the case of parallel trade distributors, they can take as much as 50% of the business. The global patient and the insurance company want to pay as little as possible for the new medicine weighing pros and cons for alternative medications. And it is **NOT** the hilltop or the valley bottom.

Optimization of Man – Man systems is both the hilltop and the bottom valley. It is the minimal cost and the maximum benefit. Optimization is the equilibrium problem, an equilibrium between the many interests of humans participating in the economic process are summed up by demand-supply functions and unit transfer costs. For Man – Man systems the duality of everything is the key to optimization. Dual variables are swinging in opposite directions. Quantities go up, prices go down; quantities go down prices go up. And the other way around. Prices being the independent variable, when prices go down quantities (sold) go up. Black Friday merchants know this very well. Optimization can be done in economic Man – Man systems **only by** actioning both dual variables price - quantity and unit transfer cost. Controlling the dual variables is the key to minimal cost, maximum benefit. Optimization for economic Man – Man systems where many humans are involved, differing interests are the driving force of Man – Man systems and the force driving economies, and in general all human transactions moving them ahead and PERSISTENT IN TIME.

Therefore, the Cosntructal Law for Man – Man systems can explicitly state what

‘Evolve with freedom’ means using the term EVOLVE OPTIMALLY.

For a finite Man – Man flow system to persist in time (to live) it must evolve optimally such as to ease and increase access to what flows.

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And the Corollary to the Constructal Law for finite Man – Man flow systems is:

For finite Man – Man flow systems to evolve optimally an equilibrium problem must be resolved to involve the dual variables price - quantity and the unit transfer cost between source and consumer.

The mathematical formulation of the equilibrium problem and in particular of the economic equilibrium is now available. See reference 2. Optimization is no longer a mental exercise, it is a mathematically calculated, predictive undertaking. Optimization of Man – Man systems is fully in accord with the predictive power of the Constructal Law. The economic equilibrium problem is not only working hand in glove with the Constructal Law but it is also quantifying the Constructal Law.

Man – Man systems are in fact the dominant, generalized concept of systems for animate and manmade systems. In fact, the Machine – Machine systems and the Man – Machine systems can be considered as subclasses of the Man – Man systems and are in the minority unless we also include in the Machine – Machine systems the inanimate systems. Who is to say if life or inanimate provide the dominant share of reality or if they are simply in balance. All human activity is driven by transactions and ultimately by commercial transactions. Every human activity can be defined by cost and benefit. Transactions are the blood line of all human existence. Commercial transactions are the peritoneum of all human activity. It is all about delivering value from the source to the consumer via a transaction cost and in accordance with the demand and supply laws based in the socio - human factor. And this is the case for any type of value. Therefore, formulating the Constructal Law with the term 'EVOLVE OPTIMALLY' is explaining the term 'EVOLVE WITH FREEDOM' for Man – Man systems. Evolving Optimally in fact is explicative of what it means to Evolve with Freedom: Optimal design, artificial design, is lessening the resistance to flow therefore the flow can occur with freedom contributing to the natural phenomenon of globalization. A Man – Man system CANNOT evolve with freedom unless the resistance to flow is resolved. Resistance to flow can be sometimes as high as 50% of the flow. Also, resistance to flow is growing faster than the flow itself because resistance to flow is legalized. From an article in IPI (Institute for Policy Innovation) titled "Parallel Trade in Pharmaceuticals" Jul 15, 2004 – "Parallel trade has grown exponentially since 2000 following the enactment of a law requiring pharmacists to replace brand names with re-imported drugs". Parallel trade is legalized in many parts of the world under the guise that it somehow will benefit the global consumer. This is contrary to our findings resolving the economic equilibrium problem with our finitely converging algorithm. See below Fig 1, 2.

Acting on only one of dual variables will allow the other dual variable to float randomly and generate market distortions via Parallel Trade. Parallel trade capital is nonproductive. In terms of the Constructal Law these distortions are the resistance to flow.

The OGP (Optimal Global Pricing) technology derived from our research at NCSU is illustrating these concepts above. It calculates the parallel trade occurring before optimization. In Constructal Law terms it calculates the resistance to flow. Followed by calculating the optimality conditions in the format of exact numerical and optimal solutions for both Optimal Prices and Optimal Trade Flows.

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Below from a study on the commercialization of Adalimumab by the pharma company AbbVie is an illustration of the claims above.

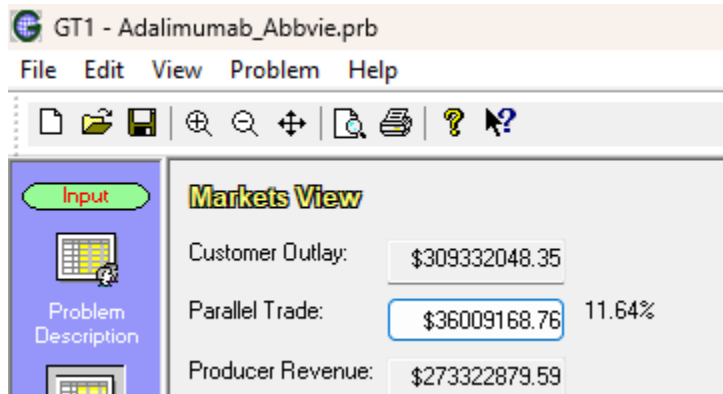


Fig 1.

11.64% of the business is lost to resistance (parallel trade) before optimization, \$36 million.

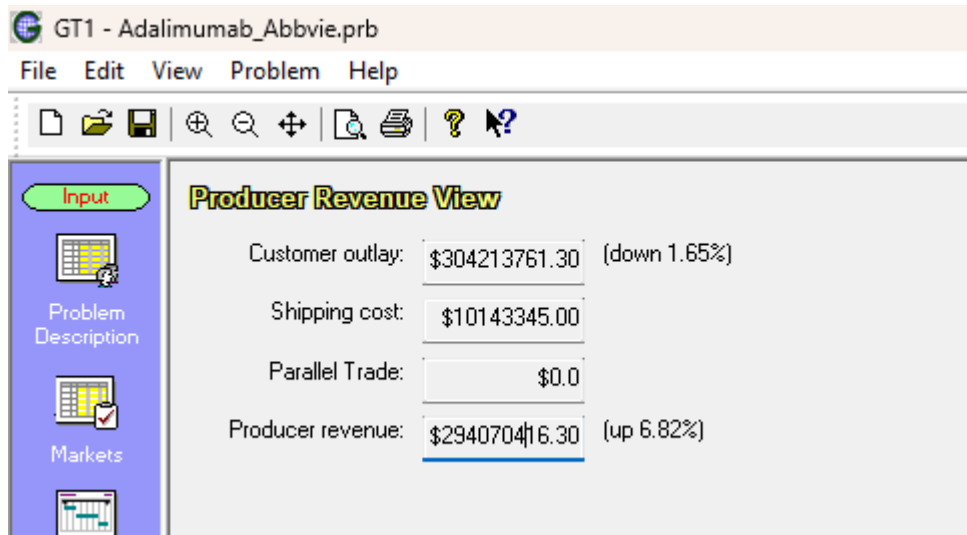


Fig 2.

With the optimal solution for both prices and trade flows this resistance is converted into increased access to what flows by improving customer welfare by 1.65% (\$5 Mil) and increasing producers' revenue which is productive capital, by 6.68% (\$21 Mil) These quantities will increase the access to what flows.

To put some prospective on this result, below another illustration in Fig 3,4 from a study on seven European countries, five medicines (to include de medicine above). The increase of the access to what flows is more substantial: \$2,427,583,377.53 + \$865,664,157,94 = \$ 3,293,247,535.47 (\$3.3 billion) At the level of the global medicine business the increased access

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to what flows is between \$100 - \$200 billion a year. This is converting resistance into productive capital. This is an estimate using our OGP technology for a limited number of medicines and extrapolating it to the global business with medicines. Other estimates, from other authors, are in the same ball park.

Below a partial graph representation of an optimal solution

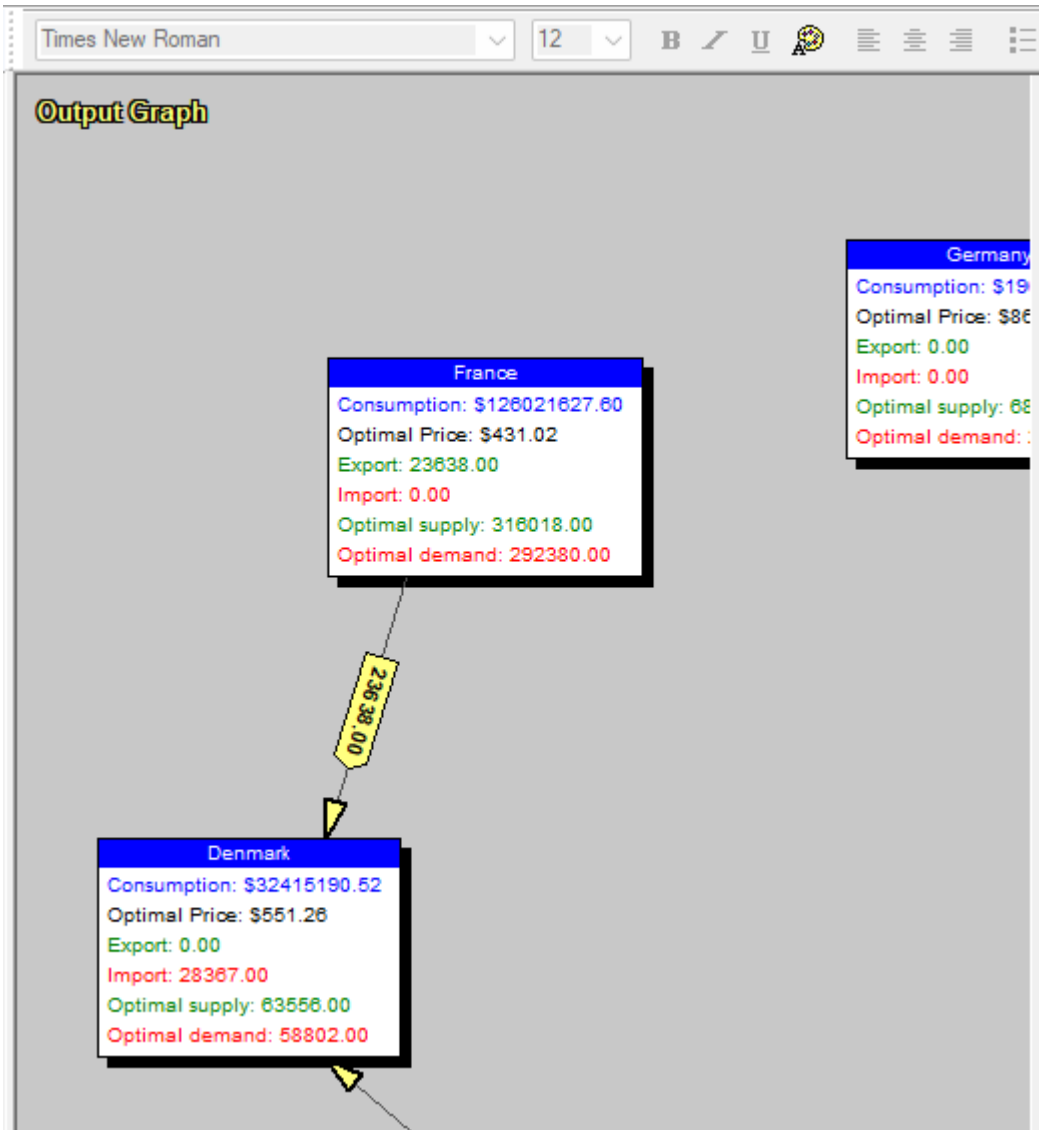


Fig 3.

Again, from the optimal prices and optimal trade flows Optimal Supply and Optimal Demand can be derived. Note: the optimal solution to the economic equilibrium problem provides solutions for all four pieces of the marketing mix: product, price, distribution, promotion. This is the complete commercial transaction. This is an important note as some paper given to the 12th edition of the Constructal Law conference in Torino is basing their conclusions on only the distribution of products. Distribution of products is not comprising the whole commercial transaction. Optimal supply will provide the producer with indications upon the product -

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production levels / capacities. Optimal price is readily available as the main result of optimization. Distribution is optimized by the Optimal Trade flows. Promotional expenses can be fit into the R&D and commercial activity budgets by simulations also known as Sensitivity Analysis. Optimal supply will typically equal or exceed optimal demand so that the optimal price is protected from erosion, persist in time, and also discourage market distortions (resistance). Optimal price will protect optimal flows. Duality of prices and flows is the key to optimization. Optimal trade flows also occupy the routes otherwise exploited by parallel traders. This is the intimate physical mechanism by which global markets will operate optimally.

Summary of the same problem is available in the table below, Fig 4.

Parallel Trade earnings in seven European countries to be returned to pharma and global patients.

Medicine	Pharma sponsor	Recorded Parallel Trade	Actual Parallel trade losses	return to pharma	welfare improvement global patient	Global Annual sales 2018	Pharma gains with optimal solution	Global patient gains with optimal solution
Adalimumab (Humira)	ABBVIE	8.48%	11.64	6.82%	1.65%	\$20,358,000,000	\$1,388,415,600	\$335,907,000
Levothyroxine Sodium	Abbot	0.59%	18.38%	12.69%	6.13%	\$2,600,000,000	\$329,940,000	\$159,380,000
Enbrel (Etanercept)	Amgen Pfizer	8.27%	15.42%	13.9%	1.76%	Not available; seven European countries sales 2017 \$2,677,631,644	\$372,190,798.52	\$47,126,316.93
Infliximab (Remicade)(DRY INF VIAL 100MG 1)	Johnson & Johnson	13.83%	17.86%	8.93%	8.61%	\$3,700,000,000	\$330,410,000	\$318,570,000
HYDROXYCHLOROQUINE (Plaquenil)	Mylan, Teva	4.54%	47.6%	13.11%	9.26%	Not available; seven European countries sales 2017 - \$50,549,039	\$6,626,979.01	\$4,680,841.01
Average			22.18%					
Total revenue returned to pharma sponsor via optimal solution							\$2,427,583,377.53	
Welfare gain to global patient								\$865,664,157.94

OGP (Optimal Global Pricing) technology can measure size of global parallel trade markets from market statistics.

Calculations performed on IMS statistics 2017.

* Factoring in client statistics will likely drive up these numbers.

Fig 4.

Notice that recorded parallel trade is always under reported due perhaps to some deficiencies in the various market statistics and also perhaps due to the explicit intent of parallel traders to

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hide some of the significant amounts of free money. Parallel traders also will need to somehow legitimize their claim that they somehow benefit the global patient and so far, they have been successful. Parallel trade is legalized in many parts of the world as a beneficial commercial activity. This is contrary to our findings.

This is a significant scientific advancement in Physical Sciences and Economics. It is about human transactional activities and would be great to be reflected in the Constructal Law.

EXAMPLES

1. Spatial / Temporal network optimization of the well-publicized problem (13) 'Fresh Sweet Cherries Distribution'. 47 markets of which 7 spring supply markets, 7 fall supply markets, 15 spring demand markets, 15 fall demand markets, available trade flows from each supply market to each demand market with unit transfer cost. The graph representation of the Mathematical market model – Demand / Supply markets with available trade routes and unit transfer costs is represented by directed arcs is in the Fig 5 below.

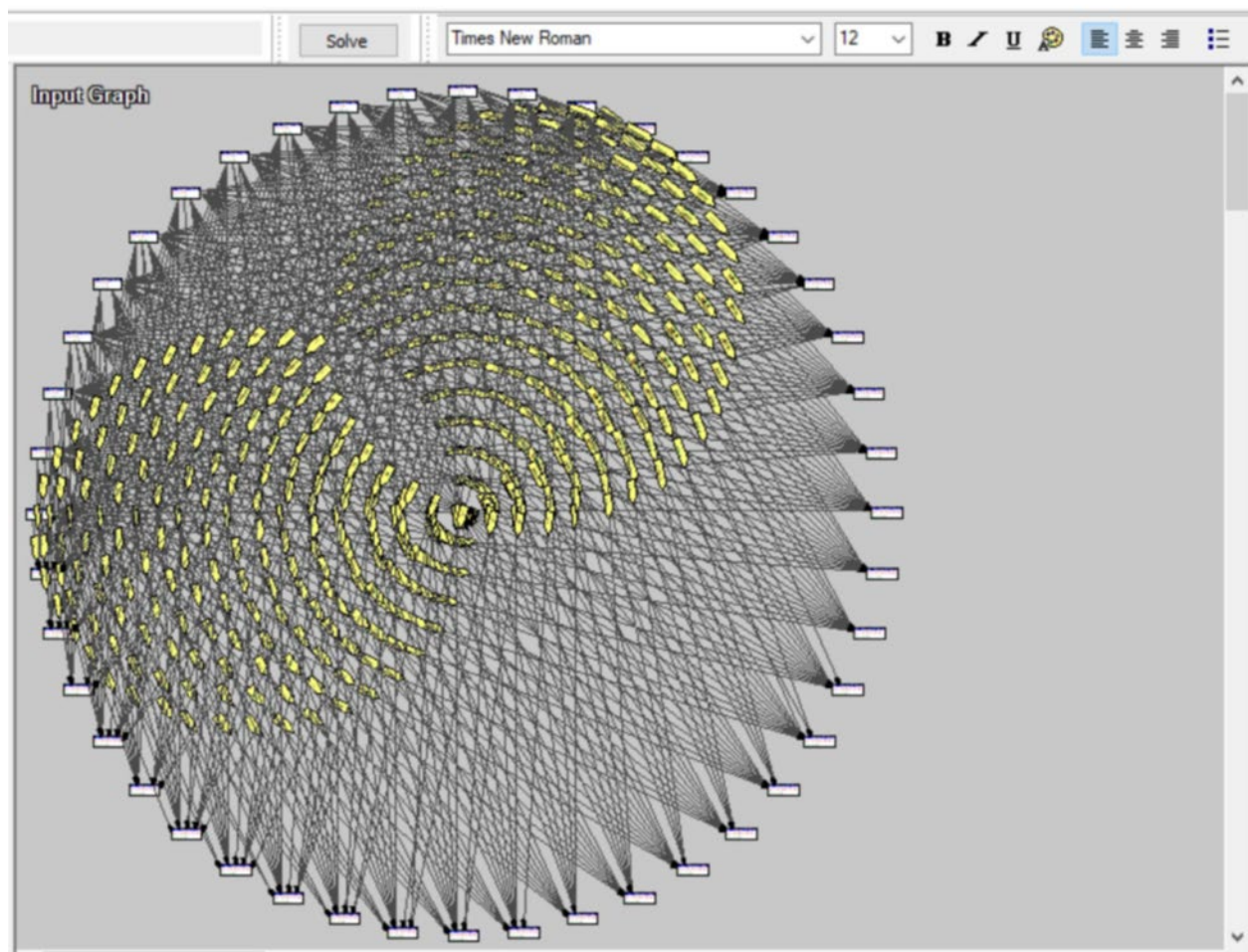


Fig 5.
A snap shot of the network trade routes, directed arcs with unit transfer cost in yellow tags is represented below in Fig 6.

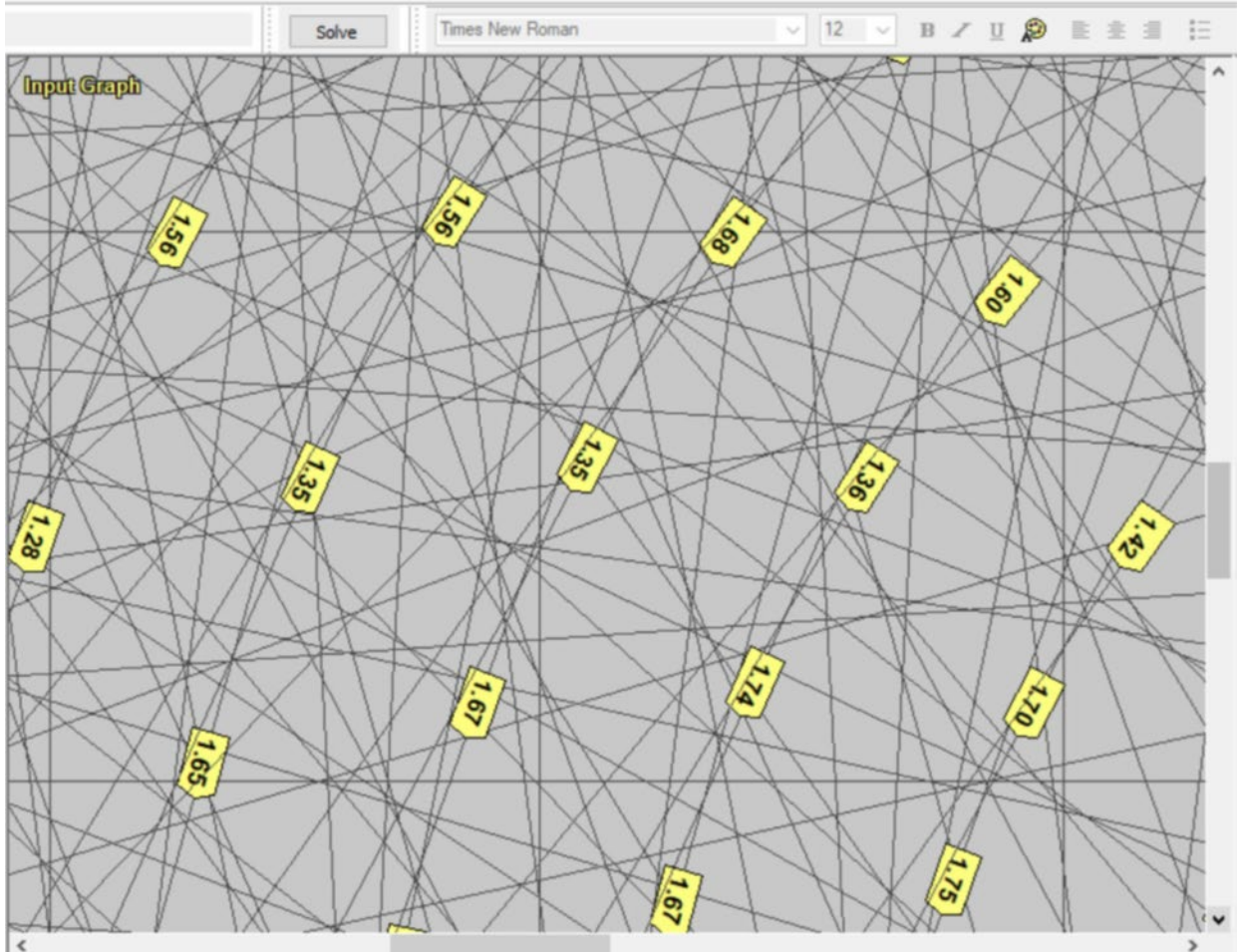


Fig 6.

Another detailed view of the original graph representation is in Fig 7. below.

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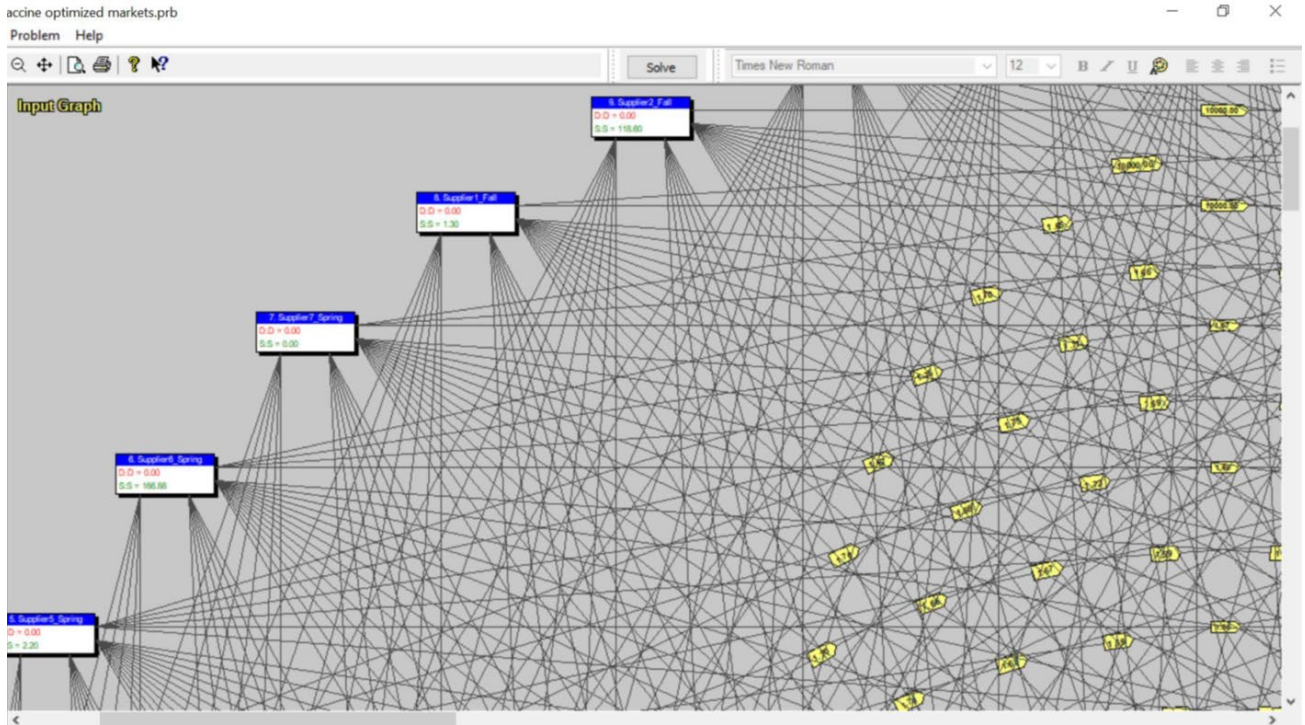


Fig 5.

This problem has been resolved previously with an infinitely converging algorithm and the solutions are significantly different from the optimal solutions resulting from our finitely converging algorithm. Optimal solutions will guarantee 'persistence in time'

2. The problem above in Fig 4. Is organized into a new table to highlight the quantification of the Constructal Law.

* Ballpark estimate

Equilibrium and Constructal Law for Man – Man flow systems are operating like hand in glove. They are two sides of the same coin and inseparable. Talking about Man – Man systems to persist intime without our present understanding of equilibrium makes no sense.

Quantifying the CONSTRUCTAL LAW – the nuts and bolts of economics, equilibrium																																															
Finite Flow System	Globally traded Humira, Enbrel, Levothyroxine Sodium																																														
To persist in time (to live)	Spatial optimization; optimized / in equilibrium markets are efficient therefore persistent in time. Simulations will extend the time frame.																																														
Evolve with freedom	Resolve resistance of 8.47%, 15.66%, 18.82% will induce evolution with freedom																																														
Greater access to flow	Greater access by \$25.9mil + \$19.46mil + \$31.0mil = \$76.36 mil																																														
Greater access to flow annual sales: \$20.36 bil, \$0.37bil, \$0.33bil	Greater access by \$1.7 bil + \$372 mil + \$489.3 mil = \$ 2.561 bil																																														
Greater access to flow Portfolio: \$58.054bil, \$100.3bil, \$43.7 bil	Greater access by \$4.9 bil + \$15.71bil + \$8.22 bil = \$ 28.83* bil																																														
Optimal Solutions: complete solution for Humira for the dual operational variable's price / flows	<table border="1"> <thead> <tr> <th></th> <th>Optimal Price</th> </tr> </thead> <tbody> <tr><td>Denmark</td><td>\$551.26</td></tr> <tr><td>France</td><td>\$431.02</td></tr> <tr><td>Germany</td><td>\$860.20</td></tr> <tr><td>Greece</td><td>\$456.40</td></tr> <tr><td>Portugal</td><td>\$469.60</td></tr> <tr><td>Romania</td><td>\$378.76</td></tr> <tr><td>Spain</td><td>\$605.47</td></tr> </tbody> </table> <table border="1"> <thead> <tr> <th colspan="5">Optimal Trade Flows View</th> </tr> <tr> <th>#</th> <th>Shipments from-to node</th> <th>Quantities shipped</th> <th>Unit transfer cost</th> <th>Shipping cost</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>France to Denmark</td> <td>23638.00</td> <td>172.50</td> <td>\$4077555.00</td> </tr> <tr> <td>2</td> <td>Romania to Denmark</td> <td>4729.00</td> <td>172.50</td> <td>\$815752.50</td> </tr> <tr> <td colspan="2">-----</td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td>TOTAL</td> <td>28367.00</td> <td></td> <td>\$4893307.50</td> </tr> </tbody> </table>		Optimal Price	Denmark	\$551.26	France	\$431.02	Germany	\$860.20	Greece	\$456.40	Portugal	\$469.60	Romania	\$378.76	Spain	\$605.47	Optimal Trade Flows View					#	Shipments from-to node	Quantities shipped	Unit transfer cost	Shipping cost	1	France to Denmark	23638.00	172.50	\$4077555.00	2	Romania to Denmark	4729.00	172.50	\$815752.50	-----						TOTAL	28367.00		\$4893307.50
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	TOTAL	28367.00		\$4893307.50																																											

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3. Resolving the medicine crises in low priced markets (case study Romania)

Medicine	Consumption before solving parallel trade problem	Consumption after solving parallel trade problem	Net consumption gain after the parallel trade problem is solved
Adalimumab	\$21,552,580.28	\$31,368,347.78	45.54% OR \$9,815,767.5
Levothyroxine Sodium	\$1,995,759.0	\$3,326,265.00	66% OR \$1,330,506.0
Enbrel (Etanercept	\$11,660,590.90	\$18,488,808.0	58.5% OR \$6,828,217.1
Infliximab (DRY INF VIAL 100MG 1)	\$2,584,024.2	\$5,311,134.13	48.65% OR \$2,727,109.93
HYDROXYCHLOROQUINE	\$287,864.82	\$495,767.19	72.2% OR \$207,902.37
Total consumption gain for medicines previously in short supply			\$20,909,502.9
Average medicine consumption gain after parallel trade problems are solved			58.18%
Total consumption gain for the 494 medicines after parallel trade problems are resolved			\$2.07 billion

Fig 6.

\$2.07 billion are retrieved for the 494 medicines in short supply in Romania. These resources were consumed in the global market by resistance / frictions / distortions and now returned to increased access to what flows; i.e. flow of consumption.

The resistance i.e. activity of parallel traders, are buying the product in low priced markets and reselling it in high priced markets depleting the product stocks in these low-priced markets. Medicine crises are wide spread in Europe and third world markets increasing inequalities and accumulating wealth to the point where wealth becomes polarized. This in turn is disturbing the buying power balance of the many poor versus the few rich. Optimal solutions in the form of Optimal Prices and Optimal Trade Flows are mitigating this resistance / waste, enabling more access to flow of consumption.

DISCUSSIONS

These resistance / distortions in the global market are causing hyped up inequalities, accumulation of wealth to the point where this accumulation becomes polarized and will interfere with the normal global economic activity and in general with human transactions. The aggravating factor is that the

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resistance to flow is presently growing faster than the flow. This in turn will disturb the buying power balance in the global market between the many poor and the few rich. This time it will be the many poor countries and the few rich countries. The negative incremental returns from the commercial activity are imposing the question: how long will it take before the global economic cycle will be coming crashing down: years? decades? In any case the global economic cycle matures. Of course, economists and policy makers learned more or less to mitigate the undesirable negative implications of the crash of an economic wave. In the US policy makers fully understand economic cycles and mitigate the negative effects of crashing of the economic wave by propping up the balance of the buying power between the many poor and the few rich by disbursing thousands of dollars to the poor individuals. This is fine except that this is only a band aid solution. The real solution is to resolve the prevailing market distortions / resistance to flow.

Will have to see how much these macroeconomic policy makers really understand the global commercial activity and how much they will be interested in mitigating the negative effects. This would be the responsibility of an emerging government of the planet which is off by how many years / generations? We have all sort of international political, social and economic organizations. Will all these organization coalesce toward a government of the planet? The timeframe is anybody's guess at this time. In any case the economist Nomi Prins sounded the alarm about this phenomenon. In her estimations the nonproductive wealth accumulation, or in Constructal Law terms the resistance to flow, is valued at \$150 trillion at this time. Of the globally generated energy 60% is wasted in global market distortions or in Constructal Law terms in flow resistance. It just may be that resolving this market resistance with our algorithm may substantially increase the global energy supply without any additional investments.

Solutions to this new approach to transactional activities are abundant and are becoming more relevant. The natural evolutionary process is working. See references.

REFERENCES

1. Mircea Scurtu: Aplicarea teoriei elasticitatii din fizica la studiul ciclurilor economice ale unei economii de piata la nivel macroeconomic. Academia de Studii Economice, facultatea Relatii Economice Internationale editiile XIX, XX Sesiunile a Cercurilor Stiintifice Studentesti Aprilie 1975, 1976; Rector
2. Mircea Scurtu, Thom Johnson, Thomas W. Reiland, Elmor L. Peterson: An Empirical Study of Spatial Economic Equilibria via Geometric Programming. NCSU 1986 Operations Research Program
3. Adrian Bejan: Freedom and Evolution. Hierarchy in Nature, Society and Science.
4. Adrian Bejan: The physics of Life. The evolution of Everything.
5. Fang, S. C. and Peterson E. L.: "Generalized Variational Inequalities" Journal of Optimization Theory and Applications, 38,3 1982, 363-383
6. _____ ' "General Network Equilibrium Analysis", International Journal of Systems Science, 14,11,1983, 1249-1275.
7. _____ ' "An Economic Equilibrium Model on a Multi-commodity Network", International Journal of Systems Science, 16,4,1985,479-490

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8. Irwin, C.L., and Yang, W.C. "Iteration and Sensitivity for A Spatial Equilibrium Problem with Linear Supply and Demand Functions". *Operations Research*, Vol 30, No. 2 March – April, 1982.
9. King, R.A. and Gunn, J., "Reactive Programming User Manual: A Market Simulating Spatial Equilibrium Algorithm" Economic Research Report No. 43, Dept. Of Ec. & Bus. NCSU Raleigh N.C. Dec 81.
10. McCarl, B.A., and All, "Sebend: A computer Algorithm for the Solution of Symmetric Multi-commodity spatial Equilibrium Problems Utilizing Benders Decomposition". Special Report 708, Agricultural Experiment Station Oregon State University (March 1984)
11. _____ ' "The Conical Duality and Complementarity of P and quantity for Multi-commodity Spatial and Temporal Network Allocation Problems". Center For Math. Studies in Economics and Management Science: Disc. Paper #207, Northwestern University, Evanston, 111., March 1976.
12. Peterson, E.L., Eaves, B.C. and Asmuth, R., "Computing Economic Equilibria on Affine Networks with Lemke's Algorithm", *Mathematics and Operations Research*, 4,3,1979 209-214.
13. O'Rourke, A.D., and Casavant, K.L., "Interregional and Intertemporal Competition in Fresh Sweet Cherries". College of Agriculture Research Center, Washington State University, Bulletin 803. (November 1974)