Econophysic Approach: Update and Extensions

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Safe and Ethical Cyberspace, digital assets and risks:
How to assess the intangible impacts of a growing phenomenon?

The World Conference on Intellectual Capital for Communities

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Value is the Problem

- Evaluating acquisition investments in defense (e.g., USA DoD) and governmental organizations do not have a non-monetized, quantitative common units value parameter
- The value/cost ratio of acquisitions of information technology are problematic for this reason
- Most information technology applications have large amounts of embedded intellectual capital as well as risk
- The value added by embedded intellectual capital cannot be determined via traditional accounting and finance
- A new theory of value is required to account for this “missing value” phenomena

Economics to Physics Analogy: Progress IC9-IC13

Economics	Physics	IC 9 – IC 13
Value Concept: Non Monetized Value **Protovalue:** Potential or Perceived Satisfaction/ Cost Barriers **Actual Value** : Use or Work Value (WV)	**Mass** **Potential Energy** **Kinetic Energy**	IC 9 (2013): PEML: Potential Energy, Momentum, Location General Model using basic Energy to Value Analogy and IC/SC Value Model
Product/Service Complexity **Proto Value (v2)** **- Product or Service Fit Matrix** **- Distance**	**Mass (v2)** Total Potential Field/Energy (PE) Distance = radius between masses **Velocity and Momentum**	IC 10 (2014): Facebook, Google: Revenue, Adoption rate velocity examples
Proto-value Adoption Curves and Revenue Curves Producer Offerings, Customer needs	**Action =** Δ Time * Δ Energy	IC 11 (2015): WhatsApp example compared to competitor over one year adoption rate period
Satisfaction = Happiness **Point of Sale: and Actual Use** Vector Coordinate Space / Normalized Distance General Solution Space	**Δ PE = Amount of Action** **Amount of Action:** ΔA = Δ PE * Δ Time ΔA = Δ KE * Δ Time	IC 12 (2016): Protovalue of Mpesa (microfinance) for Kenyans compared to South Africans
Satisfaction Flow = Exchange Rate **Point of Sale Satisfaction =** : Δ Protovalue (PV Before Exchange – PV After the Exchange) Rate of Adoption, Innovators and Imitators Effects of Advertising and Peer-to-Peer Messaging	Δ **Energy =** EΔ **Organized Potential Energy +** Δ **Organized Kinetic Energy**	IC 13 (2017): Notional Smart Phone: Adoption Phases, Customer Segmentation, Market Saturation ABFE 2017: Notional Social Influence Sensitivity Analysis
Earned Value Management: Cost, Schedule, Performance, but not ROI Earned Value Management: Cost, Schedule, Performance, and risk and volatility but not ROI IC, Creativity	Mass, Distance (adapted to EVM parameters) Physical Economy Human Perception, Biases. Event/Process based need – satisfaction parameters Turbulence Modeling	15th ARP Symposium EVM notional DoD Acquisition example IC 14 (2018): Modeling IC and creativity in DoD Acquisitions ABFE October 2018

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Modeling Intellectual Capital and Creativity

Step 1:
Build a simple equilibrium economy showing the flow of action in various forms as they progress in time through the economy and interfacing with Nature.

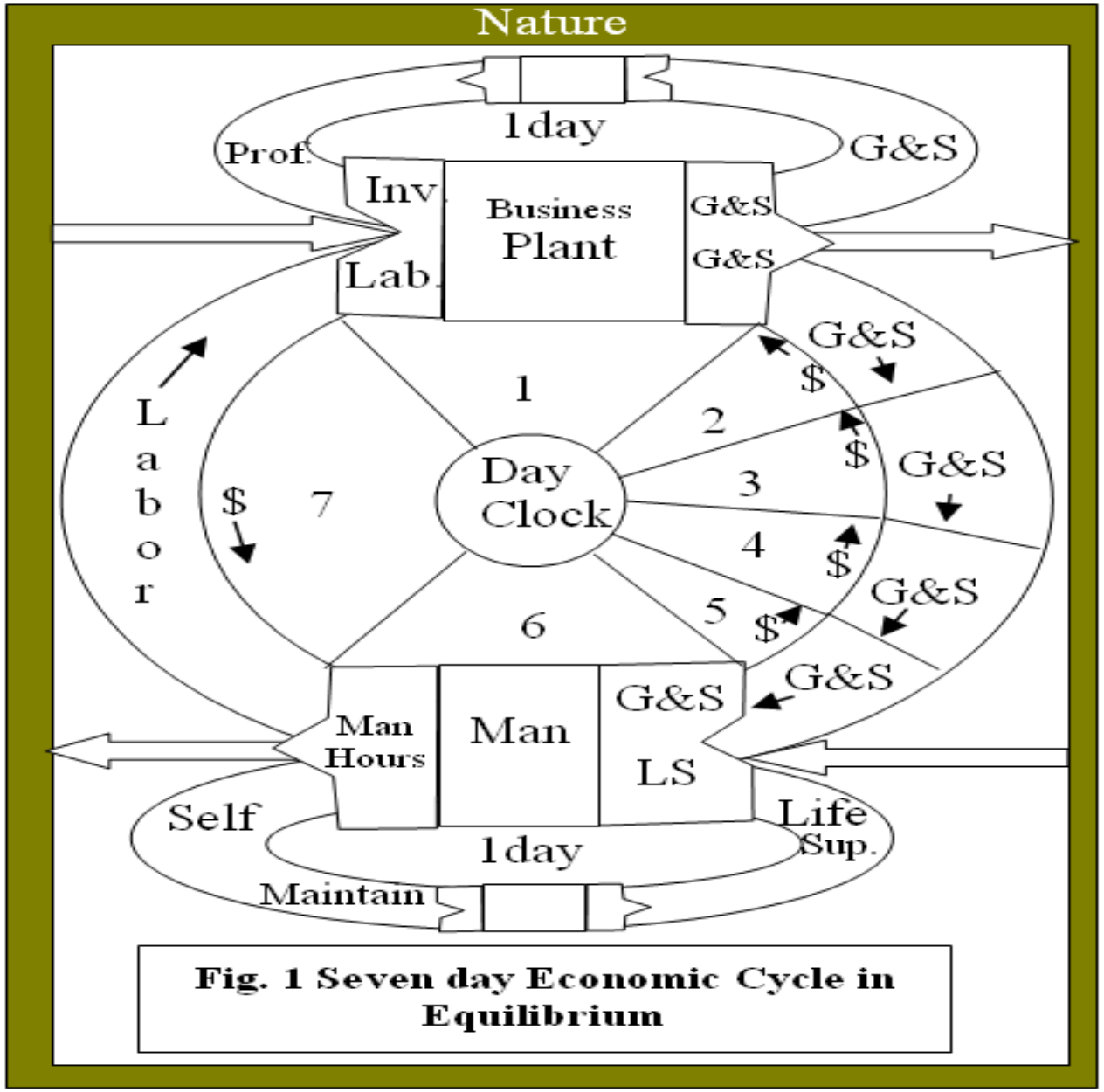


Fig. 1 Seven day Economic Cycle in Equilibrium

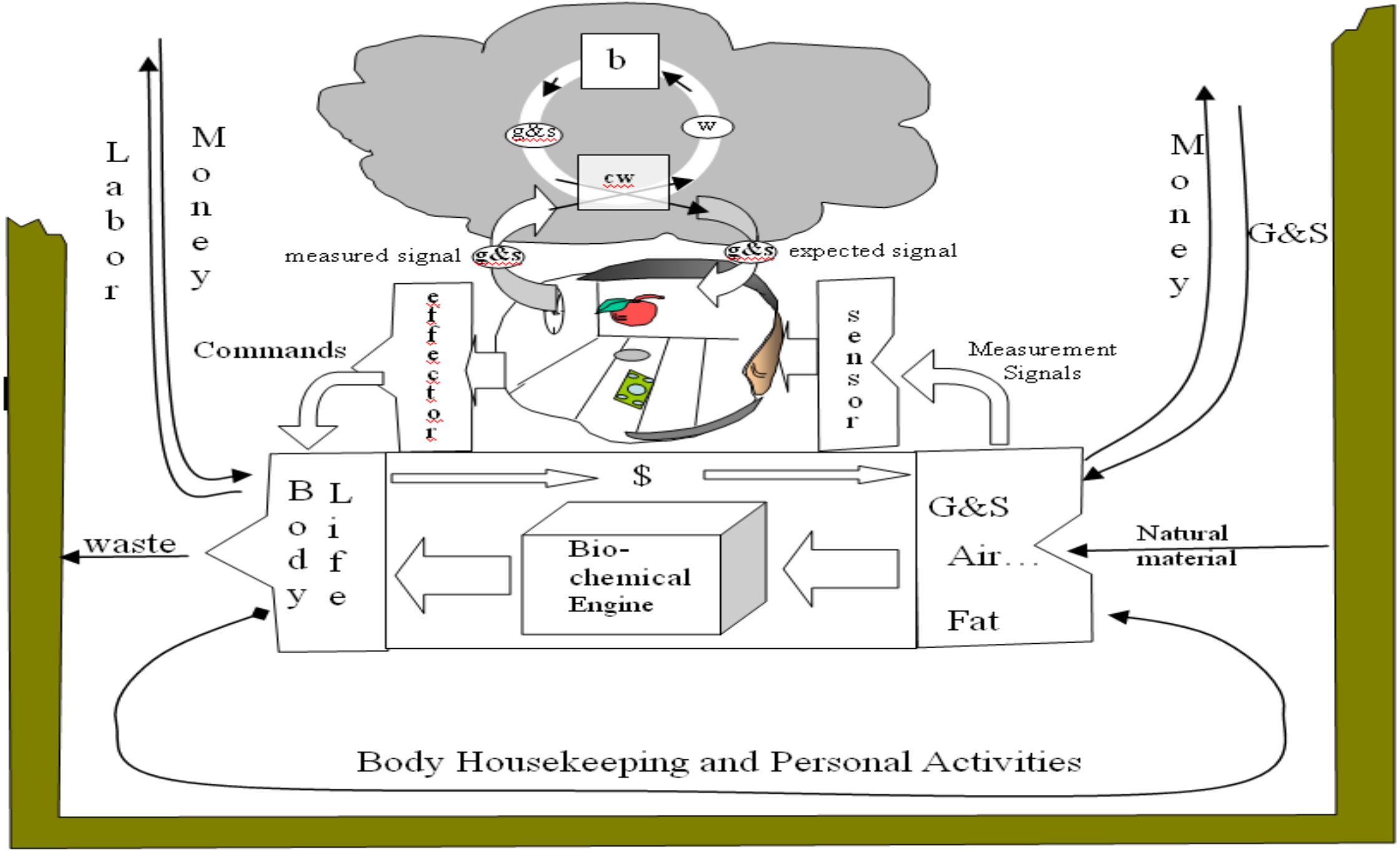
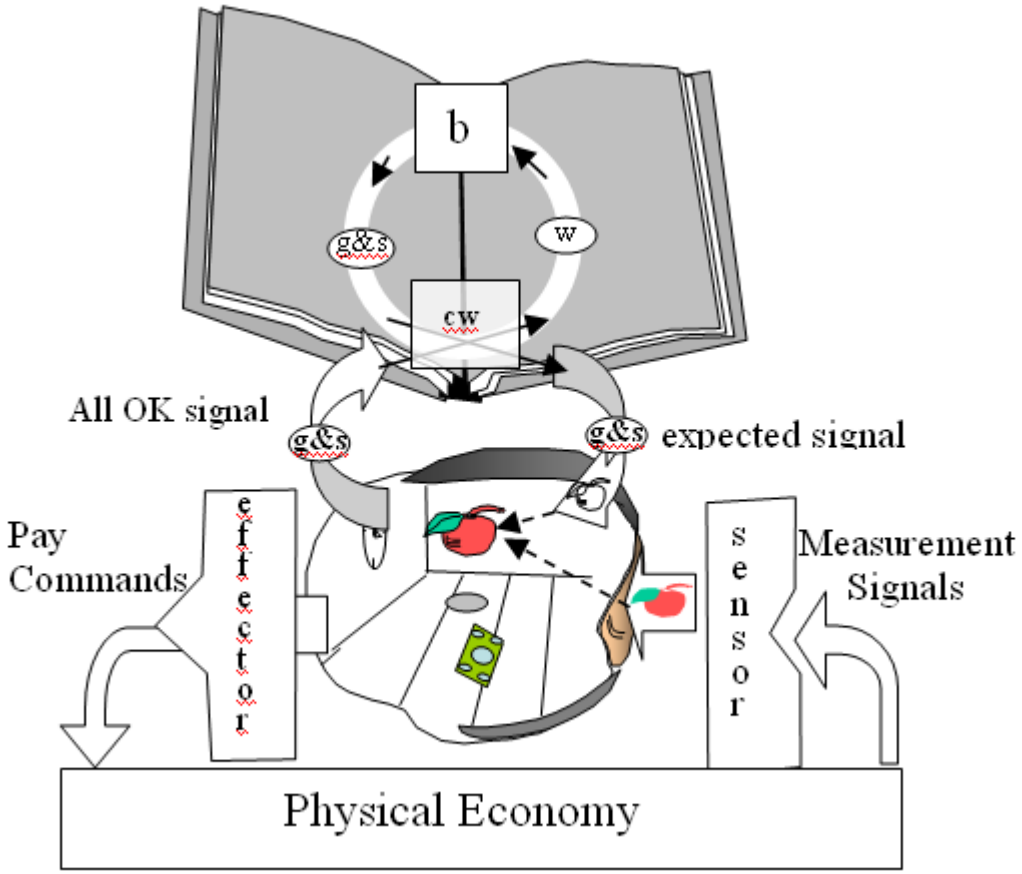


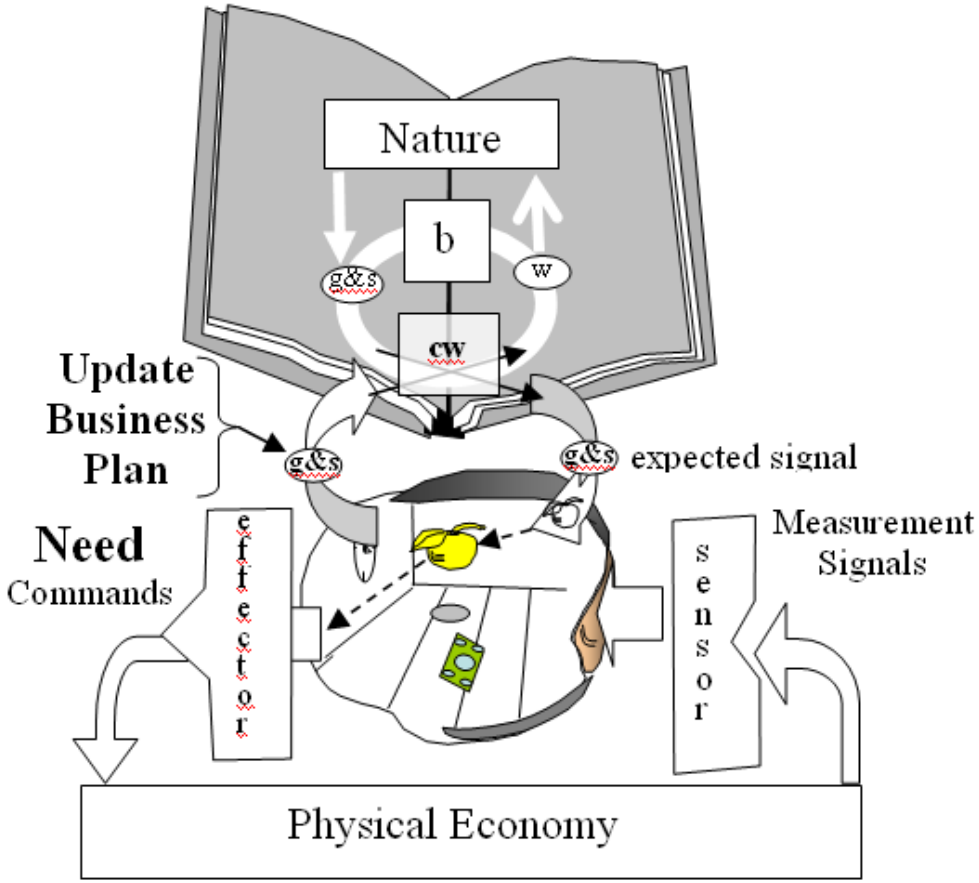
Fig. II-1 Mind and Body Model of a Customer-worker

Externalizing the Thought Process into a Business Plan

When Business Plan Works



When the Business Plan Fails



Framework of Principles for developing Quantitative Calculations for Creativity and Intellectual Capital

Treat the Business Plan as a Program implemented by economic participants

Map the control interactions between the Business Plan and economic participants

Analyze the generation of Need signals and Business Plan updates in response

Observe development of new interactions with Nature as a source of creativity

Calculate the Complexity of the Business Plan in execution of action bits

Utilize the Quantum Physics analogy where Proto Value is calculated from

$$PV = \frac{\Sigma_{f,t} \Psi_f \bullet A^f_t \bullet \Psi^{t*}}{\Delta T}$$

Where: Ψ_f are the expected and measurement signals, and "A" is the action structure of the Business Plan when implemented as a Computer Program

Conclusions and Next Steps

- The value of the IC embedded in IT acquisitions can be quantified in non-monetized parameters
- It is necessary to model the mental operations of acquisition, investment, organizational leaders and consumers, clients, users to understand how value is created from IC
- Doing so will allow the model to take into account decision maker mental biases as well as predict adoption rate and acquisition failures
- We need to integrate risk and volatility into the protovalue estimate within the non-profit Defense Acquisition program framework
- Next steps: identifying intellectual and creative inputs to consumer/work life plans via empirical work using acquisition case studies

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Back – Up Slides

Physics to Economics Analogy Expansion: Definition of Terms:

Definition of Terms: Analogy Between Physics and Psycho-Economics:		
Kinetic Energy	KE	Actual rate of satisfaction
Work Energy	WE	Useful actual rate of satisfaction
		that fits a need
Potential Energy	PE	Potential rate of satisfaction, expected or
		hoped for satisfaction rate
Lagrangian Energy	(KE- PE)	Happiness , Difference between actual and hoped for rate of satisfaction. Positive values are pleasure. negative values are pain
Hamiltonian Energy	H = KE+PE	Heaftiness , Total capacity of an economic entity (consumer or buainess)
Einstein Mass	$m=H/c^2$	Another term for identifying the concept of Heftiness
Speed of light in vacuum	c	Speed of Now in equilibrium economy
A bit of Kinetic Action	KE·dt	a bit of Actual Satisfaction
A bit of Potential Action	PE·dt	a bit Potential Satisfaction, a Need bit
Macroscopic Action	$S = \int (KE - PE) \cdot dt$	Satisfaction for a tangibly large size activity
Minimum Action Principle	$\delta S=0$	Minimum pain or maximum pleasure Principle

"Physical Material only will only move along trajectories that minimize the action relative to alternative neighboring paths"
"Economic entities will only engage in exchange sequences that maximize their pleasure relative to available alternatives."

Physics to Economics Analogy Expansion: Definition of Terms: (continued)

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Position vector of attributes in a physical quantity	$\mathbf{q}$	Position of ownership in an economic quantity
Momentum vector	$\mathbf{p_q} = dS/d\mathbf{q}$	The rate of change of satisfaction when changing ones ownership of a quantity
Force in a quantity diection	$\mathbf{F}_q = d\mathbf{p_q}/dt$	The force felt by an economic entity when it feels the opportunity for changing its satisfaction by changing its ownership of a quantity
Equilibrium condition	$0 = \sum_i \mathbf{F}_{qi}$	Vector sum of all forces of all quantities (qi) are zero
Unit vectors of quantities	$\mathbf{u_q}$, $\mathbf{u}$	Units of ownership (apples, dollars,..)
Measurement of a physical quantity	$\mathbf{q} = \#_q \cdot \mathbf{u_q}$	Measurement of an eqonomic quantity
Generalized Physical space Dimensions of measurement Types	x,y,z i,j,k	Quantity type dimensions define need, or product categories
Vectors in physical space	$\mathbf{q_x}, \mathbf{q_y}, \mathbf{q_z} \ldots \mathbf{q_f}$ $\mathbf{q_i}, \mathbf{q_j}, \mathbf{q_k} \ldots$	Vectors in economic space
Maximum Quantity	$\mathbf{q_{f,max}} = \max\#_q \cdot \mathbf{u_q}$	
Volume of physical space	$\mathbf{q_{x,max}} \cdot \mathbf{q_{x,max}} \cdot \mathbf{q_{x,max}} \cdots \mathbf{q_{f,max}}$	
	$\mathbf{q_{i,max}} \cdot \mathbf{q_{j,max}} \cdot \mathbf{q_{k,max}} \cdots \mathbf{q_{f,max}}$	**Volume of Economy**
A physical particle	[Name], [a],[b]	Economic entity

Rule: most economic or physical symbols can be augmented to refer to specific individuals , entities or symbols.
For example if C = customer , $ = money, B = business, a = apple then
KE(C,$) means the actual rate of satisfaction the customer receives from his money.
KE(B,a) means the actual rate of satisfaction the business receives from his product which is in this example the apple

Phase I - Pre Product Introduction: Proto Value
Smart Phone Platform Feature Set Example

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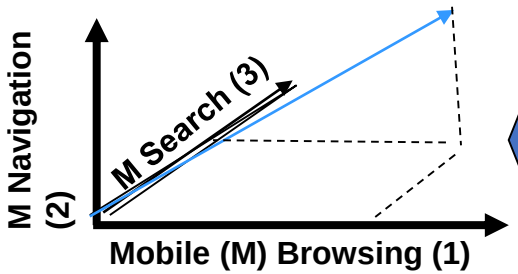
Physics Analogy Equation for PE

$$PE = \Sigma_{i,j} \frac{mj \cdot Gji \cdot Mi}{Rji}$$

Proto Value Matrix Calculation

$$PV = \Sigma_{i,j} \frac{n_i \cdot G_{ij} \cdot s_j}{D} = \Sigma_{i,j,k} n_i \bullet (H_{i,j} \bullet F_{j,k}) / D_{ik} \bullet f_k$$

Consumer Need Space



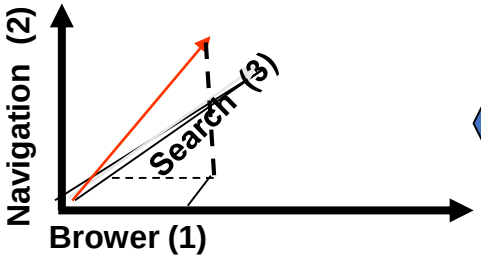
Need vector

$\mathbf{n}_i = m_i$

Solution Need Satisfaction Function

$H(n_i, s_j)$

Solution Space



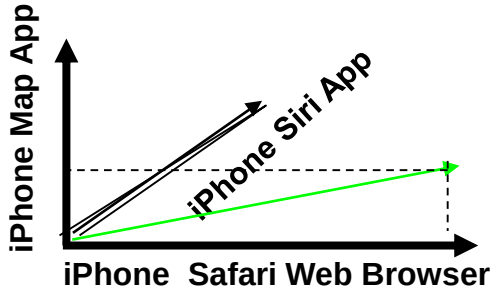
Solution Vector

$S_j = M_j$

Product Solution Function

$$\mathbf{s_j = F_{j,k} \bullet f_k}$$

Product Feature Space



Product Vector

$f_k = M_k$

Phase I - Pre Product Introduction: Proto Value Mass: Multi-vector Coordinate System

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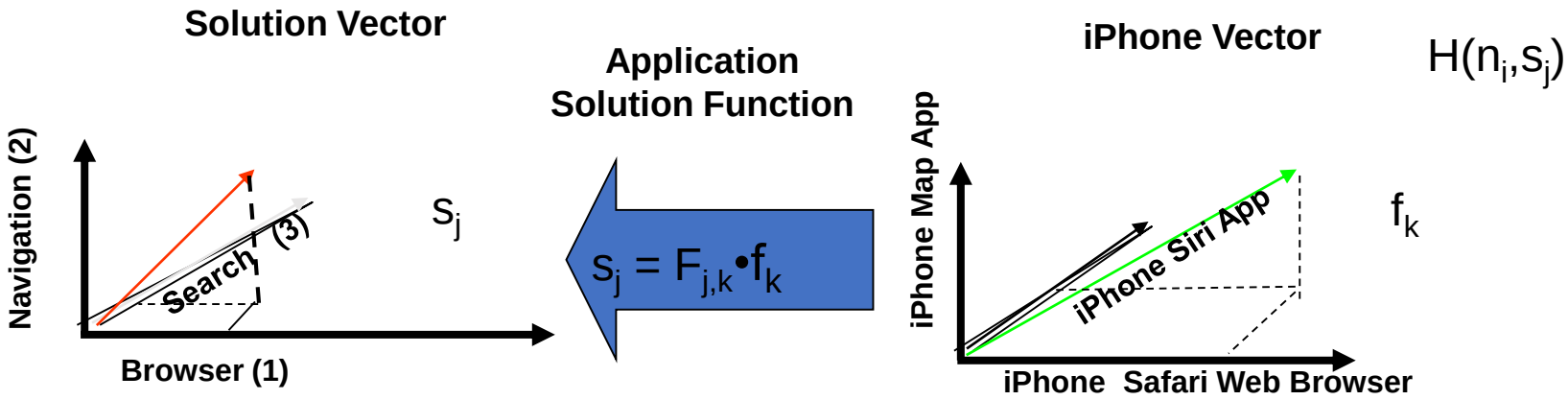
Unit of Analysis	Vector	Economics	Physics
Use Time (Hours, Minutes, Seconds, Milliseconds)	Length of vector is determined by the amount of use	Needs, General Product Solution Feature, and Actual Product Feature	Action * Δ Time
Complexity, bits, Learning Time (unit of change or bits)	Length of vector is determined by the amount of time is takes an average person to learn how to complete a particular function or the number lines of code in a software program that could complete the same function	Common units of value	Δ Energy * Δ Time

Phase I - Pre Product Introduction: Proto Value Fit: General Product Solution Transform to Product Feature Set - iPhone Feature Set Example



General Product Solution

iPhone Features

Browser (Hours per week)	2.55	=	.60	.25	.0	•	3
Navigation (Hours per week)	11.2		.0	.70	.0		16
Search SP Intelligent Assistant (Hours per week)	2.4		.30	.40	.50		2

iPhone Safari Web Browser (Hours per week)

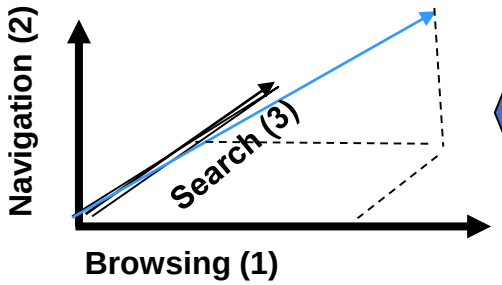
iPhone Map App (Hours per week)

iPhone Siri App (Hours per week)

Phase I - Pre Product Introduction: Proto Value
Customer Need to General Product Solution Fitness Matrix: Smart Phone Platform Example:

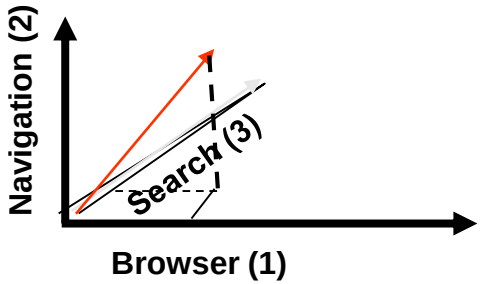
Customer Need to Solution Satisfaction Function Calculation $\mathbf{n}_i = H_{i,j} \bullet s_j$

Customer Need Space



$H_{i,j} \bullet s_j$

Provider Solution Space



Customer Need Vectors

Mobile Browse (Hours per week)	3
Mobile Navigation (Hours per week)	16
Mobile Search (Hours per week)	4

$\bullet$

Fitness Matrix

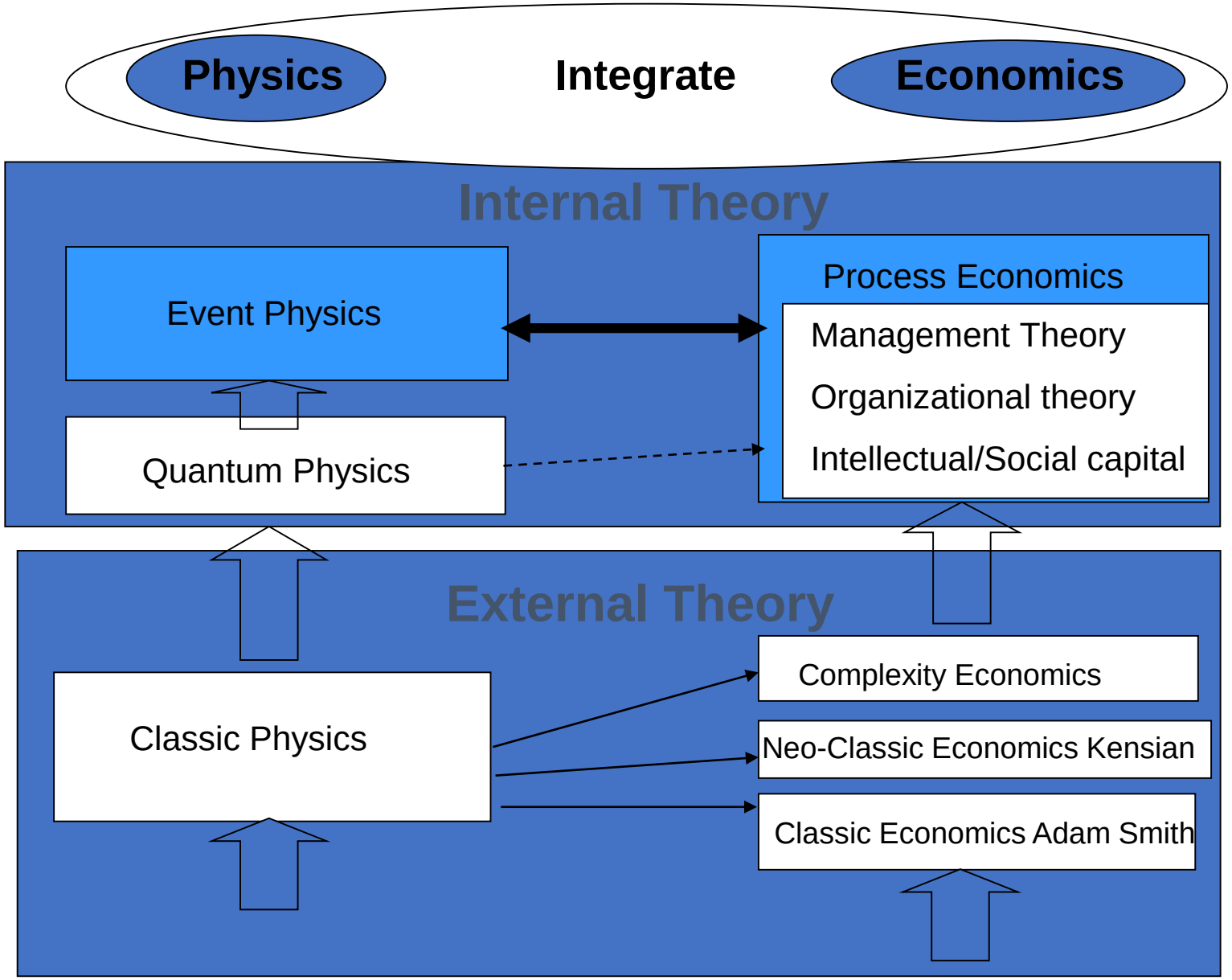
.85	.27	0
0	.70	.15
.64	.36	.60

$\bullet$

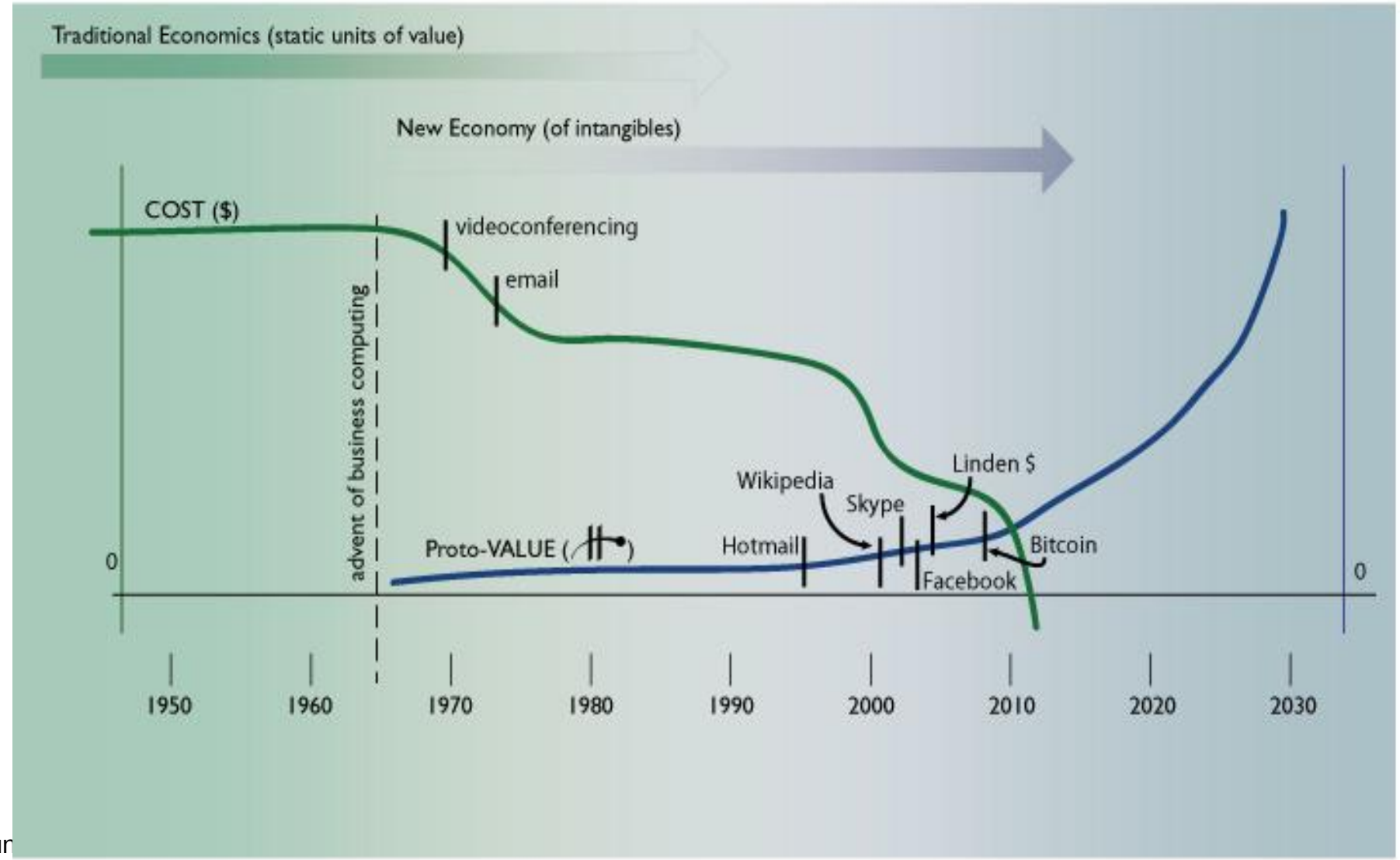
General Product Solutions

2.55	**Smart Phone (SP) WWW Browser (Hours per week)**
11.2	**SP GPS/ Mapping (Hours per week)**
2.4	**SP Intelligent Assistant (Hours per week)**

Physics/Economics Analogy History



Traditional and New Economics: Value Conflict and Opportunity



Value in Motion

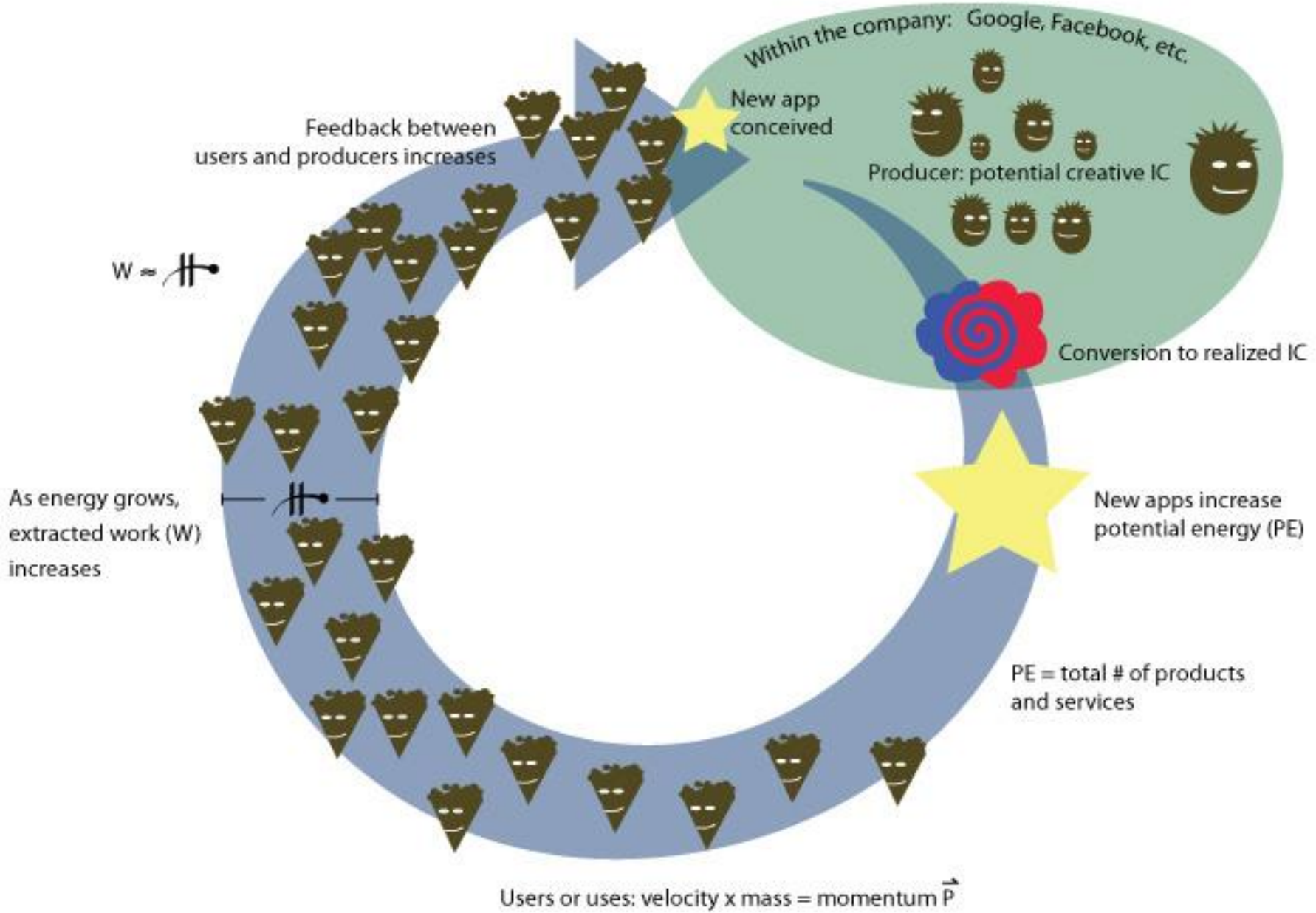


Figure 1: Econophysics Model: How To Calculate Market Performance from Fundamental Parameters

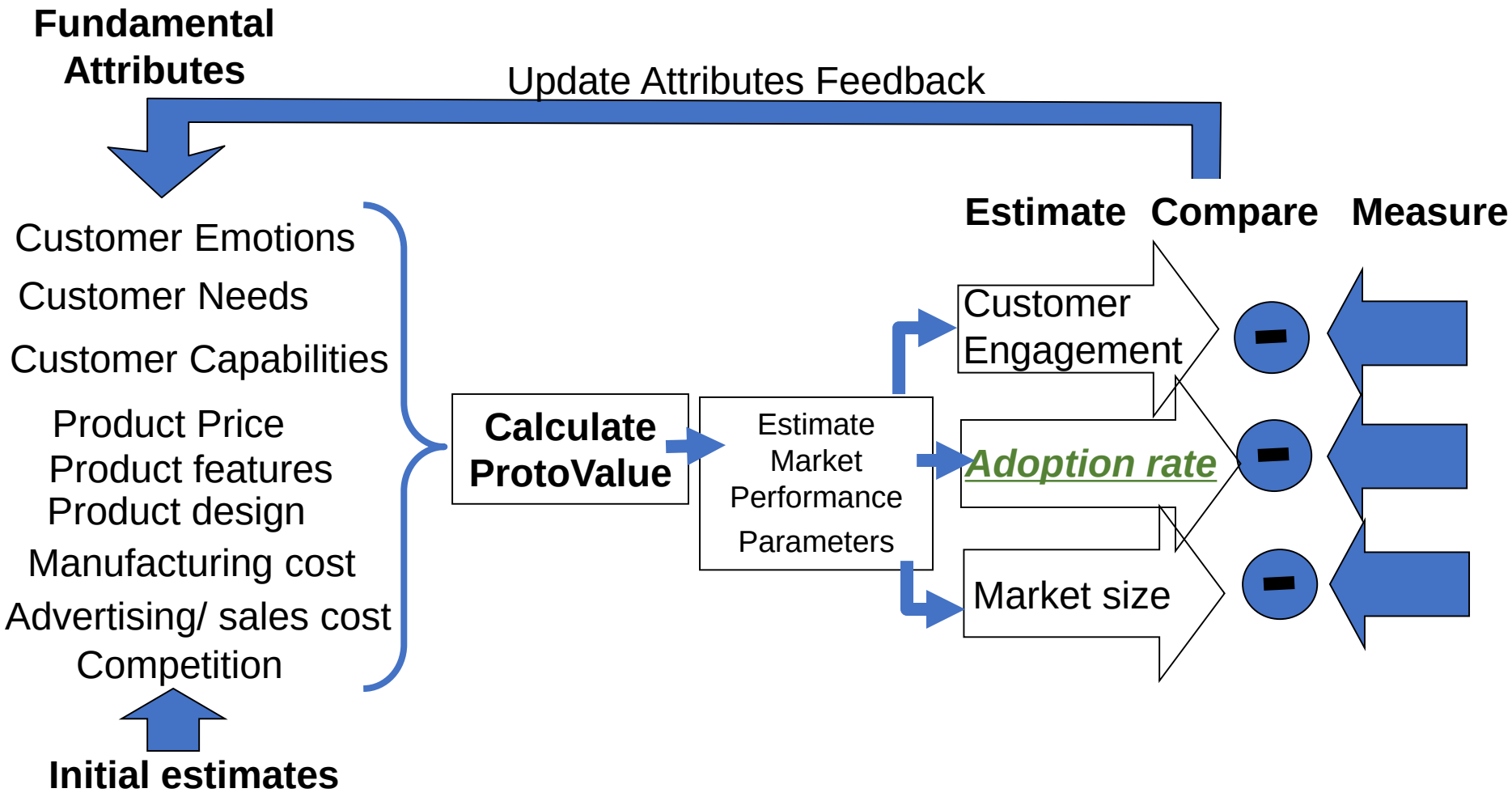


Diagram 2: Mass and Gravity Analogy

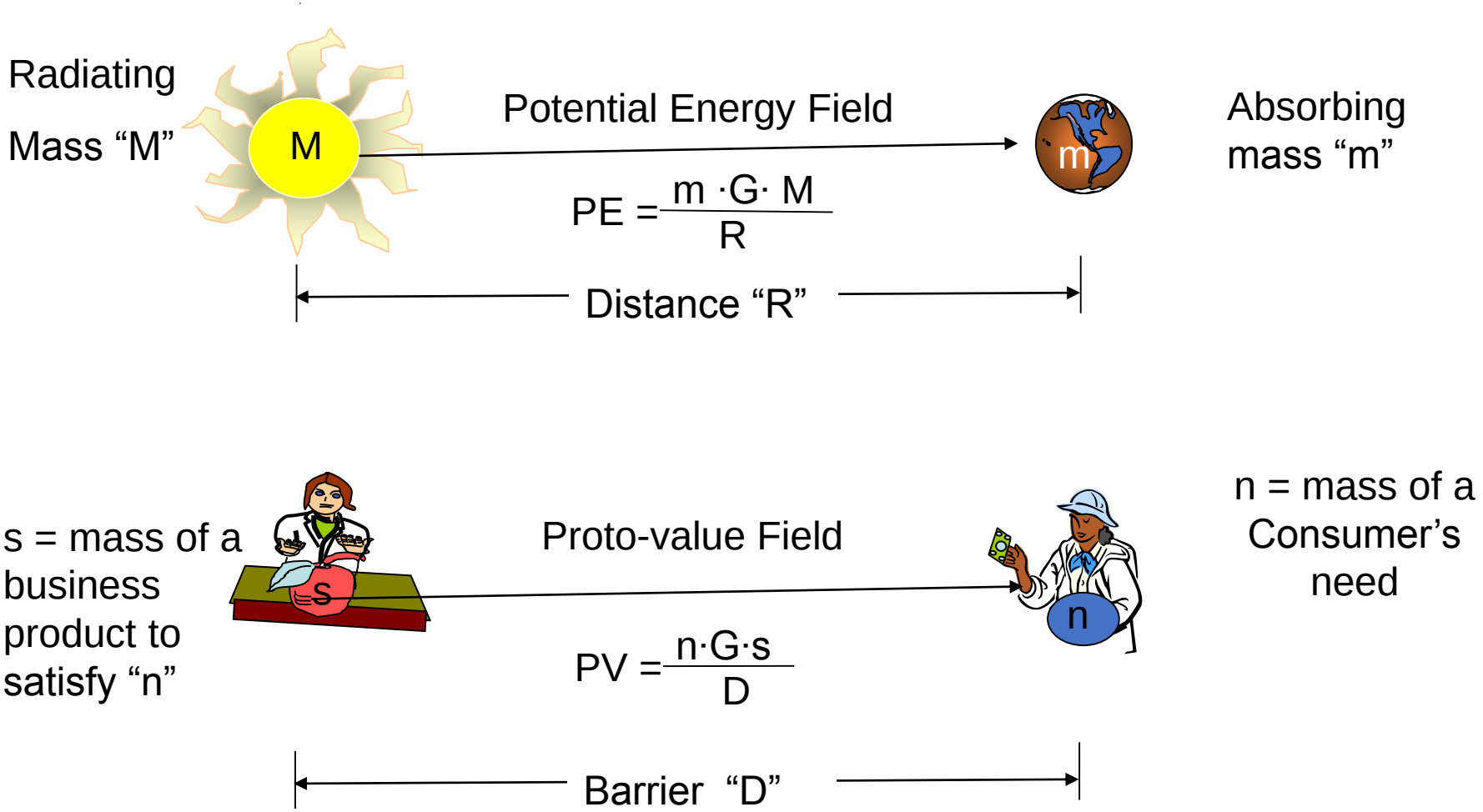


Table 1: Comprehensive Physics-Economics Analogy

ECONOMICS	PHYSICS
Proto- Value	Potential-Energy
Proto-Value = Satisfaction/Distance	Energy = Action/Time
Satisfaction is a need being satisfied	Action is a change being made
Happiness = rate at which satisfaction happens	Energy = rate of Action flowing
Proto-Value = Potential Happiness	Potential Energy = potential rate of Action flow
Distance = Barriers to Satisfaction	Distance = Radius between masses

Amount of Satisfaction = Amount of Need * Need to Solution Function* Amount of Solution

Amount of Distance = cost to purchase + time to use + Learning-time + infrastructure + … Other ..

(Baer, Housel, and Bergin, 2016)

What's App example

What happens to What's App market share when they raise their service price from $1 to $7 to justify their high acquisition price?

Using our Econo-Physics Value Theoretical framework, we can predict the value of the "intangible" social network with the result that:

WhatsApp would loose its customer base after raising the price in an environment of comparable services, that are free, in spite of its first mover advantage

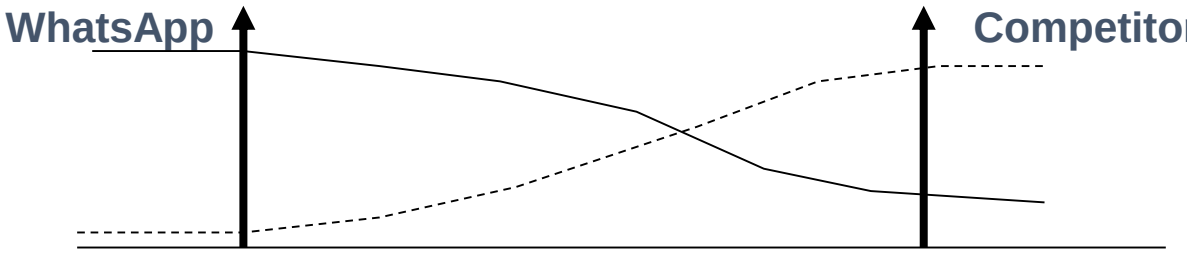
Proto-value comparison On Day 361 after price goes to $7 from $1:

$$E[B,x] = .3 \bullet .5 \bullet 360/2.2 = Q_{f'}[B] \bullet K_{f',f} \bullet q_f[x] / r^{\gamma}[B,x]$$

WhatsApp			Competitor
1	=	$Q_f[B]$ the quantity of satisfaction	= **1**
.5	=	$q_{f'}[x]$ hrs/day the quantity of need for messaging	= **.5**
.99	=	$K_{f',f}$ the fit matrix	= **.4**
.0057	=	$r^{\gamma}[B,x]$ Barrier Distance (norm. work +operations hrs./day)	= **.0005**
87	=	E[B,x] proto-value--energy units	= **400**

Dynamic changes

Fitness = # people a user wants and is able to access



Price = normalized work hours required to earn subscription

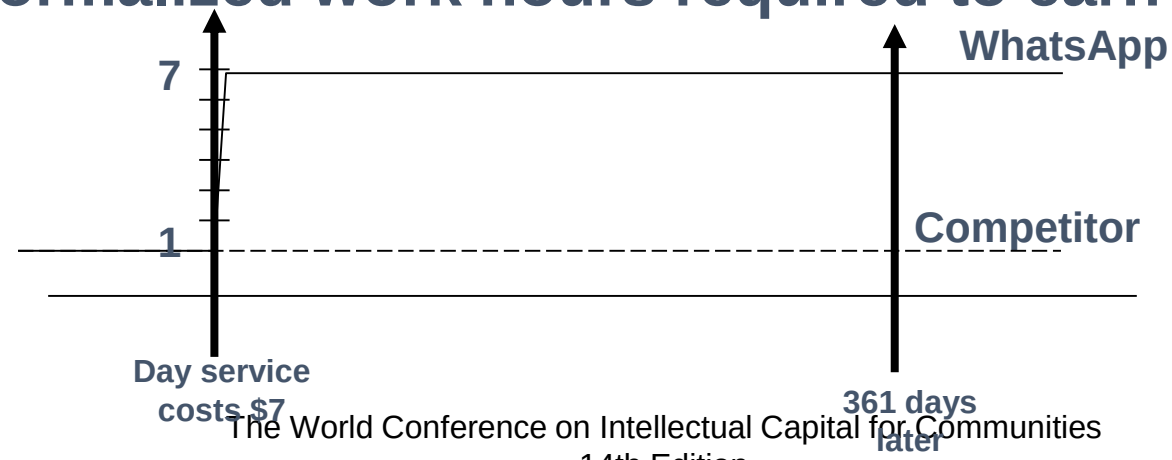


Table 5: Kenya vs South Africa

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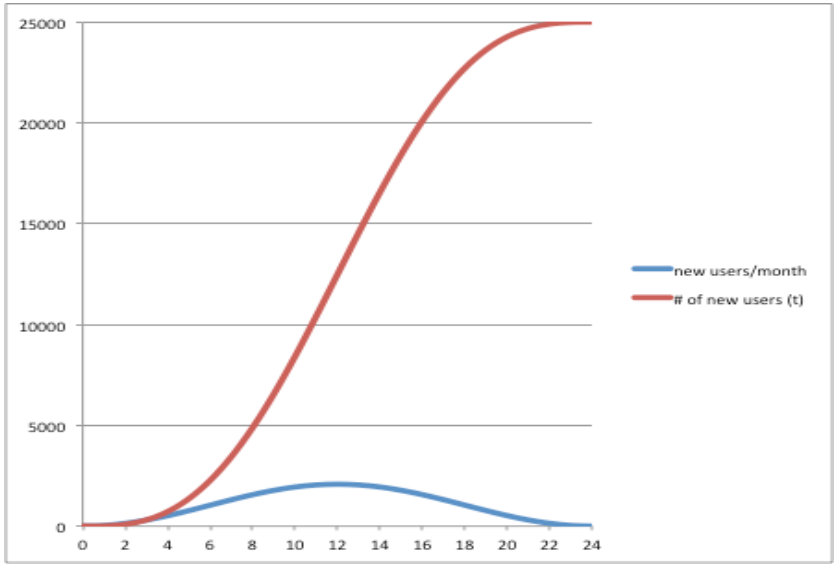
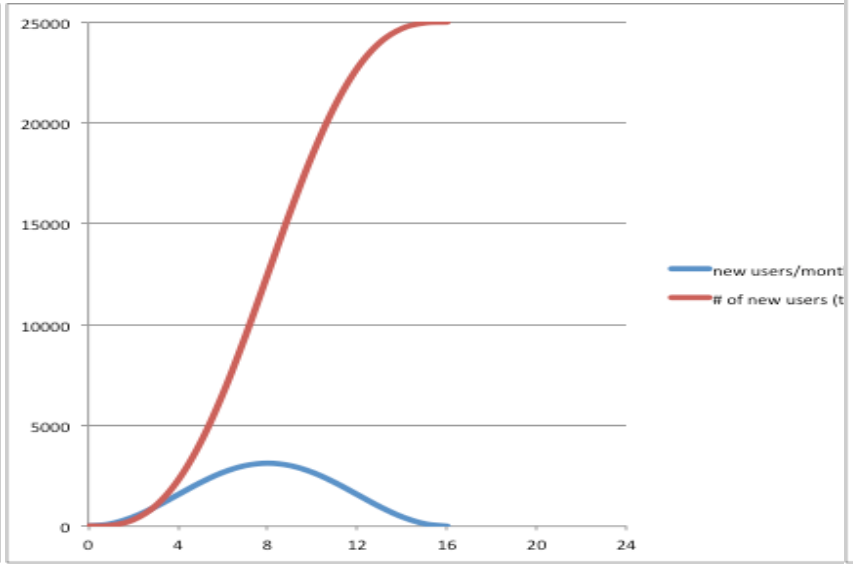
	Kenya	South Africa
• Transaction fee	27 kes/tran	2 zar/tran
• Baseline transaction cost without MPesa(wo MP)	40 min/tran	20 min/tran
• MPesa Transaction per day	$2x10^6$ tran/day	$2x10^5$ tran/day
• MPesa Tansaction Value per year	$23x10^{12}$ kes/yr	$57x10^9$ Zar/yr
• MPesa acceptance rate	58%	10%
• Value of user's time	.116 kes/sec	.095 zar/sec
• Perceived % Cash loss(wo M-P)	10%	1%
• Average income/person	1700 $/yr	9489 $/yr
• Not Acceptance Work around rate	90%	90%
• Network and server availability rate	90%	90%
• Proto-Value (local currency	803.6 kes/trans	12.3 zar/trans
• Proto-Value (usd/trans)	**7.9 usd/trans**	**.86 usd/trans**

Exchange Energy Protovalue Applied to Estimate Adoption Rate

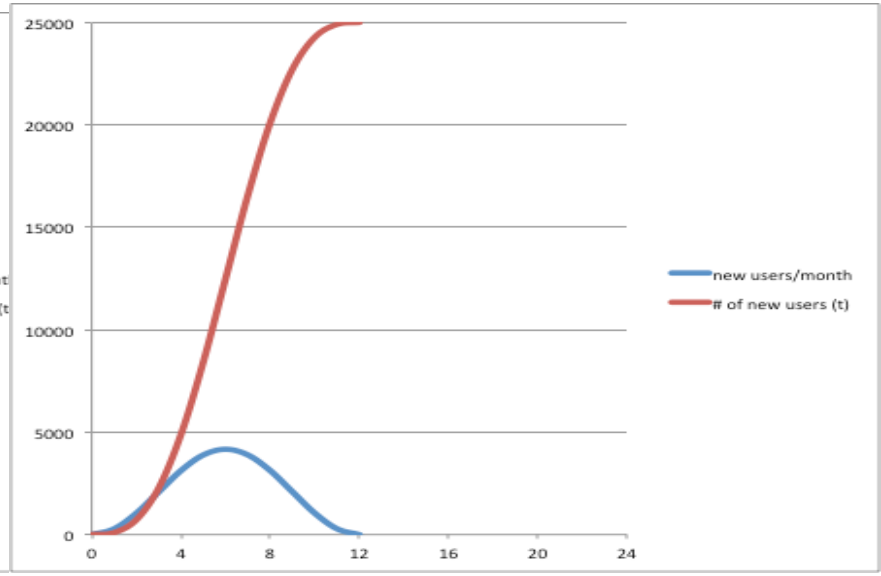
PVx = 100 ta = 24 months



PVx = 150 ta=16 months



PVx = 200 ta = 12 months



- **ta = time to total saturation**

Note: 24 month time scale

The potential energy (protovalue) before the exchange is

$$PV_{before} = PV[C, M] + PV[B, P]$$

The potential energy after the exchange is

$$PV_{after} = PV[C,P] + PV[B,M]$$

The change in potential energy if the exchange happens is

$$PVx = Pv_{after} - Pv_{before}$$

The more PV generated by an exchange the faster the exchange happens..

$$\Delta A / PVx = \Delta Tx$$