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Virtual GDP Engine: The Loop-Conveyor Problem in Sustainable Economics, and a Method for Formalizing Carnot-Like Dynamism and Win-Win & Sharing

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Abstract

This paper considers a hypothetical Carnot-like loop dynamism (powered by "money energy") in nature versus artificial bodies, and considers income growth and distribution theory (economic entities) within a sustainable loop conveyor system in the world, along with its dynamism and efficiency. This loop theory schema is a dissection of the elliptic theory of pair-map microcosms, and can be expected to be the same for the self-moving mechanism of artificial bodies, such as virtual (digital) self-driving cars on the pair map (2D/3D). This discussion first begins with the examination of a linear "Taylor system" for a virtual GDP body, and loop theory. Matsui's equation for flow time (flow number) can be used to present an example of formulation of two-level optimization, based on a closed-loop conveyor divided into "unloading" and "loading" sides. Lastly, the harmonic gain-sharing problem that faces economic bodies using a numerical and harmonic example of Win-win & sharing is also analyzed by a heuristic base.

Keywords

Pair-Map Ellipse Theory, Loop Theory, Carnot-Like Dynamism, Digital GDP Engine, Matsui's Equation

1. Introduction

We live on a planet where landmasses are bound by oceans; thus, supply-demand management of people, goods, and information involves negotiating gaps between a series of isolated islands and islets—from ships to bridges to airplanes and conveyors—to establish processes and become sustainable (nested). This supply-demand management is gathering speed as transport routes and movement shift from linear to nonlinear systems in this era of globalization.

The world seems to increasingly be moving from stationary to mobile as we approach the society of the future. Supply and demand are expected to be kept stable on the pair map (2D/3D) as management moves about on a systemized conveyor—"static in motion" (Mori, 1947). This begs the question whether the coming digital age will be a society that moves sequentially, that is, one which thinks and acts as it moves.

This is the transition from a belt conveyor to a loop conveyor (Morris, 1962; Matsui, 1972) in the artifact world, a process (Matsui, 2018) in which lot size (Q) moves from Q > 1 (integration) to Q1 (sharing). This loop society can be viewed as a kind of Carnot-like dynamism (compression > expansion > compression) on unloading (down) > loading (up) > unloading (down) that should lead to a more efficient engine.

This paper considers a hypothetical Carnot-like loop dynamism (powered by "money energy") in a natural-versus-artifact body, and considers income growth and distribution theory (economic entities) within a sustainable loop conveyor system in the world, along with its dynamism and efficiency. This loop theory schema is also a dissection of the elliptic theory of pair-map microcosm, and can be expected to be the same for the self-moving mechanism of artifact bodies, such as virtual (digital) self-driving cars on the pair map.

This discussion first begins with consideration of the linear "Tailor system" for a virtual GDP body and loop theory. Matsui's formalization of flow time (flow number) is used to present an example of formulation of two-level optimization, based on a closed-loop conveyor divided into "unloading" and "loading" sides (Matsui, 1982, 2011). Lastly, consideration is given to the harmonic gain-sharing problem faced by economic bodies by using a numerical and harmonic example of the Win-win & sharing type.

2. Loop Theory for Post-GDP

2.1. The "Tailor System" and Loop Theory

The Taylor system has existed for over a century (Taylor, 1947), and the progress of GDP expansion has posed a challenge to the productivity limits of sequential conveyor flow. That is, the division and subdivision, of labor and small-lot Q to pursue $Q \to 1$ since the time of Adam Smith has resulted in average minimization of delay (waste); however, this has simultaneously been hampered by the barrier of increased variability and the post-GDP problem. Therefore, a shift from lot Q to lot $Q < 1$ is required to break this barrier (Matsui, 2018, 2019).

This requires the division of labor in response to integration, and the harmonic balancing of sublation, which can only be achieved through the parallel ordered entry (OE) sequence equation (Matsui & Fukuta, 1977) shown in **Figure 1**, by following the loop conveyor type. This problem was first identified during a queueing cycle analysis of unloading delay (the CSPS model) (Matsui, 2005), which formed the inspiration for the author's book on probability management (Matsui, 2009). **Figure 1** depicts unloading and loading sides moving on a loop conveyor on the ground.

The loop conveyor, consisting of unloading and loading sides, usually rotates at a constant rate λ (>0). Loading delay is given by $\lambda D = 1 - \rho + \eta$ (η: mean number of follows) at Matsui's "muda" law (Matsui, 2005). Here, production rate r is the reciprocal of cycle time Z, which is the sum of work time X and delay time D. Together with overflow rate v, this is given by:

$$r = 1/Z \quad \text{and} \quad v = \lambda - r$$

The world on the ground is below the moving loop conveyor, and the operator, moving with acceleration, is stationary on the conveyor, a visualized world with a relativity bias when looking down on the ground, and at that point pursues subordinate balancing. A parallel-ordered entry-row division of labor in response to integration, and a harmonic balancing of sublation can produce a win-win & sharing world.

2.2. Sustainable "Loop-Conveyor" Theory

It is preferable to separate (bypass) going and returning to visualize the bidirectional movement between isolated islands. The loop-conveyor is a well-known systems theory in manufacturing, and based on this, we will proceed with a model example of "stationary in motion" (Mori, 1947). Loop-type flows are characterized by a parallel ordered-entry flow format rather than a linear format.

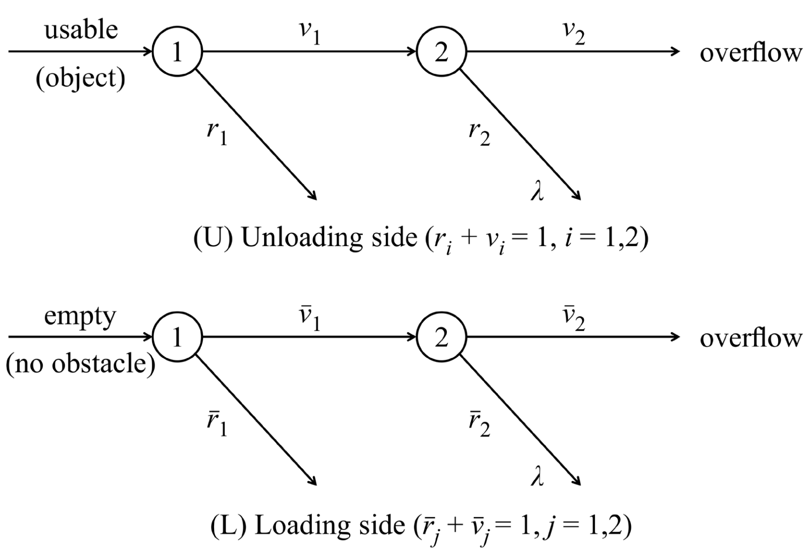


Figure 1. Unloading versus loading side: Lot-size Q ($0 < Q < 1$). Note: At Loading side, the operator finds empties between arriving un-usables (obsacles), and those are changeable by the usables at the side.

The definition of processing rate P and overflow rate B (Matsui et al., 1977; Matsui, 1982, 2011) is useful in the placement of the usables that the work targets when representing the flow. **Figure 2** shows a closed-loop conveyor that repeats the unloading and loading on a conveyor flowing in one direction: if the balance between outflow (the former) and inflow (the latter) is maintained (e.g., synchronization), this forms a kind of circulating sustainable system.

Figure 2 shows the core of the pair-hierarchy (Matsui, 2020) where the artifact operators are located at the upper level (link) under profit maximization (revenue maximization, cost minimization) (Taylor, 1947). **Figure 2** demonstrates that the loop conveyor on the ground is moving and its behavior depicts an unloading/loading waveform cycle.

The world on the ground is below the moving loop conveyor, and the operator, moving with acceleration, is stationary on the conveyor, a visualized world with a relativity bias when looking down on the ground, and at that point pursues subordinate balancing.

Each unloading r_i and loading r_j, usually consisting of one or more work stations of number n, are staggered, not equal, and are successively ordered entries, and the balancing mechanism of their outflow rate, r_i, versus inflow rate, r_j, is generally dynamic. The job at this point is not a sum of tasks, but a world of products, where the win-win & balancing (Matsui, 2018) solutions (equilibrium solution) are present. This issue can be discussed using two-level optimization in OR.

3. An Example of Matsui's Formalization of the Conveyor Loop

3.1. Loop Conveyor: Examples of the Unloading vs. Loading Sides

The flow time of the loop-conveyor in **Figure 2** is similar to the job shop flow

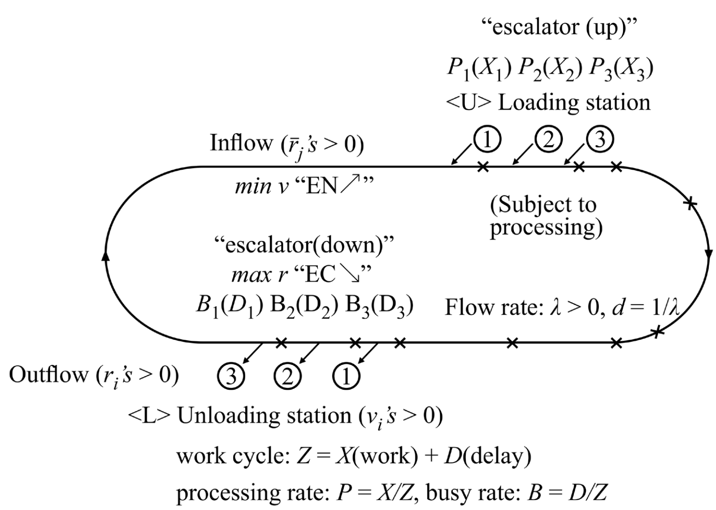


Figure 2. Type of sustainable "loop conveyor": Outflow versus inflow rate problem under $\mathrm{EC}(r)+\mathrm{EN}(v)\rightarrow\mathrm{ER}(\lambda)$.

shop type, and can be formulated using Matsui's equation. Figure 2 is divided into unloading (a) and loading (b) sides, and modeled separately before formulation, as shown in Figure 3.

Let us consider Table 1 as an example flow shop problem (Job, n = 6) to present the formulation in the next section. Shop time $F(W)$ in this case is obtained using the following equation of $FW_i, i = 1, 2, \cdots, n$ (Conway et al., 1967):

$$F(W) = \sum FW_i .$$

Here, FW_i is the job completion time, corresponding to W (=ZL) (Matsui, 2005) in Matsui's formula.

$$(M)\ (1\ 2\ 3\ 4\ 6\ 7) \times T_a \times \begin{pmatrix} 6 \\ 5 \\ 4 \\ 3 \\ 2 \\ 1 \end{pmatrix} \times \frac{1}{n} = 17: \overline{F}_a\ (W)$$

(a)

$$(M)\ (1\ 2\ 3\ 4\ 6\ 7) \times T_b \times \begin{pmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{pmatrix} \times \frac{1}{n} = 10: \overline{F}_b\ (W)$$

(b)

Figure 3. Matsui's formulation of unloading versus loading side: An example of $n/1/\overline{F}$ type of flow shop. (a) Case of unloading side, T_a (SPP): identity matrix; (b) Case of unloading side, T_b (LPT): Anti-identity matrix of T_a.

Table 1. An example of the job shop problem (Matsui, 2009): Unloading versus loading case.

Case (a): r_i SPT*		scheduling problem			Case (b): $\overline{r}_j$, LPT**
		job	work time		
ordered entry, i $i = 1 \sim n$	6	A	7	1	ordered entry, j $j = 1 \sim m$
	5	B	6	2	
	4	C	4	3	
	3	D	3	4	
	2	E	2	5	
	1	F	1	6 (m)	

*SPT: Shortest process time; **LPT: Latest process time.

3.2. Examples of Matsui's Equation for Unloading vs. Loading

Matsui's equation is a determinant consisting of *ki* (Introduction), *sho* (Development), *ten* (transformation), *ketsu* (Conclusion), B (balance), and G (goal) (Matsui, 2014, 2019; Matsui et al., 2018). Loop-conveyors generally consist of two types of repetitions, with the unloading side corresponding to SPT rules, and the loading side corresponding to LPT rules. Case (a) and case (b) are presented in contrast using the difference between ten (T_a) and ten (T_b).

Figure 4 shows a sample formulation for Table 1, where the unloading side is given by Case (a) and the loading side by Case (b). The usables available for both cases are different, i.e., the usable in Case (a) and Case (b) are the "real" unit to be unloaded and the empty (hole) for loading, respectively.

4. Win-Win & Sharing, and Benefit-Sharing Issues

4.1. A Two-Level Optimization Method for Loop Conveyors

The mathematical formulation of the loop conveyor is given in Figure 4 as a two-level optimization problem (Matsui, 2020; Conway et al., 1967) in OR terms using Matsui's equation for the flow problem in the system. This unloading (U)-side formulation has been considered diagrammatically as a trickle-down type benefit-sharing problem in terms of the win-win & sharing problem in previous literature (Matsui, 2018; Matsui, 2020).

We aim for a harmonic (average) win-win and a harmonic shared balancing between layers, for the upper and lower problems, respectively. Here, the formulation for the unloading (U) and loading (L) sides are drawn using scheduling theory, where the two are considered formally separate and distinct. Additionally, they are drawn graphically and numerically, generally with a convex curve in Case (a) and a concave curve in Case (b).

Win-win problem U: $max_d \; d \, \Pi_{i=1}^{n} B_U(d, \hat{\boldsymbol{c}}(d))$

s.t. $0 < d < T_c$.

$\bar{F}_U(W)$: $\Sigma \, W_I(d, c_i(d))$ Matsui's formulation (U)

$min_c \, B_U(\mathrm{d}, \boldsymbol{c}(\mathrm{d}))$, busy rate

s.t. $0 < \boldsymbol{c} < \boldsymbol{c}_0$, $\boldsymbol{c} = (c_1, c_2 \cdots c_n)$

(U) Case of unloading side, T_a(SPP): identity matrix

Win-win problem L: $max_d \; d \, \Pi_{j=1}^{m} P_L(d, \hat{\boldsymbol{c}}(d))$

s.t. $0 < d < T_c$.

$\bar{F}_L(W)$: $W_L(d, \hat{\boldsymbol{c}}(d))$: Matsui's formulation (L)

$max_c \, P_L(\mathrm{d}, \boldsymbol{c}(\mathrm{d}))$: busy rate (sharing)

s.t. $0 < \boldsymbol{c} < \boldsymbol{c}_0$, $\boldsymbol{c} = (c_1, c_2 \cdots c_m)$

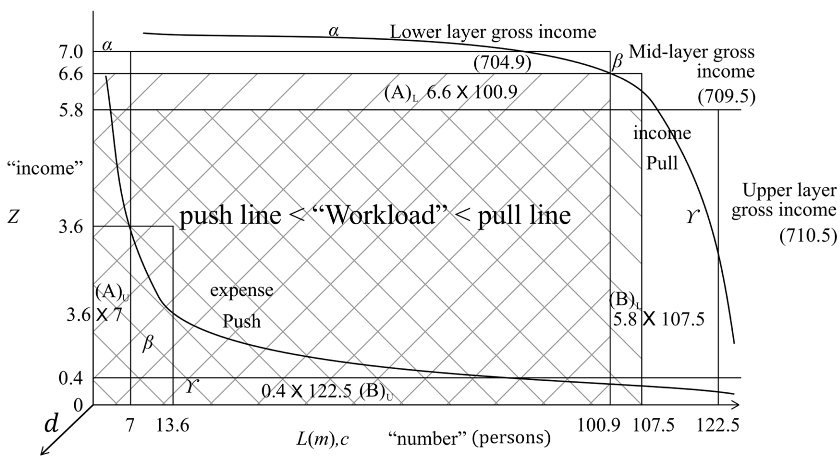
(L) Case of loading side, $T_b(LPT)$: Anti-identity matrix

Figure 4. 2-level formulation of alterative conveyor loop: Win-win & sharing type, in which the variables, c_i's and c_j's, mean the range (person in Figure 5) of look-ahead units/time on loop.

4.2. Win-Win & Sharing and the Carnot Loop

There are limitations to the use of a solvable approach (Balakrishnan, 1972; Aiyoshi & Shimizu, 1981) for finding a solution to the two-level optimization example presented in the previous section; however, the numerical approach (Matsui, 2022) yields **Figure 5** and **Table 1**. **Figure 5** demonstrates that the solution is characterized by a type of Carnot-loop behavior, as the income distribution and growth problem can be thought of as a kind of GDP engine. This problem is analogous to the Carnot loop problem in thermodynamics, and is also a dissection of elliptic theory in pair maps.

Drawing on **Figure 5**, it can be surmised from **Table 2** that win-win & sharing yields a harmonious world. Win-win is almost equally $X = Y = Z$ in the Upper-, Middle-, and Lower-layer segments for both Push and Pull. However, for Sharing, the left (A) and right (B) vary in size on the Push side, but are equal on the pull side, with sharing maximized by balance.



Subject to: (A)+(B)⟶max (sharing)

<sharing(U)> 25.2(A)+5.44(B)=30.64, $(A)_U \neq (B)_U$, Unloading

<sharing(L)> 623.5(A)+665.9(B)=1289.4, $(A)_L \neq (B)_L$, Loading

Figure 5. Numerical consideration for win-win & sharing solution and its Carnot-like dynamism of unloading & loading loop.

Table 2. Summary of win-win & sharing score: A harmonic example.

Layer / Win-win	Upper, X	Middle, Y	Lower, Z
Push (W)	49 (7.0 × 7.0)	49 (3.6 × 13.6)	49 (0.4 × 122.5)
Pull (W)	710.5 (7.0 × 100.9)	709.5 (6.6 × 107.5)	710.5 (5.8 × 122.5)
Sharing	Push $(X \to Y \to Z)_d$		Pull $(Z \leftarrow Y \leftarrow X)_u$
left (A)	25.2 (3.6 × 13.6)		623.5 (6.6 × 100.9)
right (B)	5.44 (0.4 × 100.9)		665.9 (5.8 × 107.5)
total	30.64		1289.4

5. Conclusion and Outlook

The natural vs. artifact body pair map microcosm that draws from a natural vs. artifact science has its origins in supply and demand management. The dissection of the elliptic theory has revealed a Carnot-like loop on a pair map (2D/3D). The outlook has been broadened to account for a monetary supply-demand economy, by expanding the outlook from traditional linear arguments, such as "is money good or bad?" and "does money flow round", to take into account nested economics, benefit-distribution theory and (efficient) GDP engines.

The loop-theory presented in this paper shows bi-directional supply-demand dynamism and Carnot-like loop theory from a moving stationary state perspective, evolving from linear or tree-like supply-demand matching. This presents a harmonic (average) win-win & sharing method and its space within a virtual GDP engine (driven by "money-energy"). Thus, loop-theory can be considered effective as a type of supply-demand economy theory for increasing and distributing income, and as a management theory.

Virtual (digital) GDP engine theory is expected to lead to the development of self-moving mechanisms for the next generation of virtual self-driving cars and other (artificial) vehicles.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

Aiyoshi, E., & Shimizu, K. (1981). Hierarchical Decentralization System and Its New Solution by a Barrier Method. *IEEE Transactions on Systems, Man, and Cybernetics*, *11*, 444-449. https://doi.org/10.1109/TSMC.1981.4308712

Balakrishnan, A. Y. (1972). *Techniques of Optimization*. Academic Press.

Conway, R. W., Maxwell, W. L., & Miller, L. W. (1967). *Theory of Scheduling*. Addison-Wesley.

Matsui, M. (1972). The Systems of Conveyor System. *Keiei Kougaku (Industrial Engineering), Bulletin of Engineering, Hiroshima University, Japan, 20,* 95-117. (in Japanese)

Matsui, M. (1982). Conveyor-Serviced Production System (II): 2-Level Mathematical Formulation and Application. *Preliminary Report of the Operations Research Society of Japan*, Autumn, 92-94. (in Japanese)

Matsui, M. (2011). Conveyor-Like Network and Balancing, In A. B. Savarese (Ed.), *Manufacturing Engineering, NOVA at English*.

Matsui, M. (2005). CSPS Model: Look-Ahead Controls and Physics. *International Journal of Production Research, 43,* 2001-2025. https://doi.org/10.1080/00207540412331331416

Matsui, M. (2009). *Manufacturing and Service Enterprise with Risks: A Stochastic Management Approach* (International Series in OR&MS, Vol. 125). Springer. https://doi.org/10.1007/978-0-387-84804-4

Matsui, M. (2014). *Manufacturing and Service Enterprise with Risks II: The Physics and Economics of Management* (International Series in OR&MS Vol. 202). Springer. https://doi.org/10.1007/978-4-431-54619-1

Matsui, M. (2018). A Theory of Modern Economic Growth toward Sharing Society. *Theoretical Economics Letters, 8,* 675-684. https://doi.org/10.4236/tel.2018.84045

Matsui, M. (2019). *Theory, Formulation and Realization of Artifacts Science: 3M&I-Body System*. Springer. https://doi.org/10.1007/978-981-13-3495-5

Matsui, M. (2020). A Chameleon's Harmonic Correlation, Criteria, and Diversity for a Win-Win and Sharing World. *Theoretical Economics Letters, 10,* 735-744. https://doi.org/10.4236/tel.2020.104045

Matsui, M. (2022, January). Nature versus Artifacts Body: One-Leaf Hyperboloid Type, Pair-Map Microcosm and Nested Economics. *Journal of Digital Life, 2,* 1-9.

Matsui, M., & Fukuta, J. (1977). On a Multichannel Queueing System with Ordered-Entry and Heterogeneous Servers. *AIIE Transactions, 9,* 209-214. https://doi.org/10.1080/05695557708975145

Matsui, M., Nakajima, S., & Nakada, T. (2018). Matrix Approach to Industry: Generalized Form, Interindustry Relations Decision Making and Method Consideration. In *Preliminary Report of the 9th OUKAN Conference, E-3-1, OUKAN* (Transdisciplinary Federation of Science and Technology), UEC Tokyo.

Matsui, M., Shingu, T., & Makabe, H. (1977). Conveyor-Serviced Production System: An Analytic Framework for Station-Centered Approach by Some Queueing Formulas. *Preliminary Report of the Operations Research Society of Japan,* Autumn, 104-107.

Mori, S. (1947). *Theory of Flow Line of Work Organization*. Akagi Shobo. (in Japanese)

Morris, W. T. (1962). *Analysis for Materials Handling Management* (pp. 129-169). Richard D. Irwin.

Taylor, F. W. (1947). *Scientific Management*. Harper & Brothers.