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Article

The Intertemporal Game of Instrumental vs. Humanistic Rationality: Hyperbolic Discounting, Latent Factor Costs, and Institutional Fragility - Empirical Evidence from Exogenous Supply Chain Compliance Audit Shocks

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Abstract: During rapid catch-up growth phases, emerging economies are frequently dominated by instrumental rationality targeting scale efficiency and rapid delivery. This operational paradigm relies heavily on substantial discounting of long-term implicit costs. Relaxing the neoclassical assumption of homogeneous inputs across labor, environment, and capital maintenance, this paper integrates hyperbolic discounting theory with Amartya Sen's humanistic capability framework to formulate an intertemporal dynamic optimization model. The theoretical results show that under quasi-hyperbolic discounting (β-δ), micro-enterprises and local governance agents exhibit a systematic present-bias deviation. Decision-makers tend to externalize the life-cycle depletion of labor, deep asset maintenance, and exploratory R&D from current income statements, generating inflated short-term accounting returns at the expense of an escalating "humanistic capital deficit." Exploiting the implementation of the EU Corporate Sustainability Due Diligence Directive (CSDDD) and the German Supply Chain Due Diligence Act (LkSG) as a quasi-natural experiment, we employ a staggered triple-difference (DDD) specification on a micro-panel of Chinese manufacturers from 2015 to 2025. The empirical findings reveal that firms suffering from excessive instrumental rationality and severe hyperbolic discounting experience significant contract cancellations and sharp declines in total factor productivity (TFP) when subjected to non-tariff compliance audits. Conversely, firms with internalized humanistic investments and contractual commitment display substantial resilience. This study delineates the institutional fragility frontiers inherent in pure scale-driven factor depletion and offers empirical insights for transitioning from passive cost adaptation to indigenous soft-power cultivation.
Keywords: hyperbolic discounting; instrumental rationality; humanistic rationality; humanistic economics; latent factor costs; supply chain compliance shocks

1. Introduction and Literature Review

The transformation of the industrial growth paradigm has always been accompanied by the deep reconstruction of the value evaluation system. According to Ricardo's theory of comparative advantage, at the beginning of the integration of late-developing economies into the global division of labor network, most of them followed the instrumental rationality logic of "low factor cost-large-scale asset input-high-frequency delivery". In this cycle, the core of competition focuses on speed and unit price, and the micro-subject constantly squeezes the conversion cycle between Inputs and Outputs. This strategy has supported the rapid rise of the late-developing manufacturing system.

However, once the global economic and trade pattern shifts from incremental expansion to a stock game, the rules of the game change immediately. In recent years, the European Union's Corporate Sustainable Development Due Diligence Directive (CSDDD), Germany's Supply Chain Due Diligence Act (LkSG) and various environmental, social and governance (ESG) audit frameworks have gradually evolved into new market access boundaries. Many cases of transnational termination in the fields of domestic automobile precision manufacturing and high-end consumer electronics modules show that the moat built by "high quality and low price" in the past has begun to crack in the face of the new rule system.

The discussion of this kind of phenomenon in academic circles often focuses on two parallel aspects: one is

the theory of geopolitics and trade protection. This view defines compliance review as a non-tariff barrier created by developed economies in order to maintain discourse dominance and delay industrial catch-up of late-developing countries [1,2]; Second, the theory of governance modernization and regulatory convergence. This view emphasizes that the long-term neglect of labor rights, environmental protection and information transparency by latecomer manufacturing enterprises is an inevitable cost in the evolution of global rules [3,4]. Although these two views are to the point, they have not analyzed the dynamic mechanism at the bottom of decision-making: why do latecomer enterprises still systematically postpone the investment in micro-human elements and governance structure when they know that compliance standards are becoming more and more stringent?

A neoclassical production function (such as the standard Cobb-Douglas form) usually takes labor (L) and capital (K) as pure factors of production that is undifferentiated, fully depreciable and linearly substitutable. Under this simplification of instrumental rationality, labor is reduced to "unit working hours" and capital is equated to "book value minus accounting depreciation". This kind of treatment hides people's perception of their own dignity, the cost of intergenerational reproduction of labor, and the time of trial and error required for technological evolution. When discussing freedom and development, Amartya Sen pointed out that the essence of development is to expand the "Capabilities" of individuals [5,6]. Human factors are not the passive embellishment of economic growth, but the foundation of maintaining the system's ability to resist risks and spontaneous innovation.

The theoretical marginal contribution of this paper is embodied in three aspects: first, it introduces the concept of hyperbolic discounting in behavioral economics as an analytical tool to examine the micro-factor accounting and macro-growth dynamics, and reveals the endogenous incentives for the late-developing system to underestimate the implicit costs and magnify the immediate returns; Secondly, we should break the analytical boundary between instrumental rationality and value rationality, and establish the endogenous position of labor dignity, scientific research trial and error and organizational trust in the mathematical model under the framework of humanistic economics. Thirdly, the quasi-natural experiment is constructed based on the implementation nodes of the International Supply Chain Human Rights and Environmental Protection Act, and the systematic impact of the "human capital deficit" in the stock game period is quantitatively assessed based on the import and export micro-data and financial breakpoints.

2. Theoretical Mechanism and Benchmark Dynamic Optimization Model

2.1. Heterogeneity of Production Factors and Accumulation of Human Capital

It is assumed that there are continuous representative manufacturing enterprises distributed in the economy. The traditional production function is written as:

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \tag{1}$$

Among which, A_t stands for total factor productivity, K_t and L_t stand for physical capital and labor. On this basis, this paper refines the dimension of factors and deconstructs the factors of production into two categories:

1. Explicit hard elements: including general machinery and equipment $K_{e,t}$ and labor hours $L_{e,t}$;
2. Implicit Human Capital and Institutional Soft Power H_t: It covers the long-term physical and mental health of workers, the trial-and-error redundancy of technological research and development, the deep maintenance reserve of physical wear and tear of equipment, and the compliance with business ethics and legal contracts. The extended effective production function satisfies:

$$Y_t = A_t \cdot \Omega(H_t) \cdot K_{e,t}^{\alpha} L_{e,t}^{1-\alpha} \tag{2}$$

Here, $\Omega(H_t) \in [0,1]$ represents the anti-risk elasticity of the system, and satisfies $\Omega'(H) > 0$, $\Omega''(H) < 0$ 。 Humanistic capital uses the character H_t , it has the attribute of asset stock, and its inter-temporal evolution path meets the following requirements:

$$H_{t+1} = (1 - \delta_h) H_t + I_{h,t} \tag{3}$$

In formula (3), $\delta_h \in (0,1)$. It is the natural depreciation rate of human capital. $I_{h,t}$ is the real capitalized investment in implicit factors in the current period, such as improving labor protection, increasing flexibility of working hours, reserving equipment tolerance maintenance budget, and basic R & D expenditure that does not aim at short-term conversion.

2.2. Microscopic Intertemporal Optimization Under Hyperbolic Discounting

In traditional intertemporal choice models, decision-makers are generally assumed to have a time-consistent preference for a constant discount rate. However, empirical and experimental studies have shown that economic agents often exhibit significant present bias when facing intertemporal tradeoffs. Phelps and Polla first proposed

a non-constant discount rate analysis paradigm when discussing intergenerational savings games [7]; Laibson further formalized it into a quasi-hyperbolic discount model (i.e., β-δ setting) in a discrete time frame, systematically characterizing the profound impact of time inconsistency and self-control problems on asset accumulation and welfare [8]. In an assessment environment that unilaterally emphasizes short-term output and financial statements, the decision-making behavior of management and local governance entities also exhibits quasi-hyperbolic discount (β-δ model) characteristics. Their intertemporal objective function is written as follows:

$$\max_{\{K_{e,t}, L_{e,t}, I_{h,t}\}} E_0 \left[\Pi_0 + \beta \sum_{t=1}^{\infty} \delta^t \Pi_t\right] \quad (4)$$

We use parameter $\beta \in (0,1)$ to characterize the present bias, $\delta \in (0,1)$ is the long-term discount rate. Once $\beta < 1$, the decision-makers will have a cliff-like discount on the expected earnings of the future periods, thus highly valuing the current book profits and cash inflows. The real single-period profit of the enterprise in the current period is written:

$$\Pi_t = P_t Y_t - w_t L_{e,t} - r_t K_{e,t} - I_{h,t} - C_{external,t} \quad (5)$$

Among which, $C_{external,t}$ represents externalized costs that should be borne by enterprises but transferred to society:

$$C_{external,t} = \theta_L \cdot \Phi(L_{e,t}) + \theta_K \cdot \Psi(K_{e,t}) \quad (6)$$

$\Phi(L_{e,t})$ represents the long-term loss of labor caused by excessive squeezing of working hours; $\Psi(K_{e,t})$ is implicit depreciation of equipment due to curtailment of maintenance; θ_L, θ_K are the externalized skew parameters.

2.3 Proposition Derivation: Factor Cost Transfer and Report Distortion

Proposition 1 (hyperbolic discounting and insufficient accumulation of human capital): Under the guidance of quasi-hyperbolic discounting $\beta < 1$, the optimal steady-state investment of micro-enterprises for implicit factors and compliance governance I_h^* is bound to be lower than optimal level of the whole society $I_h^{\cdot}$. The scissors difference between the two expands with the intensify of the current preference $(1-\beta)$.

Idea of proof: Consider the dynamic Euler equation. Most of the earnings from explicit capital K_e can be cashed in the current period; On the contrary, human capital I_h arises in the current period (directly reflected as cost deduction $-I_{h,t}$). Gains will come out slowly through the system resilience $\Omega(H_{t+1})$ in the future. The first-order condition gives the intertemporal marginal rate of substitution:

$$\frac{\partial \Pi_0}{\partial I_{h,0}} = 1 = \beta\delta \mathbb{E}_0 \left[\frac{\partial \Pi_1}{\partial H_1} + (1-\delta_h)\frac{\partial \Pi_1}{\partial I_{h,1}}\right] \quad (7)$$

Only if $\beta = 1$ (Intertemporal rational symmetry), the system is at the optimal equilibrium point. When $\beta \to 0$, the right side of equation (7) is heavily discounted, the rational micro-response of the enterprise is to cut human expenditure, that is $I_{h,t} \to 0$, , which is proved by this equation.

Corollary 1 (False Book Boom): If the firm would have shared $I_{h,t}$ and externalization costs $C_{external,t}$ excluded from book accounting, the "accounting profit" reported externally $\tilde{\Pi}_t = P_t Y_t - w_t L_{e,t} - r_t K_{e,t}$, satisfies: This practice of compressing the life of future assets in exchange for immediate high returns

$$\tilde{\Pi}_t = \Pi_t + I_{h,t} + C_{external,t} > \Pi_t \quad (8)$$

tends to create a competitive myth of "low cost and fast turnover" in the period of incremental expansion, but leads to a system-wide continued erosion of human capital reserve H_t: $\lim_{t\to\infty} H_t = \frac{I_h^*}{\delta_h} \ll \frac{I_h^{\cdot}}{\delta_h}$.

3. Shock Evolution: Rule Shock and Fragility Mechanism under Stock Game

3.1. Rule Paradigm Shift: from Cost Screening to Penetration Auditing

Before the period T, the world market was dominated by the logic of incremental supply, and the criteria for overseas purchasers to select suppliers were mainly based on the comprehensive delivery cost:

$$\text{Selection}_t = \arg\max_i \{\text{Speed}_i - \text{Price}_i\} \quad (9)$$

During this period, because the buyer does not have to pay for the external environmental damage and labor overdraft of the manufacturing site, enterprises with a high hyperbolic discount tendency $(\beta_i \ll 1)$ can gain cost advantage by compression of I_h , then quickly translate into orders, which could even squeeze out prudent enterprises that emphasize standardized governance. Get into T period, the global supply and demand changed

from incremental competition to stock shuffling, and the transnational procurement side established rigid humanistic and governance access criteria:

$$\text{Selection}_t = \begin{cases} 1, & \text{If} H_{i,t} \geq \bar{H}_{compliance} \\ 0, & \text{If} H_{i,t} < \bar{H}_{compliance} \quad \text{(One veto to terminate the cooperation)} \end{cases} \tag{10}$$

3.2. Mechanism Derivation: Discontinuity Risk and Hysteresis Effect

Proposition 2 (Vulnerability exposure under the impact of stock rules): The construction of human capital H_t has significant time stickiness and can not achieve a sharp increase in a short period of time through the transfer of external funds. When facing strict compliance threshold $\bar{H}_{compliance}$, the operation of hyperbolic discountis enterprises under long-term low H can easily trigger the risk of chain breakage. Even with short-term injections of bail-out subsidies S_t, the probability of business recovery is still significantly lower than that with long-term high H maintenance.

Mechanism analysis: When the purchaser starts the penetrating supply chain audit, the focus of verification is not the temporary verbal commitment of the enterprise, but the continuous evidence left in the past: the change of industrial injury rate, the authenticity of the punch card record, the actual power consumption curve of environmental protection devices, the key technology research and development log, etc. These elements cannot be repaired by a short sprint. Therefore, in the incremental stage, once enterprises with bright return on assets lose the endorsement of compliance, the original special equipment and plant will quickly become Stranded Assets, and the enterprises will face non-linear business crisis.

4. Quantitative Research Design and Empirical Identification Strategy

4.1. Data Sources and Sample Construction

This study integrates micro-enterprise financial data, patent life cycle database and customs trade statistics:

1. Enterprise finance and governance micro database: covering Chinese manufacturing enterprises from 2015 to 2025 (focusing on automotive core parts and electronic modules), with data from CSMAR and the national enterprise credit information publicity system;
2. Patent tracking database: extract the invention patent data of the State Intellectual Property Office (CNIPA), calculate its maintenance cycle, citation frequency and knowledge diffusion span, and eliminate the utility model patents that are biased towards defense and catering;
3. Exogenous regulatory event database: to sort out the legislation, review and formal enforcement of LkSG and CSDDD in major European economies from 2021 to 2024.

4.2. Measurement and Construction of Core Variables

1. Explained variable: total factor productivity (TFP_{ijt}), measured using the LP method [9]; risk of supply chain disruption (Drop_{ijt}), which is a dummy variable for enterprises to encounter sharp cuts in orders or suspension of cooperation from multinational customers.
2. Core explanatory variables and hyperbolic discounting proxy indicators: in view of the fact that the discounting parameter β is difficult to read directly, this paper starts from the capital expenditure anomaly and labor cost gap in the micro-financial statements, and constructs a comprehensive measure of proxy variables:

$$\text{Discounting_Bias}_{it} = \omega_1 \text{Abnormal_CapEx_Gap}_{it} + \omega_2 \text{Social_Cost_Deficit}_{it} + \omega_3 \text{MD\&A_ShortTerm}_{it} \tag{11}$$

In formula (11), Abnormal_CapEx_Gap is the deviation residual of the ratio of actual equipment maintenance expenditure to the original value of fixed assets to the industry benchmark; Social_Cost_Deficit is proportion of social insurance paid by the enterprise and the salary payable to the employees deviating from the statutory minimum requirements; MD&A_ShortTerm is the density of short-term delivery terms used by the management in the discussion and analysis of the annual report.

3. Human capital stock variables (Humanity_{it}): It covers the precipitation of basic research and development (self-citation rate and cited half-life of invention patents) and labor environment protection (industrial injury notification, employee turnover rate and compliance of working hours).

4.3. Setting of Measurement Model

In this paper, the Staggered DDD model is used to assess the micro-heterogeneity of compliance shocks:

$$Y_{ijt} = \beta_0 + \beta_1(\text{Treated}_j \times \text{Post}_t \times \text{Discounting_Bias}_{it}) + \beta_2\text{Humanity}_{it} + \beta_3(\text{Treated}_j \times \text{Post}_t) + X'_{ijt}\Gamma + \mu_i + \lambda_t + \eta_{j\times t} + \varepsilon_{ijt} \quad (12)$$

In formula (12), Treated_j is exposure intensity of the industry affected by regulation; Post_t is the time node for opening substantive third-party verification for regulations; μ_i is fixed effect for individual enterprise; λ_t is for the year effect; $\eta_{j\times t}$ is the industry-year joint fixed effect; $\mathbf{X}'_{ijt}$ is a control variable vector including enterprise scale, asset-liability ratio, cash flow ratio, etc.

5. Empirical Results and Analysis

5.1. Analysis of Benchmark Regression Results

Table 1 is the result of the benchmark estimates for model (12).

Table 1. Benchmark Regression Estimation Results

Variable name	(1) TFPLP	(2) TFPLP	(3) Drop	(4) Drop
Treated × Post × Discounting_Bias	-0.342*** (0.041)	-0.289*** (0.038)	0.215*** (0.029)	0.187*** (0.026)
Humanity		0.175*** (0.024)		-0.112*** (0.018)
Treated × Post	-0.056* (0.031)	-0.042 (0.028)	0.084** (0.035)	0.061* (0.032)
Control variable	Contain	Contain	Contain	Contain
Firm Fixed Effect (Firm FE)	Yes	Yes	Yes	Yes
Year Fixed Effect (Year FE)	Yes	Yes	Yes	Yes
Industry × Year fixed effect (Ind × Year)	Yes	Yes	Yes	Yes
Observed Values (N)	14,820	14,820	14,820	14,820
Goodness of Fit (R^2)	0.682	0.714	0.543	0.581

Note: The robust standard error of clustering to the enterprise level is in brackets, and * , **, *** are statistically significant at 10%, 5%, and 1%, respectively.

As shown in columns (1) and (2) of Table 1, the triple interaction coefficient is consistently negative at the 1% significance level. This means that in the face of the impact of international compliance audits, the total factor productivity of those enterprises that excessively depress employment benefits and undercount equipment maintenance expenditure in the early stage has declined significantly more than that of the control group with prudent operation. Meanwhile, in column (2), Humanity The index coefficient is significantly positive (0.175), which confirms that the daily maintenance of workers' dignity and the continuous investment in R & D at the bottom are not idle costs that drag down performance, but effective assets to digest changes in external rules. Columns (3) and (4) show that the incidence of chain breakage risk is significantly higher in hyperbolic discount firms, supporting the theoretical model hypothesis.

5.2. Robustness Test and Endogenous Defense

1. Parallel trend test: The event study method was used to examine the interaction terms of each period before the occurrence of exogenous shocks. The results show that in the three years before the implementation of the Act, the interaction coefficients fluctuate around the zero axis and are not statistically significant, which meets the parallel trend assumption.
2. Placebo test: a fictitious breakpoint test for emerging market exports that are not subject to the EU Act to exclude potential disruptions to firm productivity from global macro-cyclical fluctuations.
3. Instrumental variable method (2SLS): In view of the adverse selection problem that may exist in the enterprise discount preference, this paper introduces the clan network density of the executive's native place and the frequency of historical natural disasters in the enterprise's location as exogenous instrumental variables of cultural discount preference. The first stage F If the statistic is greater than critical value of 10, the possibility of weak instrumental variables is excluded; The core conclusion of the second stage is still robust.

6. Conclusions and Policy Implications

The analysis of this paper shows that the anti-risk ability of modern industrial system depends not only on the speed of centralized allocation of existing resources, but also on whether the micro-unit has the institutional soil to continuously evolve new forces. The empirical evidence and derivation point to clear policy implications:

First, change the factor accounting method and promote the explicitization of implicit costs and the restructuring of government and enterprise incentives. In the past, the low-cost competitiveness of some fields objectively benefited from the substantial discounting of the health of workers' life cycle, environmental carrying capacity and the cost of technological trial and error. China's growth miracle during the transition period benefited from the deep stimulation of local governments' economic vitality under the decentralization mechanism, but effective market evolution depends more on incentive-compatible institutional constraints[10].

Second, humanistic soft power is the supporting structure of hard power. The resilience of the system depends not only on the size of tangible assets, but also on the health of the underlying micro-mechanisms. The tolerance of diversified exploration, the protection of scientific truth-seeking trial and error, and the respect for the basic rights and interests of each specific worker constitute the base of modern innovation. Without the support of this humanistic background, the productivity and computing power generated only by policy subsidies and engineering mobilization are often too rigid under the impact of external rules.

Third, from passive stress to active participation in the game of rules. When dealing with the shift of international compliance supervision, it is difficult to untie the technical deadlock faced by the industry by staying in the narrative of external discrimination or resorting to antagonism. The realistic way to break the monopoly of external discourse lies in facing up to its own institutional debts and consolidating the foundation of compliance at the micro-governance level. Only by standing in the international arena as the main body of compliance and relying on the huge industrial hinterland to participate in and even lead the subsequent iteration of the rules, can a super-large-scale economy take a calm attitude when crossing the historical cycle.

Author Contributions

Conceptualization, G.Y. and Z.D.; methodology, Z.D.; software, G.Y.; validation, G.Y. and Z.D.; formal analysis, Z.D.; investigation, G.Y.; resources, G.Y.; data curation, Z.D.; writing—original draft preparation, G.Y.; writing—review and editing, G.Y. and Z.D.; visualization, G.Y.; supervision, Z.D.; project administration, G.Y.; funding acquisition, Z.D. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

This study integrates micro-enterprise financial data, patent life cycle database and customs trade statistics: Enterprise finance and governance micro database: covering Chinese manufacturing enterprises from 2015 to 2025 (focusing on automotive core parts and electronic modules), with data from CSMAR and the national enterprise credit information publicity system; Patent tracking database: extract the invention patent data of the State Intellectual Property Office (CNIPA), calculate its maintenance cycle, citation frequency and knowledge diffusion span, and eliminate the utility model patents that are biased towards defense and catering; Exogenous regulatory event database: to sort out the legislation, review and formal enforcement of LkSG and CSDDD in major European economies from 2021 to 2024.

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Conflicts of Interest

The authors declare no conflicts of interest.

References

1. Evenett, S., Baldwin, R. *Revitalising Multilateralism: Pragmatic Steps for the WTO*. CEPR Press: London, UK, 2020; 25-46.
2. Rodrik, D. Why Does Globalization Fuel Populism? Economics, Culture, and the Centrality of Trust. *Journal of International Business Policy*, **2021**, *4(1)*: 1-17.
3. Ruggie, J. *Just Business: Multinational Corporations and Human Rights*. Norton & Company:New York, USA, 2013; 81-120.
4. Porter, M., Kramer, M. The Big Idea: Creating Shared Value. *Harvard Business Review*, **2011**, *89(1-2),* 62-77.
5. Sen, A. *Development as Freedo*. Oxford University Press: New York, USA,1999; 3-53.
6. Sen, A. *On Economic Inequality; Inequality Reexamined*. Translated by Wang Liwen and Yu Zhanjie. Social Sciences Academic Press: Beijing, China, 2006: 15-78.

7. Phelps, E., Pollak, R. Second-Best National Saving and Game-Equilibrium Growth. *The Review of Economic Studies*, **1968**, *35(2),* 185-199.
8. Laibson, D. Golden Eggs and Hyperbolic Discounting. *Quarterly Journal of Economics*, **1997**, *112(2),* 443-478.
9. Levinsohn, J., Petrin, A. Estimating Production Functions Using Inputs to Control for Unobservables. *The Review of Economic Studies*, **2003**, *70(2),* 317-341.
10. Qian, Y. *Modern Economics and China's Economic Reform*. China Renmin University Press: Beijing, China, 2003.112-145.

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