Crisis of Capitalism, Systemic Transition and Economic Liberation

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Introduction

In this exposition — given in summary form at the XI International Economic Congress of Saint Petersburg, at the invitation of the Free Economic Society of Russia and the S. Yu. Witte Institute for New Industrial Development, in dialogue with the Russian economist Sergey Bodrunov —, I will address a particular aspect of the general argument about the transition from the capitalist system to an associative system based on self-management and the solidarity economy. The central argument was presented in my conference in Medellín (Mance, 2025). Here I focus on the **systemic crack in the realization of value in capitalism** and the current moment, in which the development of the productive forces unravels the social relations of production based on the purchase of labor by capital through the payment of wages.

The central focus of the analysis will be the structural insufficiency of income distributed in the economic circuit of capital to realize the surplus value produced within it. In each production cycle, the total value distributed — in the form of wages, payments to suppliers, and taxes to the state — is less than what capital needs to receive back in the form of sales revenue in order to realize the surplus-value produced in that same cycle. This difference — a systemic crack — is historically compensated by the expansion of credit, economic growth, and the successive distribution of value that allows the repayment of previously received credit. However, when the interest rate is higher than the profit rate and the distribution rate, indebtedness increases, even if economic growth occurs — as has been happening in recent decades. Global debt has already reached 249% of world GDP, and the signs of credit exhaustion as a mechanism to ensure the realization of value are unequivocal.

We are now reaching the **breaking point of this systemic crack**: the moment when wages paid as the cost of living labor become higher than the cost of using humanoid robots and AIs, reprogrammable for various functions in the production of goods and services without additional hardware costs. This point is not merely a technological variation — it is the final intensification of the historical contradiction between the development of productive forces and the social relations of production based on wage labor.

When capital substitutes living labor with robots on a large scale, it drastically reduces the wage mass distributed, which is the basis for the realization of value. The system produces ever more commodities and distributes ever less value — the systemic crack in the realization of value widens, reaching the starting point of the rupture of the economic reproduction of the system itself.

The analysis that follows traces this argument in eleven steps: it starts from the functioning of the value circuit and the crack that is structural to it; examines the two historical responses to the crisis — indebtedness and redistribution —; documents the solidarity transition already underway with respect to the exclusion of labor; analyzes the impact of humanoids on costs and the timelines for the onset of rupture by country; and arrives at the central strategic question: **what the solidarity**

economy needs to build, and by when, so that the continuity of capitalism's rupture due to insufficient value realization becomes a transition and not a systemic collapse that tends to occur at the moment of default on the unpayable debts of families, governments, and companies.

1. The value circuit: production, distribution, and realization

The capitalist economic process of value reproduction does not end with the production of commodities. It constitutes a **circuit** that needs to close: capital invests in means of production and labor power; workers produce commodities whose value added by labor is greater than what they received as wages — generating **surplus value** —; and this surplus value is only realized as profit when the commodities are sold. Sale presupposes buyers with purchasing power. Without sufficient solvent demand, the value produced is not realized, and unrealized value, immobilized, cannot be reinvested in the economic circuit.

The solvent demand that closes this circuit, with the realization of value, comes mainly from the **wages paid to workers**, which return to the circuit as consumption. The wage is the structurally dominant source of demand — it is the income that the majority of the population spends entirely on current consumption, activating not only the chains of the acquired good but also the entire network of inputs, intermediate goods, and services chained behind each product. As Marx (1962, p. 126) demonstrated, the circuit of one commodity is integrated into the circuits of many others.

2. The systemic crack in the realization of value: the value reproduced in an expanded way within an economic circuit cannot be fully realized through the value distributed within the same cycle of its reproduction.

Capitalism contains, in its very logic, a **structural systemic crack**: the set of companies distributes to workers, suppliers, and the State, in a production cycle, less value than it needs to receive back from sales to realize the surplus value produced. It is precisely this difference in surplus value that needs to be realized in the market. Within the circuit, credit is the alternative that activates purchases and covers this difference, generating debts. If economic growth and the value distribution of the following cycle allow the repayment of past debt, the mechanism repeats successively. But if there is no growth or the distribution rate does not allow past debts to be repaid, the systemic crack widens, and the realization of surplus value becomes dependent on the incorporation of external markets whose values spent on purchases were not distributed within the production circuit itself.

Currently, this crack deepens because the **development of productive forces** — the incorporation of living labor capacities into fixed capital, into machinery — progressively reduces the amount of wages paid per unit produced. With less wages distributed, solvent demand falls; with less demand, prices and profit margins are pressured downward; with smaller margins, capital intensifies automation to recover productivity — which further reduces wages paid. It is a self-reinforcing cycle.

Data confirm this structural trend: the wage share relative to GDP fell **5.8 percentage points in the USA** between 2000 and 2024, and **2.5 points in the Eurozone**. Global indebtedness, which artificially compensated for this drop in demand, jumped from 187% to 249% of GDP in the same period — evidencing that the substitution mechanism has already reached its sustainability limit (Mance, 2025, p. 5, 6).

3. Indebtedness or redistribution: the two responses to the crisis

Faced with the structural insufficiency of solvent demand, capitalism has two historical responses. The first is **indebtedness**: substituting wages with credit, anticipating future consumption to sustain present demand. This model is structurally unsustainable: when families, companies, and governments approach their indebtedness ceiling, income becomes destined for the servicing of past debts — unproductive payment of interest — instead of present consumption. The mechanism postpones the crisis at the cost of deepening it.

The viability condition of this model is that the profit rate generated with credit exceeds the interest rate on accumulated indebtedness. When this relationship reverses — as progressively occurs in the most indebted economies — the model collapses.

The second response is the **social redistribution of the value produced**: distributing part of the surplus through public funds, social protection, minimum wage, pensions, and cooperative forms, creating demand without generating future liabilities. This response not only sustains the economic circuit — it progressively advances toward the dissolution of the capital/wage labor relationship, replacing it with associative and self-managed relations.

Data confirm the divergence between the two models: while the USA and Europe experience a fall in the wage share of GDP and growth in indebtedness, China recorded an **increase of 9.9 percentage points** in the wage share of GDP between 2000 and 2024 — exactly the period in which it sustained robust economic growth and expansion of domestic demand (Mance, 2025, p. 6).

4. The systemic transition is already occurring: cooperativism, solidarity economy, and the public sector

The transition to associative and public forms of production and distribution is not a future aspiration. It is a measurable and growing process. Non-strictly capitalist forms of economic organization already represent about **23% of real world GDP**, when we include cooperatives, public enterprises, the third sector, and the popular and solidarity economy (Mance, 2025, p. 12).

Cooperativism grew from 760,000 cooperatives with 800 million members in 2000 to **3 million cooperatives and 1.24 billion members** in 2024 — reaching a penetration rate of 15.3% of the world population. The revenue of the 300 largest cooperatives jumped 45% in six years, from US$ 1.9 trillion in 2017 to US$ 2.8 trillion in 2023 (Mance, 2025, p. 14, 15).

This growth is, in part, a structural reaction to unemployment and precarization generated by capitalist automation. Workers excluded from formal employment seek self-managed forms of production — and in doing so, they build, even if partially and without explicit intention, **new social relations of production, distribution, and appropriation**. Marx (1964, p. 456) had already identified the cooperative factory as a form of transition from the capitalist mode of production to the associated mode of production that positively overcomes the contradiction between capital and labor, in contrast to the joint-stock company, which overcomes it negatively by socializing capital while maintaining the subordination of labor.

5. The rupture of humanoids: dead labor advances over living labor

It is within this structural framework that the introduction of **AI and industrial humanoid robots** into production chains acquires its full historical significance. It is not merely a technological innovation — it is the most intense acceleration ever recorded of the transfer of living labor capacities to dead labor. The industrial humanoids available in 2026 — such as AgiBot A2, Unitree H2, Figure 02, Ubtech Walker S2, and Agility Robotics Digit — cost between US$ 100,000 and US$ 250,000 per unit and are being introduced in industrial production and logistics environments, including plants operated by BMW, Mercedes-Benz, BYD, and GXO Logistics (BMW Group, 2026; Waldersee, 2025; Figure AI, 2025; Evans, 2025; Business Insider, 2025).

They are expected to follow the same trajectory of incorporation that was realized with industrial robots, known as “robotic arms” (multipurpose manipulators, automatically controlled and reprogrammable — ISO 8373:2021). With this concept, for the base year 2023, the International Federation of Robotics recorded, in relation to every ten thousand workers, a density of 1,012 robots in South Korea, 770 in Singapore, and 470 in China (IFR, 2024). In absolute numbers, the world has 4.66 million industrial robots (IFR, 2025), China 2,027,000 (43% of the total), Japan 450,000, and the United States 393,000 (The Robot Report, 2025). Russia has a stock of 14,382 and a density of 25–30 (Krysina, 2025). And Brazil has a stock of 20,000 units (Itaú, 2025) and a density of 16 (Zabeu, 2023). Humanoid robots, drones, and others are not included in this statistic.

Today, in the functions in which they operate, based on available data, **2 humanoid robots would be needed to replace 3 workers in rotating shifts in industry** — because the robot operates up to 24 hours a day, with recharging breaks, but with efficiency of about 50% relative to the human worker in manipulation tasks. This proportion, however, is not static. The decisive differential of humanoids in relation to any previous industrial machine is that their performance is determined mainly by the **AI software** — not by the physical hardware. And the software improves continuously, without equipment replacement.

Figure AI documented a **400% improvement in speed and a 7-fold increase in success rate** of the same hardware between 2023 and 2024, merely with updates to the AI model (Daws, 2024). NVIDIA CORPORATION (2025a, 2025b) implemented a distributed fleet processing architecture (*Fleet Learning*) with the robot brain in the cloud, in which **each robot learns from the experience of other robots anywhere in the world** — through the manufacturer, via retraining cycles and updating of the base model — with no additional cost to the owner (Bailiss *et al.*, 2025). Boston Dynamics and the Toyota Research Institute (2025) demonstrated a *Large Behavior Model* for Atlas in August 2025 — a generalist behavior model that allows sharing improvements in robot task execution.

The result of these processes is a decreasing curve of robot/human ratio (projected from humanoid operational performance data and Wright's Law applied to industrial robotics hardware, with an average rate of 20% every two years): in 2028, 1.7 robots per 3 human shifts; in 2030, 1.4 robots; in 2032–2034, a single robot; and between 2036 and 2038, one robot tends to be capable of replacing

4 or more workers in different functions due to its speed, precision, and fatigue resistance superior to humans — Table 1. With this, a robot purchased today can, over its 5 to 10-year useful life, progressively multiply its capacity to replace living labor — without additional hardware investment.

Table 1: Living labor substitution curve by industrial humanoids — projection by Wright's Law (20% biennial rate, base 2026)

Year	Efficiency	Workers replaced (24h)	Robots per 3 shifts
2026	50%	1.5	2.0
2028	60%	1.8	1.7
2030	72%	2.2	1.4
2032	86%	2.6	1.2
2034	104%	3.1	1.0
2036	124%	3.7	0.8
2038	149%	4.5	0.7

Source: Author's elaboration, starting from the current 50% efficiency of the humanoid robot relative to human efficiency in the industrial activities in which it is employed.

6. The total cost in 5 years and the timelines of rupture of the production crack and the realization of surplus value by country

The economic criterion adopted in this study to evaluate when the adoption of humanoids becomes economically rational for capital — and, therefore, competitively necessary for the company not to be eliminated by competition — is not the payback period of investment, but the **5-Year Total Cost of Ownership (TCO)**: the period in which, in the most drastic evaluation, complete equipment depreciation would occur — although, in fact, it can remain functional for a much longer period, particularly due to firmware and application software updates. If, in this period, the accumulated cost with the robot fleet becomes lower than the accumulated cost with the human work team performing equivalent tasks, the substitution is economically viable and advantageous for capital.[1]

In an American industrial plant, a fleet of 2 robots (US$ 100,000 each) costs US$ 510,000 in the first 5 years — compared to US$ 900,000 for the work of 3 human shifts in the same period, based on the average general US manufacturing wage of US$ 29.77 per hour in February 2026 (Trading Economics, 2026). The cost reduction is **43% in 5 years**, with accumulated surplus of US$

1 TCO (Total Cost of Ownership) measures the total cost of operation over a determined period — in this text, five years. The comparison between humanoid robots and human workers considers, for each side, the following cost categories. For industrial robots: hardware acquisition cost; installation and integration into the production process; electricity consumption; preventive and corrective maintenance; software and firmware updates; training of operators and technicians responsible for the fleet; and equipment depreciation. For human workers: gross salary; social and labor taxes; benefits (health, transportation, food); training and qualification; costs associated with absenteeism and turnover; and supervision.

390,000, as shown in Table 2. The investment is recovered in less than 23 months. This calculation considers current prices and the static proportion of 2 robots per 3 human shifts with 50% efficiency. However, with improved speed, increased success rate, and projected drop in robot prices upon fleet renewal, gains progressively amplify.

Table 2: Annual Cost Comparison — Human Team vs. Fleet of 2 Industrial Humanoid Robots (Values in US$ — Base year 2026)

Cost Component	Human Team (3 Shifts/Year)	Fleet of 2 Robots — Year 1	Notes
Acquisition / Salaries	138,000	200,000	2 × 100,000 (AgiBot A2 or equivalent)
Payroll Taxes and Benefits	41,400	0	30% overhead in the USA
Initial Integration	0	40,000	ERP software, 5G, safety (~20% of hardware)
Depreciation (5 years, linear)	0	40,000	20,000 per robot/year
Opex (Energy + AI + Maintenance)	600	14,000	~7,000 per unit/year
TOTAL COST YEAR 1	**180,000**	**294,000**	Robots more expensive than living labor only in the 1st year (high capex)
Recurring Annual Cost (Year 2+)	**180,000**	**54,000**	Only Opex + Depreciation
TOTAL COST IN 5 YEARS	**900,000**	**510,000**	Accumulated savings: **390,000** (43% lower)

Based on **Wright's Law** — an empirical pattern validated in dozens of technologies — it is projected that for each doubling of accumulated production of humanoids, the cost falls by 15% to 25%. For solar panels, this law implied a 99.6% drop in 43 years (Roser, 2023). For electric vehicle batteries, 97% in 25 years (Ziegler; Trancik, 2021). For industrial-use humanoids, starting from US$ 200,000 in 2024, we arrive at US$ 100,000 in 2026 and project US$ 25,000 between 2032 and 2034, in the base scenario of 18% per doubling — similar to the learning curve in battery production. In 2026, more than 140 Chinese manufacturers and global AI platforms (NVIDIA, Google DeepMind, OpenAI Robotics) are actively competing, putting pressure on hardware and software prices simultaneously.

With these data, the **map of rupture of this systemic crack by country** — calculated by the 5-year TCO with actual wages and payroll taxes of each economy — reveals much closer timelines to the breaking point, where using humanoid robots becomes more economical for capital than hiring living labor to perform increasingly diversified functions, thereby accentuating several other systemic cracks of capitalism (see endnote 1).

Table 3 — Systemic crack breaking point for selected countries

Country	Annual wage (USD)	Payroll taxes (%)	Total cost/ worker/ year (USD)	Human TCO 5y (USD)	Fleet TCO (USD)	Rupture	Robot/ human efficiency (%)	Robots in fleet (units)	Robot price (USD)
USA	75,275	22.0	91,836	1,377,540	510,000	2026	50.00	2.0	100,000
Germany	64,873	20.4	78,107	1,171,605	510,000	2026	50.00	2.0	100,000
South Korea	50,947	12.5	57,315	859,725	510,000	2026	50.00	2.0	100,000
Japan	49,446	15.5	57,110	856,650	510,000	2026	50.00	2.0	100,000
China	18,148	42.0	25,771	386,565	304,880	2028	60.00	1.7	67,240
Russia	20,131	26.0	25,365	380,475	304,880	2028	60.00	1.7	67,240
South Africa	19,831	3.0	20,426	306,390	304,880	2028	60.00	1.7	67,240
Brazil	7,430	68.0	12,483	187,245	186,759	2030	72.00	1.4	45,212
Indonesia	10,500	11.0	11,655	174,825	147,787	2031	78.87	1.3	37,074
Mexico	5,741	25.0	7,176	107,640	94,925	2033	94.65	1.1	24,929
Vietnam	4,040	21.5	4,908	73,620	63,285	2035	113.58	0.9	16,762
India	2,921	12.0	3,272	49,080	43,874	2037	136.29	0.7	11,271
Bangladesh	1,558	7.5	1,675	25,125	23,551	2041	196.26	0.5	5,096

Source: Author's elaboration with wage data from ILO (2026) for countries with 2024-2025 information and from Trading Economics (2026b) for others. Details of formulas and application examples can be seen in **Annex 1**.

With the learning rate per doubling at 18%, reducing robot prices each year, and with the efficiency gain rate at 20% every two years, we see in Table 3 — based on the *average wage* of countries and the *payroll taxes* applied to it, resulting in the *total cost* of one worker per year — the temporal points of the onset of systemic rupture for different countries, when the cost of maintaining a team of 3 workers for 5 years exceeds the cost of a fleet of humanoid robots in the same period, which with their machinic action can replace them with the same collective efficiency in performing their tasks.

Among the countries selected for analysis, this moment of rupture has already arrived in the United States, Germany, South Korea, and Japan. If there is no organization of Solidarity Economy Circuits and public income transfer policies in these countries, as analyzed in the Medellín Conference (Mance, 2025), social exclusion tends to lead to the expansion of the criminal economy as a perverse form of income appropriation.

In the case of China, Russia, and South Africa, this breaking point is reached in 2028, and in Brazil in 2030. These BRICS countries have a strategic window of 4 years to design and develop their transition initiatives with the organization of Solidarity Economy Circuits and expansion of income distribution policies, promoting a strategy of liberation of the productive forces. Because, from that moment on, capitalist competition tends to initiate the replacement of worker teams with humanoid fleets, adaptable to different tasks based on firmware updates, application software, and AIs.

Based on these projections, Indonesia will reach this moment in 2031, Mexico in 2033, Vietnam in 2035, and India in 2037. However, even in these countries, in industrial segments where teams of workers receive better wages, this transition may begin earlier, though without greater propagation throughout the entire economy.

In the case of Bangladesh, this moment would tend to occur around 2041. However, in this case, which illustrates countries with extremely low average wage levels, it can be seen that the transition — previously initiated in other countries with higher wages — will tend, through competition from even cheaper products in the international market, to force an even greater reduction of already extremely low wages. For, lacking conditions to promote the incorporation of these technologies for cost reduction and productivity gain, the tendency is an even greater realization of the super-exploitation of hired labor.

7. The super-exploitation of living labor as a delay — and future acceleration — of the systemic crisis

The breaking point calculated based on TCO does not imply automatic and immediate adoption of this technology. Capital has an alternative response mechanism to face competition that employs it: **wage compression**, making living labor cheaper through super-exploitation, thereby expanding the rate of extraction of absolute surplus value and postponing investment in robotics, waiting for equipment prices to fall further. This mechanism operates through three pathways: technological threat as an instrument of union discipline (the robot as bargaining power even before being installed); precarization and informalization of labor to reduce payroll taxes; and productive migration to lower-wage zones that will accept even more accentuated conditions of super-exploitation.

This delay is, however, structurally contradictory. The super-exploitation of living labor **deepens the systemic crack**: by compressing wages, capital further reduces the solvent demand it needs to realize the value produced. This modality of surplus value extraction has physical and political limits. When wages can no longer be compressed and the worker is already at the limit of resistance, automation returns as the only way out — and it does so abruptly, without the transition period that would allow requalification of the workforce for the self-management of technologically advanced cooperative enterprises.

For Brazil, this effect can extend the advance of rupture from 2030 to 2034 — depending on the political trajectory of wages and public incentives for robotic and AI development in the country. But the scissors effect between falling robot prices and the maintenance of current policies of wage increases (even if moderate) to ensure solvent demand and the realization of surplus value tends to guarantee that the advance of rupture will occur within this interval.

8. Extraordinary surplus value: competition that concentrates surplus value and eliminates the competitor

The introduction of humanoids does not create new value in the economic sense — it redistributes surplus among competitors through the expropriation of value in market competition, in which the loser does not realize the surplus value produced in its company, selling the product below its value although above cost; for the winner, selling at average market prices, sells at prices above the value of its own product, realizing as profit for itself the surplus value that was not realized by the competitor. **Extraordinary surplus value** occurs when a company reduces its individual labor time below the socially necessary time in the sector — for example, with the use of humanoids that results in savings of **43% in 5 years** compared to competitors, as seen in the case of Table 2 — but sells the product at the market price, still determined by companies using human labor. The difference is supplementary profit, as an extraordinary realization of surplus value produced in other companies but not realized by them.

This advantage is transitory by nature: it lasts as long as the technology is not generalized. When all competitors adopt it, the market price of the product tends to fall to the new cost level with a margin compressed by competition for surplus value realized as profit, and extraordinary surplus value disappears. However, companies that did not adapt are eliminated by inability to compete. **The extraordinary surplus value of the technologically advanced vanguard is the prelude to the bankruptcy of the rearguard that remains technologically lagging.**

Secondly, as automation becomes generalized, as we have seen, there occurs a reduction in the value of commodities that make up the worker's basic basket. This reduces the cost of reproduction of labor power and, stabilizing wage payments against productivity gains, equally increases the rate of relative surplus value with respect to workers who remain employed — without their nominal wage growing in the same proportion as the company's productivity.

Thirdly, distributed fleet AI processing adds an unprecedented dimension to this process: each robot in a fleet learns from the collective experience of the other robots of the same operator — and, when the manufacturer makes available a common base model, also from robots of other operators using the same platform, even if they are competitors. This collective learning occurs without additional cost to the hardware owner: the productivity gains generated revert entirely to the fleet owner, without any redistribution of the surplus thus produced. It is a forced socialization of learning — mediated by the platform manufacturer — that operates as a vector of surplus value concentration: the larger the fleet, the greater the volume of aggregated experience, the greater the differential productivity gain compared to operators of smaller fleets or different, less efficient platforms.

9. The contradiction closes: robotics and AI deepen capital's realization crisis

The generalization of humanoids does not resolve the systemic crack of capitalism — it **decisively deepens it**. Each robot that replaces 3 workers eliminates three wages from the distributed wage mass. These three wages cease to return to the economic circuit as solvent demand. Multiplied by millions of industrial plants in advanced economies — and progressively in developing economies — this process structurally contracts the base of surplus value realization globally.

At the same time, the indebtedness that artificially compensated for this drop in demand — in economies where the interest rate is higher than the average profit rate and the average distribution rate — approaches the limit of its sustainability. When the two processes combine — fall in wage mass due to automation and exhaustion of debt capacity — the value realization crisis becomes systemic in these economies and no longer conjunctural.

Faced with the breaking point of this systemic crack, capital's immediate response is not to adopt robots — it is to **compress wages**. Paying less for the same work and maintaining the same production, capital generates absolute surplus value and reduces its costs to compete with automation. But this strategy has an insurmountable structural limit: **robots will be used to produce more robots**. At the moment when the cost of reproducing automated fixed capital itself falls below the cost of living labor, even super-exploited, wage compression ceases to be a viable strategy — and the replacement of living labor by robotic action becomes irreversible in capital's economic circuit.

Thus is created the historical contradiction that Marx identified as driving the transition of the capitalist mode of production: the social relations of production based on wages and private accumulation begin to **hinder the productive potential of the already existing productive forces**. The development of productive forces — automation taken to the limit — enters into irresolvable contradiction with the social relations that sustain it. Capitalism cannot resolve this contradiction within its own framework: any solution that preserves the wage as a central category distributes less than what is needed to realize the value produced in a cycle of production and value realization; any solution that eliminates the wage eliminates the very basis of solvent demand. And since the economic growth that would allow covering the credit of the previous cycle with the realization and distribution of value of the following cycle progressively reduces the very distribution of value — through the contraction of the wage mass in each value reproduction cycle — the form of capitalist growth historically achievable in the past based on anticipated credit also ceases to be viable after the breaking point of this systemic crack.

> *The economic rupture approaches not merely as an economy point in the TCO with the adoption of humanoid robot fleets replacing worker teams. It announces itself as the collapse of the structural viability of the capitalist circuit of production and realization of value, based on wage labor and consumption sustained by it. It is the rupture of the system itself in its most central crack.*

10. Solidarity Economy Circuits as an alternative for communal liberation

For the Solidarity Economy, this process presents both a threat and an opportunity simultaneously. The threat: if the solidarity economy does not organize self-managed circuits of production, circulation, and consumption, it will become one of the main **sources for the realization of extraordinary surplus value** of robotized capital. Each purchase that a solidarity enterprise makes in the capitalist market transfers value from the solidarity field to capital — realizing the surplus that capital extracted from external living labor, mediated by the machinic action of robots and AIs of its companies. And robotized capitalist companies will begin to offer products at prices that solidarity production, with living labor, cannot match, progressively eliminating the market niches that the solidarity economy currently occupies.

The opportunity, however, is structurally powerful. The incorporation of robotics and AI in the processes of the solidarity economy organized in **Solidarity Economy Circuits (SEC)** allows doing what capital cannot: **distributing surpluses as free goods or at prices below capitalist cost**.

The argument is economic, not moral: a cooperative that operates humanoid robots and does not need to remunerate shareholders can reduce the prices of its products to the marginal cost of operation — energy, maintenance, depreciation. Any capitalist company needs, structurally, to extract a profit rate on invested capital. The robotized solidarity economy that redistributes surplus can charge less than any capitalist can charge — and still be economically sustainable.

Moreover: part of the production can be distributed **free of charge** as community surplus — reducing the need to purchase capitalist products, eroding capital's value realization base, and expanding the Good Living of communities. When the SEC produces and distributes free or subsidized goods that previously needed to be bought in the market, it subtracts solvent demand from capital without replacing it with another: it eliminates it from the mercantile logic.

The gift-exchange: realizing surplus outside the market

There is an additional — and especially powerful — pathway to realize the surplus produced in SECs in the face of scarcity of value distributed as wages for the realization of surplus value: the **gift-exchange**, that which is realized as multi-reciprocal donation. If participants organize their exchange based on the principle "from each according to their abilities, to each according to their needs" (MARX, 1987, p. 21), value remains within the solidarity circuit without needing to pass through the money-form. When an enterprise produces more than it needs, it places the surplus in a *gift catalog*. When it needs raw materials or means of production, it obtains them from the same catalog — without money, without exchange credits, only mutual contribution and receipt.

As these catalogs can be interconnected globally — organized through *blockchain* or equivalent systems — a local cooperative can contribute goods to a regional circuit and receive means of production from a circuit located in another country. The surplus is realized in **physical products, not in money or credits**. This has a decisive structural consequence: capitalism **cannot realize its surplus in this way**. Capital needs the money-form to pay investors, settle debts, and accumulate. If the gift-exchange expands in the Solidarity Economic Circuit to the point of progressively replacing the monetary market in the basic needs of communities, the market system loses its operational base through functional obsolescence.

With respect to the approaching breaking point, Solidarity Economy Circuits must consider several simultaneous dimensions: **robotized solidarity production**, with collective ownership of equipment and AI data and total control of programming and data flows of this equipment, to keep them subordinated to their purposes; **self-managed digital platforms connecting consumption, exchange, production, and credit in economic circuits**, where solidarity economy actors integrate their production, exchange and consume among themselves, and organize joint investments; **collective ownership of AI models**, trained with solidarity economy data and shared among solidarity enterprises; **redistribution of surplus for the good living of all and expansion of exchanges of purchase-sale, non-monetary exchange, and gifts**, mediated by solidarity catalogs locally and globally interconnected on solidarity digital platforms.

11. The strategic imperative: Brazil and Russia facing the same window

Brazil and Russia have differences in the global wage map, with an annual cost of industrial labor respectively around US$ 13,680.00 and US$ 23,436.00 per worker, with payroll taxes included. However, by the 5-year TCO criterion, both reach the breaking point of the value realization crack with adoption of humanoid robots in the period 2028 to 2030, depending on wage trajectories and falling robot prices. However, the conditions each country faces to respond to this moment are **distinct**.

Brazil: window open, but decreasing

Brazil has between 4 and 8 years before this breaking point — 2030 in the base scenario, 2034 if capital resorts intensively to super-exploitation of living labor as a delay mechanism. Therefore, this near window is not a guarantee that the capacity to compete in the international market with productivity gains through the use of humanoid robotics in various areas will occur. For when the process gains traction in the country, it will already be much more advanced elsewhere.

For its part, the Brazilian solidarity economy is one of the largest and most organized in the world, with cooperatives, fair trade networks, community banks, and self-managed enterprises in all states. The country has a legal framework, training infrastructure, and accumulated experience to build Solidarity Economy Circuits before the advance of this rupture makes living labor industrially unviable in many functions and sectors.

The specific **risk** for Brazil is the combination of two processes that reinforce each other: the **super-exploitation of living labor** as a mechanism for delaying automation — with precarization, "legal entity outsourcing" (pejotização), and wage reduction —, and the **absence of industrial policy** for technological transition. If Brazilian capital opts for wage compression instead of investment in robotics, it postpones the rupture and at the same time deepens the systemic crack — arriving at it without requalified workers, without technologically prepared cooperatives, and without structured solidarity economic circuits to absorb the transition. The result would be a ruinous scenario: abrupt automation on an extremely precarious social base.

On the other hand, the **opportunity** is real and measurable. A Brazilian industrial cooperative that incorporated a fleet of humanoids without dismissing workers could expand total production at lower individual costs, facilitating the commercialization of its products, and would distribute the surplus instead of transferring it as profit to shareholders. It could advance in the realization of community good living: with reduction of working hours, subsidized products, transition fund for displaced workers, or offering free goods in the Solidarity Circuit that remove consumption demand from the capitalist circuit. Brazil has the necessary social movement to do this. However, it lacks the strategic decision to liberate the productive forces, realize their socio-technical adaptation, and incorporate them into the solidarity economy, before this window closes.

Russia: economically open window, but conjuncturally blocked

Russia presents a complex situation in the context of this transition: the country **simultaneously has the wage conditions that would justify large-scale automation in the medium term, but is conjuncturally prevented from accessing the technology** necessary to realize it. Western sanctions have severely restricted access to advanced semiconductors and critical components for industrial robotics. The leading humanoids — AgiBot A2, Figure 02, Agility Robotics Digit, Unitree H2 e Ubtech Walker S2 — are manufactured in China and the USA. Robots with qualified components for advanced industrial use are subject to dual-use export restrictions.

Military efforts have strongly activated the industrial sector in Russia, which, in turn, has increased labor demand and has been raising wages in the sector above the national average. This, consequently, also raises wages in civilian industry. And although this increase expands the power of surplus value realization in the domestic market, it also **economically anticipates the breaking point of the value realization crack in the economic circuit where the exchange of living labor for humanoid robots becomes necessary for capital to realize extraordinary surplus value, defeating competitors that do not reduce costs.** However, Russia's domestic robotics capacity has not yet reached the levels of humanoid supply required for this transition.

As a result, wages rise, making living labor more expensive; on the other hand, humanoid robots are inaccessible due to sanctions; and domestic robotics is insufficient to meet the demand required in this transition phase. Consequently, nations that do so will sell their products at the average price in the international market although their costs are well below it, realizing extraordinary surplus value that was produced in competing companies that delay in making this transition. According to projections, Russia reaches the systemic crack breaking point of value realization in 2028 and has a national robotic development strategy (Krysina, 2025) that must be adjusted to these new advances. Nations that delay in this transition will tend to lose industrial competitiveness relative to economies that advance in humanoid robotization first.

The contrast within BRICS

Technological sovereignty is a prerequisite of economic sovereignty in the era of humanoids that is beginning and that tends to be driven by the immanent law of capitalist production. In this context, it is not enough to have a social movement, cooperative tradition, or political will: it is necessary to have access to technology. On the other hand, it is not enough to have access to technology if there is no collective project to distribute the surplus it generates for a real process of economic liberation of society as a whole for the good living of all. Brazil has the second element, a potential collective project and increasing wage mass, without guarantee of the first, technological mastery in humanoid production. Russia is blocked in the first, although it has a high **technical and scientific capacity** and advances in the second element, with increased distributed wage mass. China, in turn, advances in both — being the world's largest manufacturer of humanoids and the country among the large ones that most increased its wage mass relative to GDP in the last 25 years. This means that productivity gains from the robotization of the economy that allow the realization of extraordinary surplus value internationally have been distributed, also feeding internally the realization of surplus value with the sale of production in the national market.

The systemic transition that productive forces are imposing on capitalism can lead in two opposite directions: a reconfiguration of the system that maintains private accumulation under new technological forms — with massive structural unemployment, super-exploitation of remaining workers, and extreme concentration of wealth —; or a transition to **associative, self-managed, and solidarity** social relations of production, distribution, and appropriation, in which the productivity gains of robotics and AI are converted into reduction of necessary labor and expansion of Good Living for the entire community.

> *The question for the Economics of Liberation is not whether robots will come. It is what the solidarity economy will have built when they arrive — and whether countries will have sufficient technological sovereignty to choose how to use them. The systemic transition is underway. What is at stake is: the configuration of the mode of production, circulation, and credit most adequate to best harness the potential of developing productive forces; which are the social forces that will conduct the employment of these technologies; what will be the use of these technologies in processes of economic domination or economic liberation; what social relations of production, circulation, credit, and consumption will emerge from this transition; what social form, of an authoritarian or substantively democratic nature, will develop in this process, restricting or expanding the good living of all; and, finally, who will be the beneficiaries of this technological transition.*

Conclusion: the breaking point as the beginning of a transition to an associative system that ensures good living or as an acceleration of indebtedness and exclusion leading to the capitalist collapse of value realization

The argument developed in this text can be summarized in four interlinked propositions.

The **first** is structural: capitalism contains in its own logic an irresolvable systemic crack. In each cycle of expanded reproduction of value within the economic circuit, the distribution of value is always less than that necessary to sell commodities and realize as profit the surplus value contained in them. Indebtedness artificially compensates for this insufficiency as debt to be repaid in subsequent cycles. But when recurrently the interest rate is higher than the profit rate and the distribution rate, indebtedness grows ever more. And this has been occurring for decades. This movement, which has reached its limit, has achieved a global debt of 249% of GDP — which corresponds to 2.5 years of global production as debt to be paid. There is no cyclical exit from this contradiction, which is constitutive of the mode of production.

The **second** is technological and economic: humanoid robots have made the breaking point of this systemic crack measurable and datable. It occurs when it is cheaper to use a fleet of these robots than a team of human beings in performing some activity. The more these fleets spread throughout the economy under the logic of capital accumulation and concentration, the less wage is distributed and the smaller the solvent capacity for realizing the surplus value produced and paying past debts. For high-income economies, it has already arrived in 2026. For middle-income economies such as Brazil, Russia, India, and China, it is between 2028 and 2038. The 5-year total cost with a fleet of humanoids is already 43% lower than with equivalent human labor in the USA — and this difference grows each year, with robot prices falling and their efficiency increasing, even without hardware replacement. Finally, when robots are widely used in the production of robots, wage compression will cease to be a viable strategy for capital.

The **third** is political and geopolitical: the systemic transition has no predetermined outcome. Technological sovereignty — access to the means of automation and to AI models, as well as their production and development — becomes a prerequisite for economic sovereignty. The existence of an organized movement around a transition project, with public policies, a legal framework, and accumulated experience in organizing solidarity economic circuits, is a necessary but not sufficient condition: it must be articulated with the incorporation of technology.

The **fourth** is strategic: the solidarity economy has a structural advantage that capital cannot replicate. A robotized cooperative that does not need to remunerate shareholders can reduce its prices to marginal cost — below any sustainable level for capital. And it can go further: realize its surplus not in money, but in **physical products, distributed as gifts in solidarity economic exchange** — through globally interconnected catalogs, organized by the principle of each *offering according to their capacity* and *receiving according to their needs*. Capitalism cannot do this: it needs the money-form to pay investors and settle debts. If the solidarity economy expands the gift-exchange to the point of progressively covering the basic needs of communities, the market system loses its great operational base — not by political decree, but by functional obsolescence.

As we have seen, based on the analyzed data, this is not about wishful optimism. It is the objective conditions that tend to force the transition process. The price of robots is falling faster than that of cell phones, and their diffusion should follow a similar trajectory. Sooner or later they will reach the Solidarity Economy Circuits. The question is not whether they will arrive — it is **with what preparation this will occur**. If solidarity circuits do not advance in this transition from the breaking point, capitalism may simply plunge into chaos — with massive structural unemployment, rise of authoritarian forces that cut income distribution programs without offering alternatives, wars for critical resources for the technological transition itself, and growth of the criminal economy until it collapses with the default of unpayable global debts. There are already many signs of this path underway.

Only distribution policies — historically defended by leftist forces and the solidarity economy — can create an orderly and smooth transition to the new associated mode of production. The forces that oppose these policies have no solution for the approaching rupture: technological development advances in the abolition of wage labor as the dominant form of value distribution, and no right-wing policy resolves the contradiction between automated productive forces and social relations based on wages. This contradiction is resolved — positively, by the expansion of solidarity economic circuits, or negatively, tending to lead to the collapse of the system itself.

> *The Economics of Liberation is a field of research that investigates how to realize this positive overcoming: organizing Solidarity Economy Circuits and realizing the liberation of the forces of production, circulation, and credit, incorporating technologies as tools of emancipation, organizing systems of solidarity economic exchange with digital platforms and catalogs of purchase-sale, exchanges, and gift-exchange as forms of realizing value, transitioning from the logic of the market in which surplus value is realized as purchase and sale to that of the communal economy in which it is realized in the form of economic means socially exchanged according to capacities and needs. The systemic transition is underway. What is at stake is whether it will be conducted in a self-managed way by societies, or simply suffered under the conduct of Big Techs with their AIs, drones, and fleets of robots of all kinds — including humanoid robots — programmable for civilian or military purposes.*

Endnote

1 As we analyzed when investigating "*The cracks of capitalism and its systemic overcoming*" (Mance, 2008), "from the last quarter of the last century, both the ongoing technological revolution (which involves informatics, biotechnology, robotics, materials technology [...]) [...], as well as the superdevelopment of speculative capital and the intangible goods economy, impressed new determinations upon capitalism. In this passage [...] a progressive modification occurs in the dominant method of production" (p. 49), aggravating its systemic cracks. On one hand, "[...] as the volume of resources distributed by it is not sufficient to circulate all production, it is necessary to generate credits to ensure its realization" (p. 42), which increasingly deepens the indebtedness of society as a whole. On the other hand, with the progressive modification of the production method, "[...] capitalism develops the productive forces under a logic that is currently incapable of incorporating about half of the economically active population of the planet into the production and consumption flows with remuneration that would allow them to exit the poverty line. In turn, the greater importance that the knowledge economy gains in the reproduction of the system, as a whole, tends to further widen this crack [...]" (p. 49). "The power of knowledge, in increasing productivity through technological innovation, generated the situation [...] in which it is more profitable for capital to make greater investments in constant capital — in more productive machinery to be operated by a preferably smaller number of workers — than to exploit a greater volume of labor power by hiring more employees" (p. 53). "Thus, at the same time that the value of commodities is reduced, by the reduction of production costs, an ever larger portion of society becomes impoverished, being excluded from the productive and consumption process, while another portion, which holds capital, continues to enrich itself" (p. 55). We now reach the breaking point of this crack, in which the action of humanoid robots and AIs becomes more economical than living labor for capital in performing different functions, further intensifying the cracks in the distribution and realization of socially produced value.

Annex 1: Calculation of the breaking point of the systemic crack in value realization

The criterion adopted is the comparative Total Cost of Ownership (TCO) over 5 years between a fleet of humanoids and a team of 3 workers covering 24 hours in 8-hour shifts.

1. Number of robots needed:

$R = H \times Th / (24 \times E)$

Where:

R = number of robots needed
H = number of human workers (3)
Th = hours per human shift (8)
E = robot efficiency relative to human worker in year t
24 = hours of continuous robot operation per day

Applying:

$\mathbf{R = 3 \times 8 / (24 \times E) = 24 / (24 \times E) = 1 / E}$

Examples:

Year	E(t)	Calculation	R
2026	50%	24 / (24 × 0.50) = 24 / 12	**2.00 robots**
2028	60%	24 / (24 × 0.60) = 24 / 14.4	**1.67 robots**
2030	72%	24 / (24 × 0.72) = 24 / 17.28	**1.39 robots**

2. Evolution of humanoid operational efficiency:

$E(t) = E_0 \times (1 + rate)^{((t - t_0) / period)}$

Where:

E(t) = robot efficiency relative to human worker in year t
E_0 = 0.50 — initial efficiency in 2026 (50%)
rate = 0.20 — efficiency gain per period
period = 2 — interval in years (biennial)
t_0 = 2026 — base year

Applying:

$E(t) = 0.50 \times (1.20)^{((t - 2026)/2)}$

Examples:

Year	E(t)	Calculation	E
2026	50%	$0.50 \times (1.20)^0 = 0.50 \times 1$	**0.50**
2028	60%	$0.50 \times (1.20)^1 = 0.50 \times 1.20$	**0.60**
2030	72%	$0.50 \times (1.20)^2 = 0.50 \times 1.44$	**0.72**

3. Evolution of robot price

$P(t)=P_0\times(1-rate)^{(t-t_0)}$

Where, by Wright's Law applied to hardware, with an 18% annual decrease:

- **P(t)** = robot price in year *t*
- P_0 = 100,000 — initial price in 2026 (US$)
- **rate** = 0.18 — annual price reduction rate (18%)
- t_0 = 2026 — base year

$P(t) = 100{,}000 \times (0.82)^{(t - 2026)}$

Examples:

Year	Calculation	P(t)
2026	$100{,}000 \times (0.82)^0 = 100{,}000 \times 1$	**US$ 100,000**
2028	$100{,}000 \times (0.82)^2 = 100{,}000 \times 0.6724$	**US$ 67,240**
2030	$100{,}000 \times (0.82)^4 = 100{,}000 \times 0.4521$	**US$ 45,212**

4. Fleet TCO over 5 years

TCO_fleet = R × P(t) × f + R × Opex × n

Where:

TCO_fleet = total cost of the robot fleet over n years
R = number of robots in the fleet
P(t) = robot price in year t
f = cost factor incorporating acquisition, integration and depreciation
Opex = annual operating cost per robot
n = number of years in the analysis period

With data from Table 2:

TCO_fleet = R × P(t) × 2.20 + R × 7,000 × 5

Where:

R = number of robots in the fleet
P(t) = robot price in year t
2.20 = factor incorporating: hardware (1.00) + integration (0.20) + depreciation (1.00)
7,000 × 5 = Opex per robot over 5 years — kept constant, although it also tends to decrease

Year	R	P(t)	Calculation	TCO fleet
2026	2.00	100,000	2.00 × 100,000 × 2.20 + 2.00 × 35,000	**US$ 510,000**
2028	1.67	67,240	1.67 × 67,240 × 2.20 + 1.67 × 35,000	**US$ 305,536**
2030	1.39	45,212	1.39 × 45,212 × 2.20 + 1.39 × 35,000	**US$ 186,808**

Note: marginal differences from the main table arise from intermediate rounding in the decimal places of R and P(t).

5. Human team TCO over 5 years:

TCO_human = C × H × n

Where:

TCO_human = total cost of the human team over n years
C = total cost per worker per year
H = number of workers
n = number of years in the analysis period

With data from Table 3:

TCO_human = C × 3 × 5

Where:

C = total cost per worker/year (wage + payroll taxes)
3 = number of workers
5 = years of the analysis period

Country	C	Calculation	Human TCO
USA	91,836	91,836 × 3 × 5	**US$ 1,377,540**
Brazil	12,483	12,483 × 3 × 5	**US$ 187,245**
India	3,272	3,272 × 3 × 5	**US$ 49,080**

6. Breaking point

The breaking point is the first year in which:

TCO_fleet < TCO_human

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