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THE RISE AND FALL OF NEOLIBERALISM: AN ECOLOGICAL AND REGULATIONIST ANALYSIS OF FRANCE (1960-2022)

In this article, we enrich Regulation Theory with metrics from ecological economics: thermodynamic efficiency, exosomatic metabolic rate and the weight of energy expenditure relative to GDP. Then, we use this framework to analyze French capitalism since 1960.

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The rise and fall of neoliberalism: an ecological and regulationist analysis of France (1960-2022)

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Abstract: According to the regulationist school of thought, 2007 marked the beginning of a structural crisis for neoliberalism. When it is mentioned, the role of energy is limited to that of an exogenous shock which, at most, contributed to the bursting of the real estate bubble. This article argues against this minimalist interpretation of energy's role in the neoliberal crisis. To achieve this, we systematically integrate energy flows into the analysis of accumulation regimes by crossing two bodies of knowledge: ecological economics and regulation theory. We use this framework to analyze the trajectory of French capitalism since 1960. We show that, far from being a mere exogenous shock, energy appears to be a key endogenous variable, one that is a source of contradictions that the historical configurations of capitalism must contain and overcome if accumulation is to continue. While Fordist capitalism succeeded in overcoming its energy contradictions by switching to the neoliberal mode of development, the emergence of new contradictions in the early 2000s has not yet been overcome by neoliberalism. What's more, neoliberal recipes for reconfiguring the metabolism have generated major imbalances likely to call into question the very reproduction of this regime (financial crises, trade imbalances, social unsustainability).

Keywords: Regulation theory, metabolic constraints, Fordism, Neoliberalism.

JEL classification: B52, E01, P18, Q43, Q57.

1. Introduction: the role of energy in the 2007 crisis - a simple exogenous shock?

For some economists, the Great Recession of 2008 was a sign that neoliberalism was entering a structural crisis. Far from being the effect of a passing conjuncture, the financial deregulation that led to the 2007 subprime crisis is in fact a central element of the neoliberal mode of development. Within the framework of Regulation Theory (RT), the excessive financialization that led to this disaster is therefore analyzed as an internal contradiction of the regime, and the central banks' tutelage of the financial system from 2008 onwards is a symptom of the neoliberal regime's failure to reproduce itself (Boyer, 2009).

But like the prevailing beliefs about the origins of economic growth, the commonly accepted explanations for the onset of the Great Recession of 2008 have a fundamental flaw: they generally have no connection with what really drives the global economic machine, namely energy, and oil in particular (see Appendix for a summary of the origins of the financial and economic crisis of 2007-08). This is as true for neoclassical economists as it is for the various heterodox schools of thought (neo-Keynesian, post-Keynesian, Marxist, regulationist), which tend to overlook the importance of material and energy flows in the economic process, and thus miss the inherent ecological dimensions of crises (Kallis et al., 2009)[1].

Nevertheless, a few isolated voices have attempted to establish this link. For example, Tverberg (2012) argues that the global peak in conventional oil production, reached around 2005, led to stagnation in oil production, limiting global economic growth. The subsequent increases in energy and raw material costs weighed down economies and exacerbated debt problems. According to Tverberg, these factors contributed significantly to the 2008 financial crisis, demonstrating the crucial role of oil supply in global economic stability. Hamilton (2009) does not hesitate to describe the 2007-2008 period as an oil shock. He identifies a combination of factors, including stagnant world oil production in the face of growing demand, particularly in China, to explain the gradual rise in oil prices during the 2000s and their surge in 2007. The consequences resembled those observed during previous oil shocks (notably those of the 1970s), with significant downward effects on consumer spending and domestic car purchases. Hamilton argues that this episode should therefore be added to the list of US recessions

[1] However, insofar as economic and financial crises are also a matter of money flows, the dynamics specific to these spheres must not be overlooked. This explains why a significant part of ecological macroeconomics has turned to the post-Keynesian framework (Hardt and O'Neill, 2017).

significantly influenced by oil prices.[2] Wu et al (2019) clarify the causal chain between oil prices and the onset of the 2007 subprime crisis. Using a model calibrated on Californian data, these authors show that 2007's unforeseen rise in gas prices increased commuting costs to the point of decreasing the value of homes far from city centers. Home foreclosure rates then skyrocketed, as homeowners struggled to pay their mortgages due to high gasoline expenses.

As we have seen, when energy is considered to have play a part in triggering the 2007 crisis, it is perceived as an exogenous and temporary shock, a position echoed even by the *École de la Régulation* (Boyer, 2009). To our knowledge, only Auzanneau (2023) adopts a more systemic approach and gives energy the status of an endogenous long-term constraint to explain the onset of the Great Recession. For him, the rise in Federal Reserve policy rates between 2004 and 2006 was a direct response to the deterioration in the US trade balance and the loss in value of the dollar that began in 2003. This trade deficit is attributed to the steady decline in US conventional oil production since 1970, which led to a gradual rise in the price per barrel between 2003 and 2007. It was therefore fundamentally due to the reduced accessibility of oil that two major economic factors - energy-related inflation and the rise in key interest rates - emerged, ultimately damaging the solvency of the most modest households, and leading to the bursting of the *subprime* bubble and the Great Recession.

From the perspective of regulation theory, this paper aims to address the question: Does energy only act exogenously, as a shock amplifying contradictions that have arisen because of other factors, or does energy act at a more fundamental level, directly causing regimes to go into crisis? This article defends the second option. To achieve this, we propose in section 2 to enrich regulation theory (RT) with certain indicators of ecological economics (thermodynamic efficiency, exosomatic metabolic rate and the weight of energy expenditure relative to GDP). Applying this analytical framework to French capitalism over the last sixty years, section 3 shows that the rise of neoliberalism in the 1980s was already a response to the energy crisis of Fordism. Section 4 then argues that the neoliberal mode of development today is incapable of overcoming its energy contradictions. Finally, section 5 summarizes our main contributions and opens the door to the possible emergence of a post-liberal capitalism, due to the impossibility of sustaining past abundant levels of energy and financial bridging mechanisms made possible by highly accommodating monetary policy.

[2] A similar, albeit more nuanced, analysis can be found in Kilian (2009).

2. Methodology: enriching regulation theory with an ecological approach

In this section, we first present Regulation Theory (2.1), followed by a few key indicators of ecological economics (2.2). We will then show how the application of these quantitative tools within a regulationist framework allows us to better account for the role of energy in the functioning of a given regime of capitalism (2.3).

2.1. Regulation theory: capitalism's regimes and their crises

RT is a macroeconomic theory that emerged in the 1970s (Aglietta, 1976) in an attempt to explain the stagflationary crisis of the time. To achieve this, regulationists propose a framework at the crossroads of three currents of thought: Keynesianism, Marxism and the École des Annales (Boyer, 2011). For regulationists, while Marx identified in its purity the *ideal type of capitalism*, in practice, capitalism is subject to different regimes in time and space (Amable, 2005). These different *regimes of capital accumulation* can be distinguished and identified on the basis of certain regularities: the pace of investment, productivity gains, the share of wage consumption relative to foreign demand, etc. These stylized facts exist as the product of institutions that organize accumulation, a set of diverse rules that form the *mode of regulation*. These rules cover a wide range of areas (5 according to the initial TR), from the management of money, the type of competition between firms, the rules organizing the workforce (wages, working hours), to the degree of trade openness (figure 1). Schematically, a mode of regulation is characterized as *competitive* when coordination through prices is central, and as *administered* when coordination through authority (State, large corporations) is strong. Hereafter, we'll refer to the *capitalist mode of development as* the combination of a capital accumulation regime and the mode of regulation that supports it.

Take, for example, the post-war capitalist mode of development known as Fordism. It can be described as the combination of an intensive accumulation regime, where strong productivity gains are accompanied by aggregate demand strongly driven by wage consumption (mass consumption). These regularities are made possible not only by a balanced distribution of value added (the Fordist wage compromise), but also by regulated competition on the domestic market (strong industrial policy) and abroad (relative protectionism). Stop-and-go policies, along with a strong framework for the financial system (financial repression), completed the regulatory system of this period. Regulation theory thus enables us to identify a succession of development modes, the typology of which is specific to each nation (for France, we can agree on the sequence presented in Table B.1 in Appendix B).

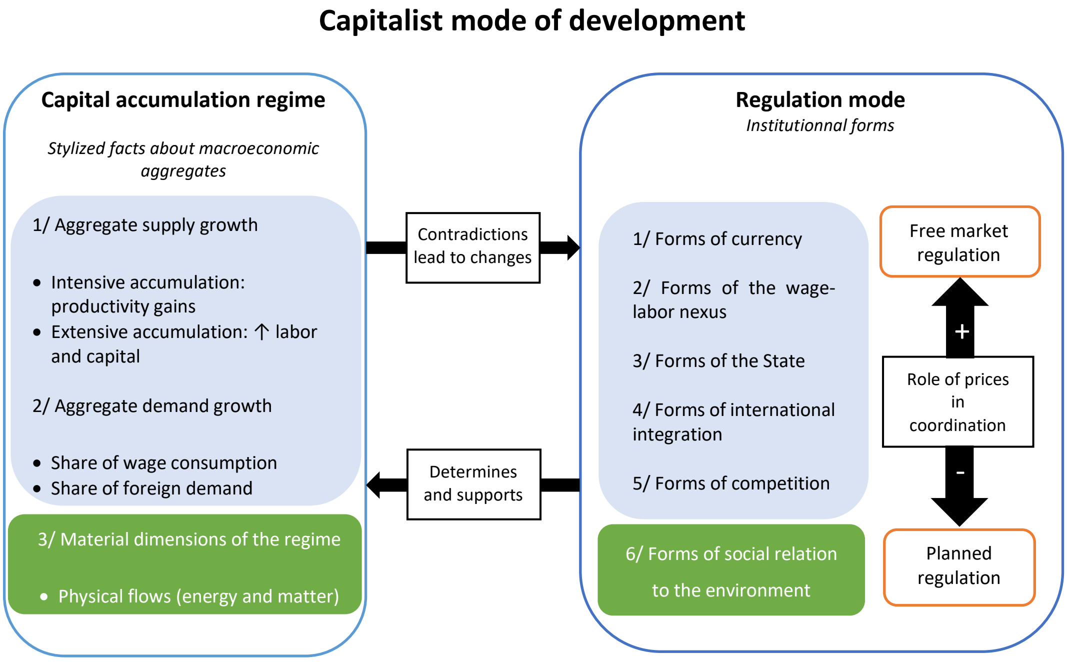

Figure 1. The regulationist theoretical framework. Source: authors.

On this basis, regulation theory proposes a *typology of crises*. Small, so-called "cyclical" crises reveal partial and temporary imbalances in accumulation regimes which can be overcome by relying on the existing regulatory system. For example, a negative demand shock can be absorbed by fiscal or monetary policy. Major or "structural" crises, on the other hand, signal a mode of accumulation that is running out of steam. This was the case with the crisis of the 1930s, analyzed as a contradiction between mass production methods (Taylorism) and a lack of mass consumption (due to the absence of wage rules enabling wage demand to emerge and absorb this production). Faced with such a crisis, only a new "accumulation regime/regulation mode" can overcome it. Regulation theory thus proposes an analysis of social change that is endogenous, due to the emergence of contradictions.

This concern to endogenize crises may have led regulation theory to neglect the material dimensions of the production process, so dear to ecological economists. Founding father Robert Boyer explains, for example, that "regulation theory was in fact built against the standard interpretation of the crisis [of 1973-74] as the result of an exogenous oil shock" (Boyer et al., 2023, p.6). For Lipietz (2002 [1995], p. 351), another historical figure in regulation theory, this relegation of material dimensions can be explained by the fact that it was "difficult to claim that Fordism entered into crisis through the society-environment relationship" (Lipietz, 2002

[1995], p. 351).)[3]. Another, more epistemological reason can be put forward: emphasizing the flows of energy and matter in economic dynamics could then be perceived as material and asocial determinism (Cahen-Fourot, 2023).. It should be noted that the physical-material dimensions appear in Table B.1 only in the form of meteorological constraints for the first two development modes. They are not taken into consideration in the dynamics of subsequent regimes.

Since the early 2000s, there has been a movement (green area in Figure 1) to take greater account of sustainability and natural resource issues within RT. These dimensions are integrated from the concept of social relationship to the environment, defined as the set of rules governing "access to the physical environment and the modalities of its use for production and reproduction activities" (Becker and Raza, 2000, p. 11). Following Polanyi (1944), capitalism requires three fictitious commodities[4] to develop: land, labor and money. The fact that RT was concerned only with the institutions governing the use of labor power (forms of the wage relation) and money (forms of money) was a major gap that this concept fills.

To fully integrate ecological dimensions into the analysis, however, we need to characterize the flows of energy and matter a regime of accumulation mobilizes. Indeed, insofar as all production is material, macroeconomic dynamics cannot be assessed solely based on monetary aggregates. Later, RT began to carry out this work, whether for water (Buchs, 2012), energy (Cahen-Fourot & Durand, 2016) or matter (Cahen-Fourot and Magalhães, 2023)..

It is important to note that the rules forming the social relationship to the environment are not the only institutions organizing the dynamics of physical flows[5]. To take just one example, regulatory policies encouraging energy savings (forms of social relationship with the environment) have an impact on physical flows, as does the intensifying globalization (form of insertion into the world economy): thus, relocation explains in part countries' energy trends (lower energy intensity).

[3] In fact, the slowdown in productivity gains began in the 1960s. It therefore predates the oil shocks (Rousseau and Zuindeau, 2007).

[4] For Polanyi, "labor, land and money *are not* commodities [insofar as]; as far as they are concerned, the postulate that everything bought and sold must have been produced for sale is flatly false. [...] Labor is but the other name for the economic activity that accompanies life itself – which, for its part, is not produced for sale but for entirely different reasons – nor can this activity be detached from the rest of life, stored away or mobilized ; land is simply the other name for nature, which is not produced by man; finally, real money is simply a sign of purchasing power which, as a rule, is not in the least produced, but is a creation of the mechanism of banking or state finance. None of these three elements – labor, land, money – is produced for sale; when they are described as commodities, this is entirely fictitious" (Polanyi, 1944, chap. 6, p. 107).

[5] This is why some RT authors have favored the concept of "environmental institutional arrangements" (Elie et al., 2012). The aim was to emphasize that these were institutions, not material flows.

In short, the 6 institutional forms belong to the *regulation mode*. All of them are therefore responsible for the energy and material flow dynamics belonging to the accumulation regime (figure 1). This is where the link with ecological economics may be relevant. This is what is proposed by Cahen-Fourot and Magalhães (2023) when they call for a cross between regulation theory and *material flow analysis* (MFA). In the following sections, we continue in this vein, but focus on other metrics relating to energy flows.

2.2. Ecological macroeconomy metrics: *exosomatic metabolic rate*, thermodynamic efficiency, energy footprint and expenditure

For ecological economists, economic production is highly dependent on the capacity of human societies to mobilize exosomatic energy (from outside the human body). One of the key indicators is *the exosomatic metabolic rate* (EMR), the pace of which will be compared with that of apparent labor productivity (2.2.1). The EMR may be affected by progress in energy efficiency or by the type of integration into world trade (2.2.2). More recent studies have focused on a synthetic indicator: the weight of energy expenditure (2.2.3).

2.2.1. EMR and its link to apparent labour productivity

The *exosomatic metabolic rate* (EMR_i) relates the amount of $i \in [P, F, U]$ energy consumed per working hour (h) per year:

$$EMR_P = \frac{P}{h}, \qquad EMR_F = \frac{F}{h}\ , \qquad EMR_U = \frac{U}{h} \tag{1}$$

This indicator is fundamental: the increase in energy per hour worked explains most of the growth in what economists call "labour productivity", i.e. “the ratio” between GDP and hours worked (PIB/h) (Cleveland et al., 1984; Giampietro et al., 2014). From a socio-metabolic perspective, this labor productivity results from replacing human labor by machines powered by energy (mostly of fossil origin still today). It is these productivity gains, enabled by energy, that make it possible to reduce working hours (share of inactive people, lifelong working hours) and develop new sectors in industrial economies (in the most advanced countries, mechanization and fossil fuels have reduced the population working in agriculture to now just 1.5% of the total working population). For example, Semeniuk (2016) compared the quantity of fossil energy per hour of work and labor productivity for 95% of world production between 1950 and 2012. The average elasticity observed is close to unity.

2.2.2. Energy efficiency and footprint

Two factors can affect the dynamics of EMR. Firstly, EMR can decrease thanks to progress in energy efficiency: all other things being equal, a more efficient machine leads to lower energy use per hour. By measuring the quantities of energy consumed at the national level in primary (P), final (F), and useful (U) forms, we can assess the energy efficiency of the economy by calculating the ratios of these aggregates. To increase precision and account for the quality of energy carriers, these aggregates are expressed in terms of exergy rather than energy (Figure 2)[6] . This allows us to calculate the primary-to-final (F/P), final-to-useful (U/F), and primary-to-useful (U/P) ratios for a given machine, sector, or the economy as a whole.

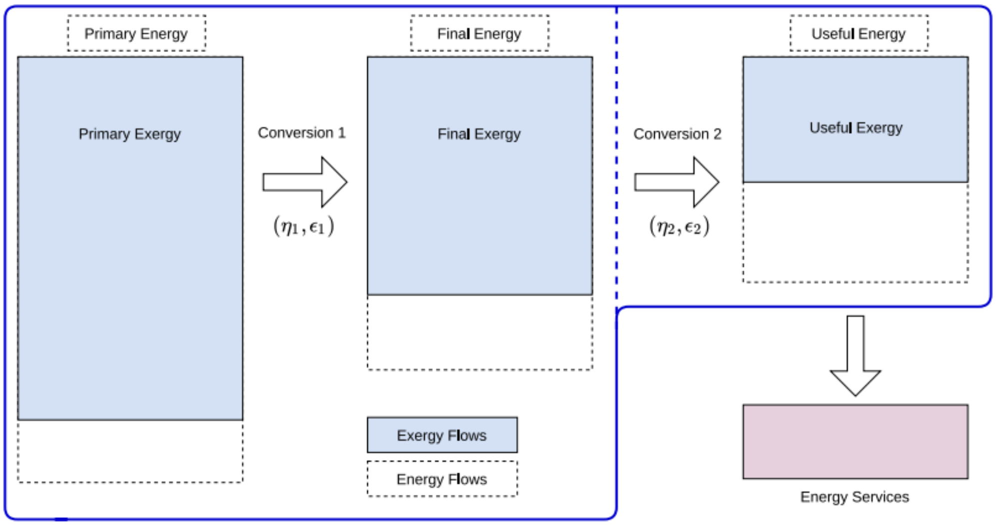

Figure 2. Representation of the energy conversion chain. Dashed blue line: conventional final energy analysis. Solid blue line: useful stage analysis. η_1 and η_2 represent respectively the energy efficiency of the first and second conversions, and ϵ_1 and ϵ_2 represent respectively the exergy efficiency of the first and second conversions. Source: (Aramendia et al., 2021).

EMR can also decline because of energy-intensive processes being relocated abroad. In this case, it may be relevant to consider the quantities of energy consumed outside national borders to produce imported goods. The advantage of this approach is that it is based on consumption rather than production alone. In this case, however, the energy consumed

[6] Energy in the form of heat is not equivalent to energy in the form of mechanical work: exergy is the maximum amount of mechanical work that can be extracted from a given quantity of energy. Exergy allows us to grasp that not all forms of energy are qualitatively equivalent, even in equal quantities: "1 kWh of mechanical work can be converted into 1 kWh of heat at 30°C, but 1 kWh of heat at 30°C can be converted at most into 0.066 kWh of mechanical work [...] Mechanical work is the most valuable form of energy because it is the one with the highest efficiency of conversion to other forms of energy" (Santos et al., 2018, p.112).

domestically to produce exported goods must of course be considered. Where data is lacking, this analysis can be carried out in terms of carbon dioxide emissions rather than energy. This type footprint analysis shows the extent to which a country benefits from an ecologically unequal exchange (Dorninger et al., 2021) allowing it to artificially reduce its EMR.

2.2.3. Energy expenditure in relation to GDP as a synthetic indicator

Another ecological indicator useful to our analysis is energy expenditure, i.e. the cost of supplying energy (domestically produced and imported) in relation to gross domestic production (Bashmakov, 2007; Fizaine & Court, 2016; Murphy & Hall, 2011).

In theory, energy expenditure can be calculated at the primary, final, or useful level. D_i with $i \in [P, F, U]$. In practice, they are most often estimated at the final level. Furthermore, by noting p the general price index, p_i the energy price of type i and distinguishing between nominal GDP (GDP_n) and real GDP (GDP_r), energy expenditure as a percentage of nominal GDP can be analyzed as the product of three factors:

- the *exosomatic metabolic rate* (i/h), with $i \in [P, F, U]$,
- the relative price of energy (p_i/p),
- the inverse of apparent labor productivity (h/GDP_r).

$$\frac{D_i}{GDP_n} = \frac{i}{h} * \frac{p_i}{p} * \frac{h}{GDP_r} \qquad \text{avec } i \in [P, F, U]. \tag{4}$$

The weight of energy expenditure thus appears to be a valuable synthetic indicator, as it integrates into the analysis not only EMR and apparent labor productivity, but also the relative price of energy.

All other things being equal, a rise in the relative price of energy translates into an increase in energy expenditure as a proportion of GDP. This effect can, however, be mitigated by changes in the quantities of energy consumed per hour worked, or by productivity gains. When energy expenditure rises faster than GDP, incomes cannot keep pace, and discretionary consumption and investment are reduced (King & Hall, 2011) leading to a slowdown in growth. In the US, Court and Fizaine (2016) have shown that above 11% of GDP, the weight of energy expenditure is significantly correlated with a recession.

We'll now look at how these different indicators and results can be integrated into the regulationist framework to characterize accumulation regimes in more detail.

Table 1. Main indicators extracted from the ecological economics literature. Source: authors.

Acronym	Indicator	Unit
P, F, U	Primary, final, or useful exergy	TJ
F/P, U/F, U/P	Thermodynamic efficiency: primary to final, final to useful and primary to useful	%
P*, F*, U*	Primary, final, or useful energy footprint	TJ
EMR_i	Exosomatic metabolic rate (with $i \in [P, F, U]$)	TJ/hour
D_i/GDP	Energy expenditure to GDP (with $i \in [P, F, U]$)	%

2.3 Greening regulation theory concepts

Following Huber (2013)we believe that "regulation theory does not necessarily require a new ecological dimension of research, but rather a reformulation of the key concepts of regulation in an ecological sense" (p. 173). RT must be able to acknowledge the fact that the supply of goods and services always rests on a material base (more or less intense). In practice, taking Figure 1 as a starting point, it's not enough to *superimpose* an analysis of material flows *onto* conventional variables, but rather to "materialize" the analysis of supply and demand. We need to be able to think in terms of *the articulation* between physical and monetary aggregates. To put it another way, energy and material flows must feed into the regulationist concepts used to characterize the progression of supply and demand. If we refer to Figure 1, our approach implies focusing more on how the contradictions of accumulation regimes lead the mode of regulation to evolve (and less the other way round).

On the supply side, a first possibility is to reformulate the intensive or non-intensive nature of accumulation regimes based on material categories. The EMR offers this possibility, given its unit elasticity with apparent labor productivity (Semieniuk, 2016). Nevertheless, this apparent productivity can increase independently of EMR, particularly when an advantageous specialization reduces the energy intensity of production. The energy footprint must therefore be considered (if possible, at the final level, F*). On the other hand, by construction, EMR at the final level (F/h) can also be affected by progress in energy efficiency.

Another possibility for ecologization is offered by the rate of profit. To grasp this point, it's useful to go back to Karl Marx's binary definition of the rate of profit. For Marx, the rate of profit R is calculated by dividing monetary profit (or surplus value, noted as SV) by the value of capital employed, of which we distinguish two categories: constant capital (i.e., machinery and raw materials, noted C) and variable capital (i.e., labor power, noted V):

$$R = \frac{SV}{C + V} \quad (5)$$

By dividing the terms by V we can rewrite the equation with a new variable, $\frac{SV}{V}$ which designates the exploitation rate Ewhich is:

$$R = \frac{E}{\frac{C}{V} + 1} \quad (6)$$

The rate of profit can be analyzed as the product of two variables: the rate of exploitation (E) of labor power and the *organic composition of capital* (OCC), $\frac{C}{V}$. The OCC is a *value* composition. It is therefore distinct from the *technical composition of capital* (TCC), i.e., the capital intensity of the production process, $\frac{K}{L}$. To put it another way, OCC is the product of TCC and the relative price of capital and labor, $\frac{r}{w}$:

$$OCC = TCC * \frac{r}{w} \quad (7)$$

For Marx, the development of the productive forces involves substituting dead labor (machines) for living labor (workers), resulting in an increase in the technical composition of capital. However, this does not predetermine how the organic composition of capital will evolve, because the price ratio between capital and labor is also a determining factor. In fact, the increase in technical composition also affects the value of equipment (the labor time required to produce it is reduced), which has an impact on the OCC[7] . The increase in technical composition therefore has two contradictory effects: a volume effect (the quantity of machines increases relative to the number of workers) and a price effect (the price of goods decreases due to productivity gains).

[7] Marx explains that "the same evolution which causes the mass of constant capital to increase in relation to variable capital causes the value of its elements to fall as a result of the increase in the productivity of labor, and thus prevents the value of constant capital, which is nevertheless constantly increasing, from increasing in the same proportion as its material volume. In such and such a case, the mass of the elements of constant capital may even increase, while its value remains unchanged or even decreases. [T]he same causes which give rise to the tendency of the rate of profit to fall also moderate the realization of this tendency" (Marx, III, 1867, pp. 248-249)..

This technical composition of capital can be reformulated in terms of the exosomatic metabolic rate (EMR). Faced with the impasses of measuring a physical quantity of capital per hour worked other than in money (Robinson, 1971) the EMR is an interesting alternative. Insofar as the machinery used requires energy to be put into motion, the energy mobilized per hour worked is a good approximation of the quantity of capital per hour worked. This reformulation of the technical composition of capital allows us to integrate energy quantities into the analysis of profit dynamics:

1. As the productive forces develop, capital per hour worked increases (**the TCC increases**), as does the amount of energy mobilized. All other things being equal, the **OCC rises**, driving **down the rate of profit.**
2. This mobilization of energy reduces the labor time needed to produce goods, thus lowering the value of capital goods. The ratio $\frac{r}{w}$ decreases, so **the OCC falls, and so the rate of profit rises**.
3. These productivity gains also occur in the production of wage goods, reducing the value of labor power ($\frac{r}{w}$ increases, so **OCC rises and profit falls**), but employees can claim a share of these productivity gains in the form of higher wages ($\frac{r}{w}$ decreases, so **OCC falls and profit rises**).

The effects of increasing the amount of energy per hour worked on the rate of profit are therefore indeterminate. We can already see the importance of codifying the various institutional forms, and particularly the rules governing redistribution of productivity gains on profit dynamics.

The second variable that needs to be included in the analysis is the relative price of energy. Indeed, an increase in this price also affects the level of OCC, since energy belongs to the constant capital price (r). Econometric studies of 16 European countries over the period 1995-2019, have shown a significant negative relationship between the relative price of energy and the rate of profit (Pellegris, 2022). In addition, descriptive statistics for France show a negative correlation between the weight of energy expenditure and the profit rate (Husson, 2009).

On the demand side, the weight of energy expenditure in GDP must be considered. As Cahen-Fourot points out, "the availability of low-cost energy also enables mass consumption, which is necessary to absorb the products of these productivity gains and ensure the coherence of the accumulation regime" (2023, p. 90). The fact remains that neither the weight of energy expenditure nor the relative price of energy is analyzed in the most applied regulationist works.

Yet these data do exist, and it's also possible to analyze this dimension in greater detail by looking at the weight of energy expenditure in household income.

Figure 3 summarizes our proposals for greening, or rather "energizing", regulationist concepts. All the categories presented belong to the analysis of the accumulation regime.

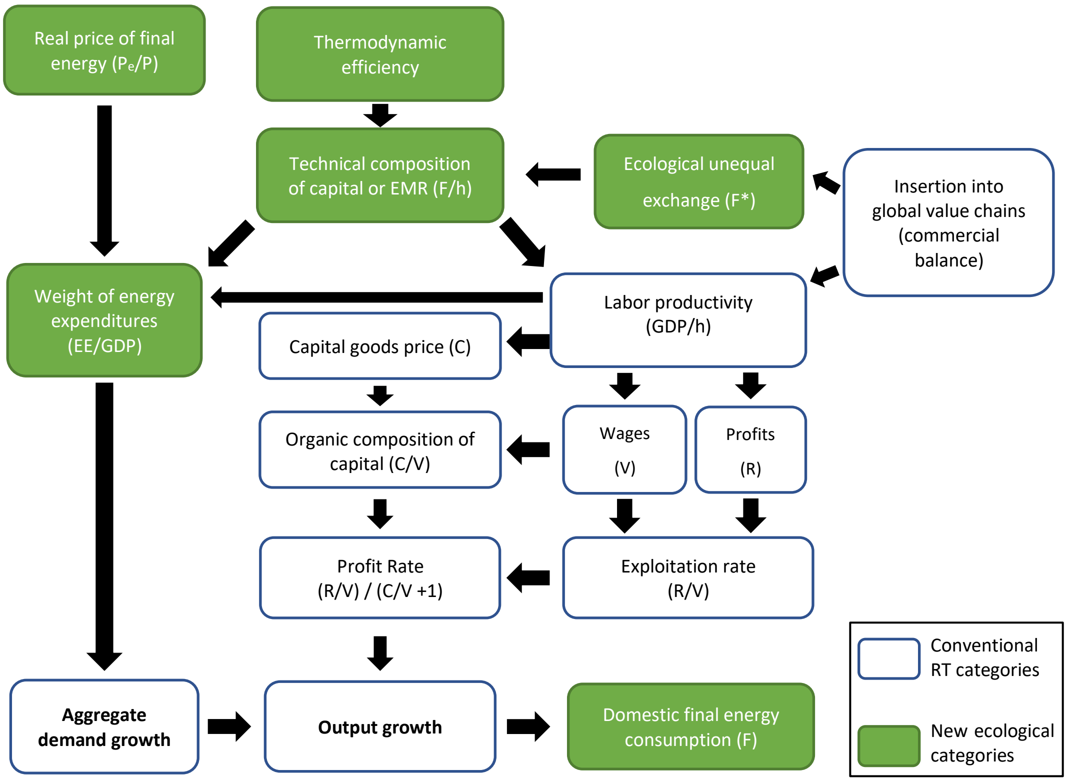

Figure 3. Energizing the analysis of accumulation regimes. Source: authors.

Sections 3 and 4 show how these categories are relevant to a renewed understanding of the rise and subsequent crises of Fordism and neoliberalism in France. This article thus extends the seminal work of Cahen-Fourot and Durand (2016) in several directions. By integrating new categories (weight of energy expenditure), the characterization of accumulation regimes is enriched, and the metabolic constraint is more explicitly exposed. It also extends the analysis to the 2020s, providing a genuine "comparative reading of the great crisis of the 1970s and the great contemporary crisis" that these authors were calling for.

3. Results: neoliberalism as overcoming the energy contradictions of Fordism

3.1. The stylized energy facts of Fordism (1960-1974)

During the Fordist period, EMR and apparent labor productivity grew at the same pace, against a backdrop of falling energy prices. The weight of energy expenditure thus remained low and went hand in hand with a high rate of profit.

3.1.1. Unitary elasticity between EMR and apparent labor productivity

Between 1960 and 1974, whether for the economy as a whole or for the productive sectors alone[8] , EMR increased by a factor of 2.5, i.e., by an average of around 7%/year (see figure 4). Thermodynamic efficiencies also increased between 1960 and 1969, after which they began to stagnate (Figure 5). As a result, the EMR measured at the useful stage increased even more sharply: it multiplied by 3.5 over the period, i.e., an average annual rate of 9.6%. Contrary to popular belief, energy efficiency is no stranger to the Fordist period, but these efficiency gains fueled a powerful rebound effect (Berner et al., 2022 ; Brockway et al., 2021) whereby thermodynamic efficiency (U/F) rose by 33%, while final energy consumption increased by a factor of 2.3. In addition to advances in energy efficiency, another powerful factor driving the incorporation of energy into the production process was the relative price of energy. As Figure 6 shows, the relative price of energy fell by 17% between 1960 and 1973, before starting to rise sharply in 1974 (the level reached was then that of 1960).

The increase in capital per hour worked (based on energy per hour worked) and its power (captured by the useful stage) led to significant gains in labor productivity. These grew by 6.2%/year between 1960 and 1974 (see figure 7). Here we find a unitary elasticity between EMR (at the final stage) and apparent labor productivity, in line with the observations made by Semeniuk (2016).

[8] By productive sector, we have tried to remove household energy consumption as far as possible, to retain only the uses of productive entities (companies and public administrations). To achieve this, we have subtracted residential and road transport consumption from total final energy consumption. This aggregate remains imperfect insofar as road transport includes both household and business consumption. However, it remains an interesting proxy for interpreting any discrepancies with total final energy consumption.

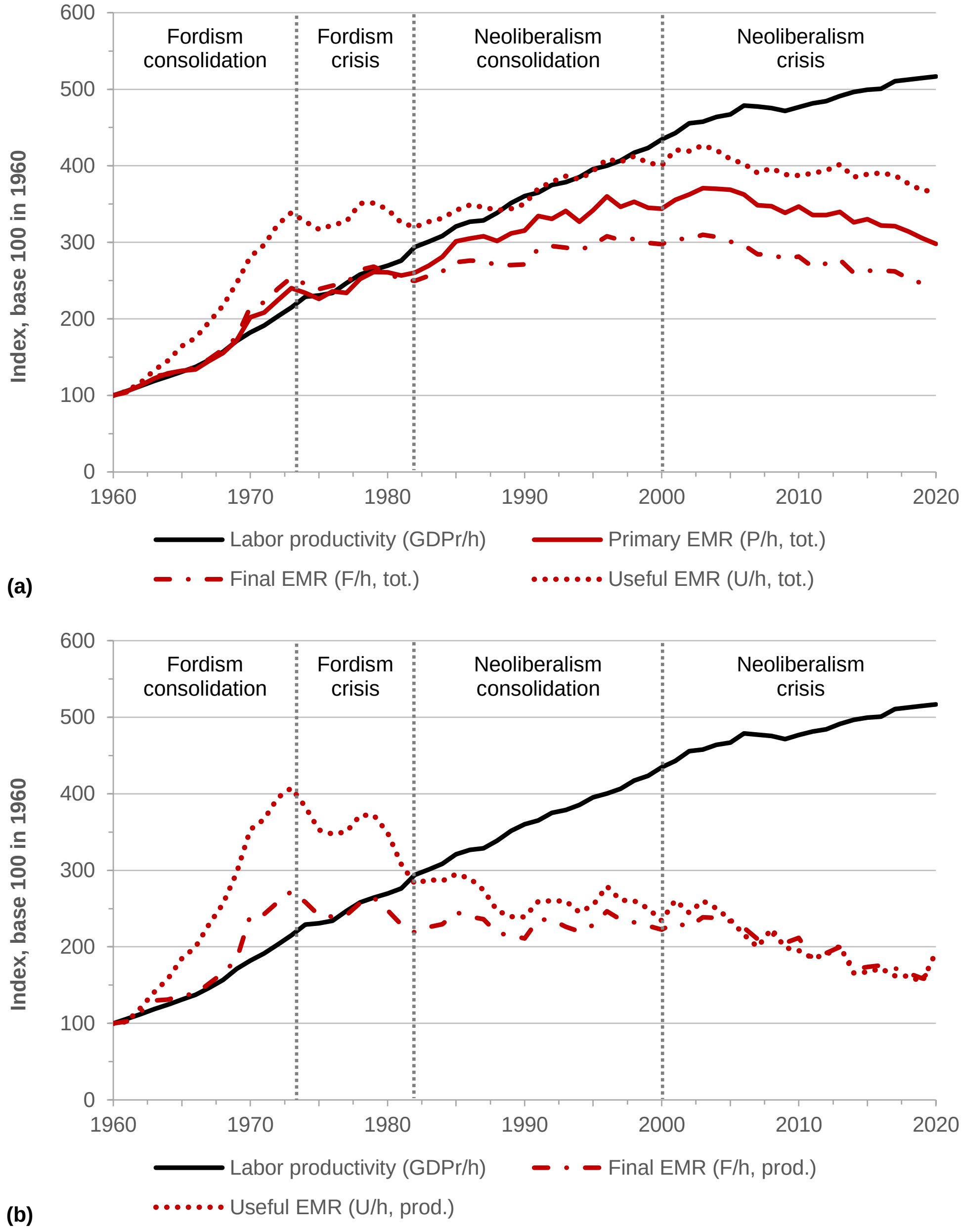

Figure 4. Apparent labor productivity and technical composition of capital estimated by the *exosomatic metabolic rate* (EMR) at the final and useful stages in France (1960-2020), for the national economy (a) or just the productive sector[9] (b). Source: authors based on data from (Brockway et al., 2024).

[9] The productive sector is obtained by subtracting the residential and transport sectors from the national economy.

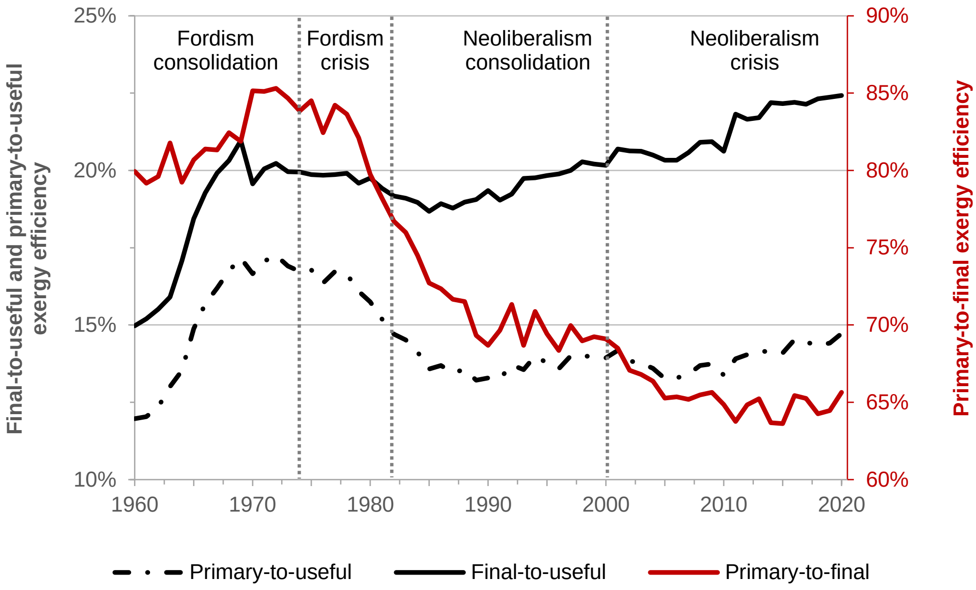

Figure 5: Thermodynamic efficiency in France (1960-2020). Source: authors based on data from Brockway et al. (2024).

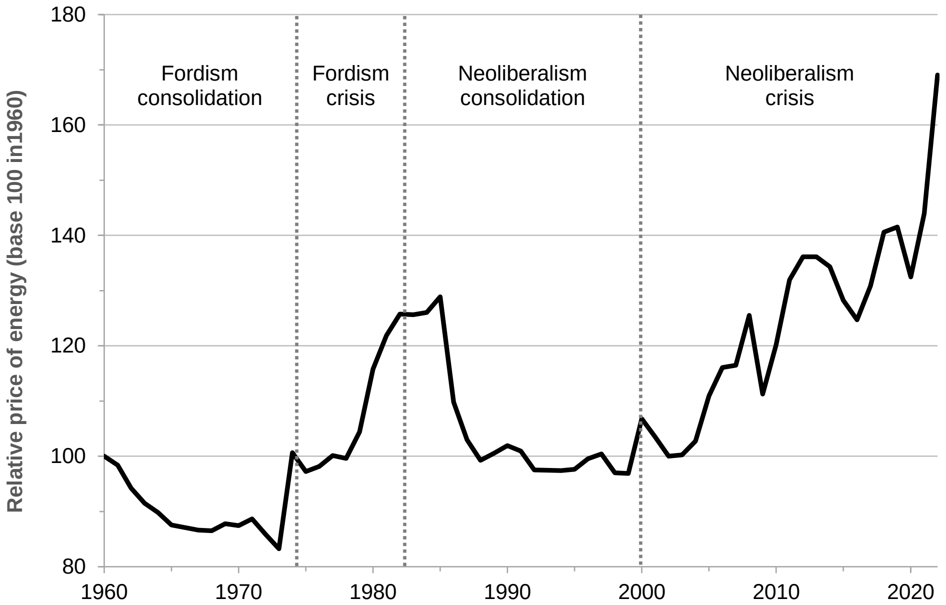

Figure 6. Relative energy prices in France (1960-2022). Source: authors, based on data from OECD (2024a).

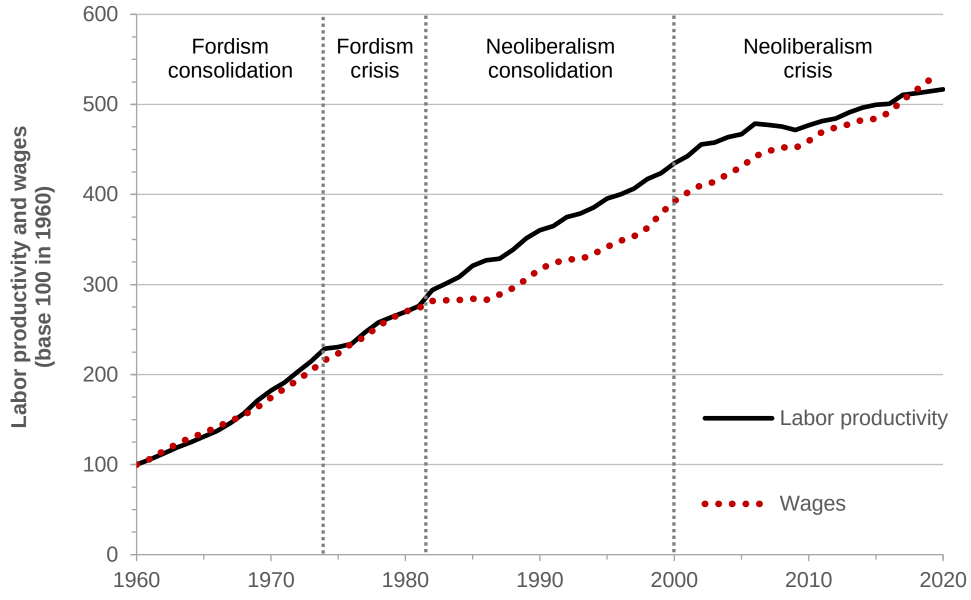

Figure 7. Apparent labor productivity and real wages (in € of 2022) in France (1960-2020). Source: authors, based on data from INSEE (INSEE, 2022) for productivity and Feenstra et al. (2015) for wages.

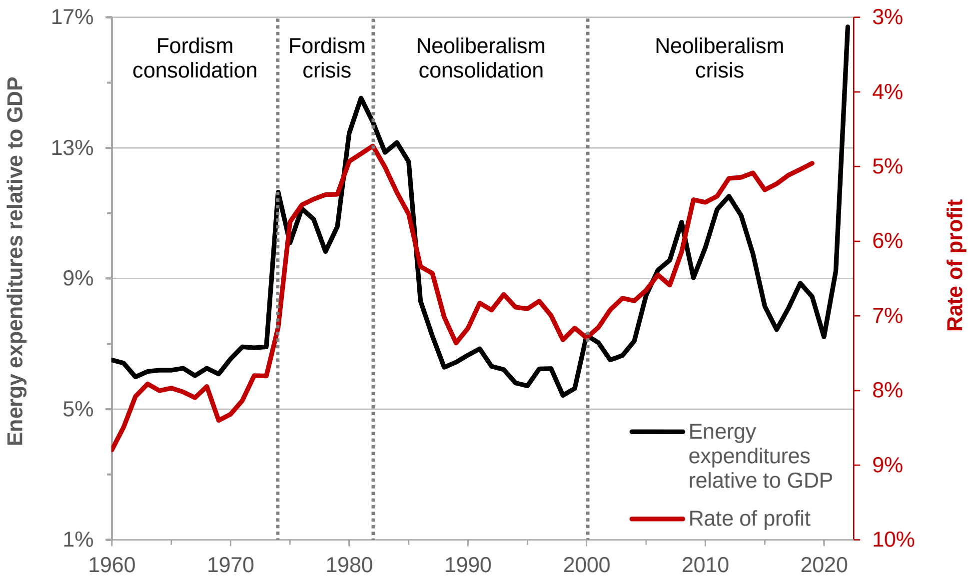

Figure 8. Energy expenditure as a percentage of GDP and profit rate in France (1960-2020). Source: energy expenditure calculated by the authors by adding the added value of hard coal and lignite production, hydrocarbon extraction, coking and refining, electricity, gas, steam and air conditioning production and distribution (INSEE, 2022) and the energy bill (SDES, 2022). For profit rates, data are taken from Basu et al. (2022).

3.1.2. A relatively high and stable profit rate

Over the period, the economy's profit rate remained relatively high, fluctuating between 8.8% in 1960 and 7.8% in 1973 (see figure 8). The decline was not linear, as the 1973 level was similar to that of 1963. The exploitation rate remained broadly stable over the period, in line with Fordist regulation: the ratio between total profits and total payroll was 31% in 1960 and

1973. It is therefore the relatively small increase in the organic composition of capital that is behind the slight drop in the rate of profit (-1 point over the period). Whereas constant capital represented 3.5 times the wage bill in 1960, this ratio was 4 in 1973 (an increase of 15%). This increase is relatively modest compared to the rise in technical composition (+140% over the period). This shows that productivity gains were diffused to the capital goods sector (decrease in C) and served to increase the purchasing power of the salaried class (increase in V). Thus, with a stable exploitation rate and an organic composition slightly on the incline, the profit rate remained at a high level, losing only one point (see figure 8).

3.1.3. Low weighting of energy expenditure

On the demand side, stability was also the order of the day. From 1960 to 1970, energy spending remained at a historically low level, in the range of 6 to 6.5% relative to GDP (Figure 8). A turnaround began in 1969, with a gradual increase to 6.9% of GDP shortly before the first oil crisis. The share of energy in household budgets followed a similar pattern. This share of the budget fell until 1964, when it reached a minimum (close to 7%) over the studied period. Thereafter, a gradual rise began. As early as 1971, it represented around 8.3% of income, and remained at this level until 1973.

Insofar as the relative price of energy was continually falling (-17%), while the EMR was increasing (+6.4%) and labor productivity rising at the same rate (+6.2%), the weight of energy expenditure remained relatively stable. The low price of energy allowed capital intensity to rise, which in turn enabled productivity gains. As the energy bill did not increase, income was available to be allocated to non-energy consumption, in this case, production surpluses made possible by productivity gains. In this way, the energy dimensions of the system contributed to the coherence of Fordist accumulation.

In short, Fordism is characterized by a sharp rise in final energy consumption and thermodynamic efficiency. Energy per hour worked increases, reflecting a rise in the capital intensity of production. These productivity gains are made possible by the fact that the real price of energy continues to fall over the period. As a result, energy expenditure by households and the national economy increases very modestly. Accumulation can therefore continue and outlets are assured, as evidenced by the relative stability of the profit rate at a high level. However, this regime appears relatively fragile and extremely sensitive to energy price increases.

3.2. The crisis of Fordism (1974-1982): what role for energy?

For regulationists, energy is not considered to have been the cause of the Fordist crisis. The rise in energy prices (in 1974) is thought to have occurred after the slowdown in apparent labor productivity (from the late 1960s onwards, see Figure 7). What's more, by 1986, the relative price of energy had returned to its 1960 level, so neoliberalism would not have benefited from an energy context so different from that of Fordism. However, by shifting the focus from prices alone to the weight of energy expenditure, the role of energy can be reassessed. From this point of view, 1969 appears to have been a turning point:

- thermodynamic efficiency stopped to improve;
- apparent labor productivity was no longer increasing as fast as EMR in the final stage;
- relative energy prices failed to fully offset this trend, and the weight of energy expenditure began to rise in the late 1960s.

From 1969 onwards, the Fordist system seemed to run out of steam: the virtuous dynamic of previous years began to disappear, and the oil crisis only accentuated this reversal. Indeed, it was the rise in the relative price of energy from 1974 onwards that dealt the final blow to Fordism. The first sharp rise of 20% occurred between 1973 and 1974 (the first oil shock). The price level reached that of 1960. This was followed by a further 30% rise between 1978 and 1985 (second oil shock). Cumulatively, the real price of energy rose by 54% between 1973 and 1985 (Figure 6).

These developments went hand in hand with a change in the technical composition of capital. Here, we note a divergence between the national economy and productive sectors. For the productive sectors, EMR fell between 1974 and 1982, especially from 1978 onwards, with a 15% drop at the final stage and 28% at the useful stage. The decline in EMR continued thereafter, reaching a low point in 1990. This marked the start of a relative deindustrialization, or decapitalization of production, which began timidly in 1974, then lasted from the second oil shock onwards. At the level of the global economy, the final EMR did not fall, it continued to grow, but at a very slow rate of 0.3%/year, well below the rate previously seen under Fordism (6.8%/year). At the useful stage, there was even a decline in EMR, averaging 0.2%/year.

Apparent labor productivity also slowed, but to a lesser extent. It fell by two points to 4% between 1970 and 1980. The unit elasticity observed under Fordism disappeared, raising questions about the origin of productivity gains under this new regime (see 3.3).

By design, the result was an explosion in energy expenditure. On a macroeconomic level, this expenditure rose from 8.2% in 1973 to 11.6% in 1974, and finally to 13.8% in 1982.

An increase of almost 5 points. For households, the increase is less significant, with energy expenditure rising from 8.3% to 11% (+3 points). We can assume that it was the indexation of wages to prices until 1983 that limited the damage. In any case, this compression of non-energy purchasing power affects growth dynamics via the consumption channel.

The rate of profit also deteriorated sharply, halving between 1974 and 1982. The contribution of the organic composition of capital was very modest (+12%): payroll and fixed capital grew at roughly the same rate, despite virtually stagnating technical composition of capital and payroll increases due to the indexation of wages to rising prices. This suggests a significant increase in the cost of capital goods. Thus, the main variable explaining the dynamics of the rate of profit is the rate of exploitation, which collapsed by 10 points: whereas profits represented 30% of the wage bill, in 1982 they represented only 20%. Wages grew faster than corporate profits, due to wage indexation on rising prices until 1983. As evidenced by the rise in the relative price of energy (figure 6) capital owners were unable to fully pass higher energy prices on to consumers through selling price hikes. This lower profitability deterred resident companies from investing, hence resulting in lower growth and productivity.

In short, Fordism was experiencing a structural crisis whose energy origin was more salient than a simple exogenous price shock. As early as 1969, the virtuous circle of Fordist metabolism broke down, as the unitary elasticity between EMR and productivity disappeared, creating a first increase in the weight of energy expenditure and a first drop in the rate of profit. The Fordist mode of regulation is unable to overcome these difficulties: wage indexation feeds an inflationary spiral and squeezes profit. Accumulation could not continue as it was, and a new growth regime gradually took shape: neoliberalism, which, as we shall see, is also a neo-metabolism.

3.3. Emergence and consolidation of neoliberalism (1982-2000)

Neoliberalism overcame these contradictions. Reduced weight of energy expenditure and increased profit rates were set in motion as early as 1982, four years before the oil counter-shock of 1986. To achieve this, French capitalists acted on two levels. They succeeded in establishing a relative decoupling between apparent labor productivity and EMR through gains in energy efficiency, tertiarization, internationalization and financialization. At the same time, they altered the distribution of these productivity gains in their favor.

3.3.1. Sharing productivity gains in favor of capital

Further accumulation presupposes restoring the rate of profit. The first way to achieve this is to increase the exploitation rate. The 1983 de-indexation of wages to prices was accompanied by a restoration of the exploitation rate from 20% to 33% (figure 9), a level slightly higher than in 1973. Thus, the first specificity of this regime was to break the link that had existed between wage progression and apparent labor productivity (figure 7).

But restoring profits is not simply a matter of changing the way value-added is shared. Major reconfigurations of production (and therefore of the metabolism) accompanied this movement. Productivity continued to rise throughout the 80s, by an average of 3%. However, these productivity gains were no longer based on an increase in the technical composition of capital (final stage EMR only increased by 1%). The elasticity of apparent labor productivity to EMR, which was unitary under Fordism, is now 3. Several tightly linked phenomena (energy efficiency, tertiarization, delocalization and financialization) enabled this relative decoupling of the energy base.

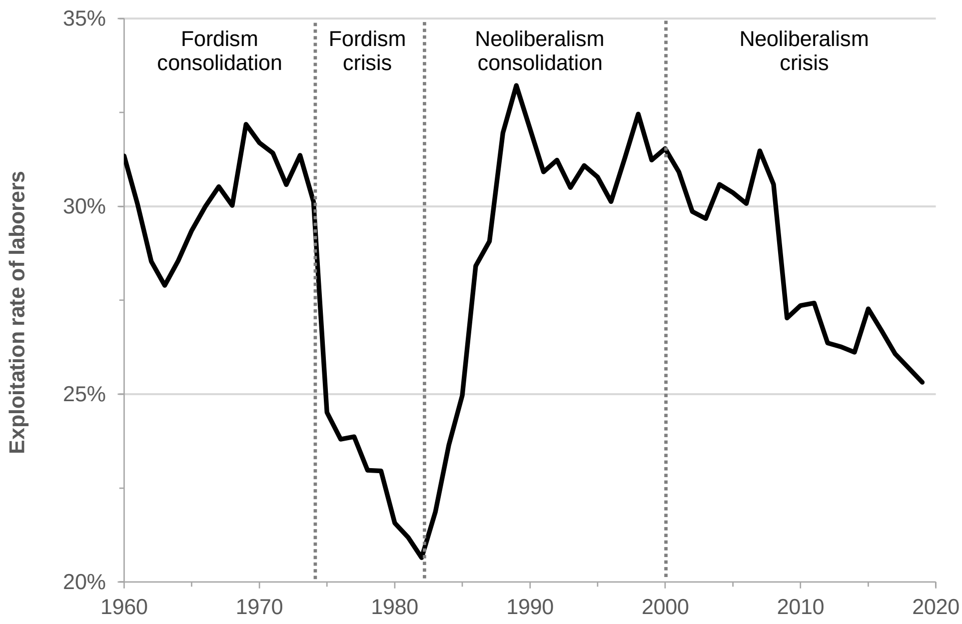

Figure 9. Exploitation rate of workers in France (1960-2019). Source: authors based on data from Basu et al. (2022)

3.3.2. Thermodynamic efficiency: present but insufficient

First, advances in thermodynamic efficiency made this decoupling possible: productivity could grow without increasing final energy consumption per hour worked thanks to the use of more efficient machines. However, this hypothesis does not stand up to scrutiny, at least for the period 1974-1985, when thermodynamic efficiency fell by 7%. If we follow Serrenho et al. (2014), this drop indicates the relocation of high-temperature industries: the energy efficiency of these processes being higher, their relocation leads to a drop in aggregate thermodynamic efficiency. From 1985 onwards, thermodynamic efficiency began to rise again (+8% until 2000) although the contribution of energy efficiency to decoupling remains relatively modest: EMR at the useful stage grew by only 1.3% per year between 1985 and 2000, well below the 2.2%/year increase in apparent productivity over the same period.

3.3.3. Tertiarization and relocation enabled by a new international integration

Tertiarization contributes to the decoupling of productivity gains and EMR. Indeed, service activities have productivity gains that, while lower, are less correlated with energy use (Hardt et al., 2021). Furthermore, this structural change is not strictly domestic, it simultaneously extends into the international division of labor. Firms *outsource* certain industrial activities in order to cut costs and improve profitability (Milberg & Winkler, 2013). The industrial and material basis of accumulation does not disappear altogether, it is heavily outsourced. Carbon content analysis of the trade balance (exported emissions minus imported emissions) is consistent with this thesis. As Figure 10 shows, unequal trade is on the increase for the entire post-1970 period, with a clear deepening from 1984 onwards.

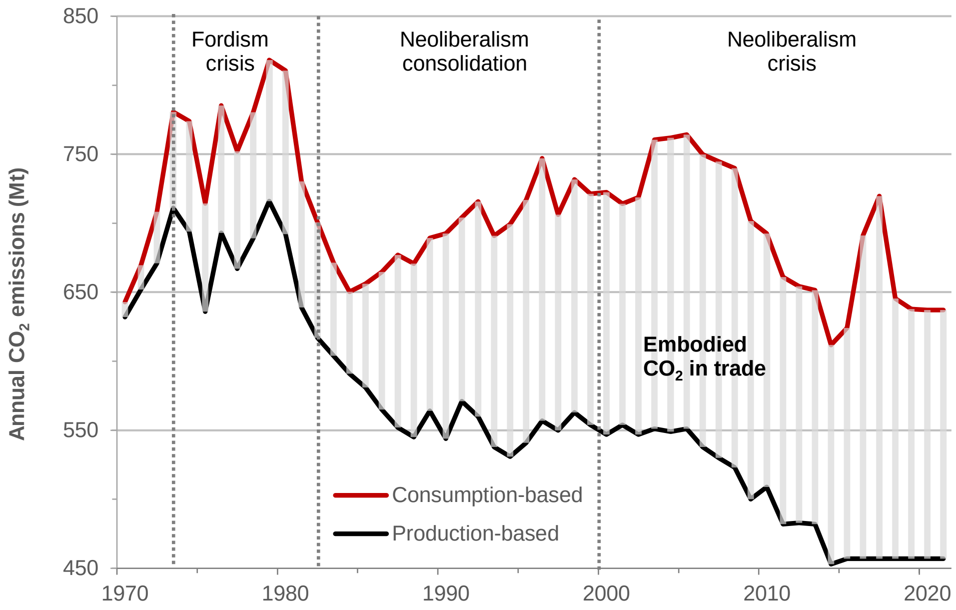

Figure 10. CO_2 content of France's trade balance (1970-2021) in millions of tons. Source: authors, from Eora database database (Lenzen et al., 2012).

3.3.4. The key role of financialization

These developments must be seen in the context of a key feature of the new neoliberal regime: financialization. Financialization can be defined as the tendency of productive units to generate a flow of value from financial assets rather than real assets. The degree of financialization can therefore be assessed on the basis of several indicators relating to non-financial companies, such as the disconnection between the rate of investment and the rate of profit (Cordonnier, 2006) or the share of financial assets relative to real assets or value added (Kovacic et al., 2018).

Financialization contributes to the decoupling of apparent productivity and EMR through at least three channels. Firstly, from a post-Keynesian perspective, a certain rate of profit is normally achieved through a certain rate of investment (see Appendix C for a presentation of Kalecki's law). The only way to achieve a given rate of profit without an equivalent rate of investment is to increase other variables, such as the public deficit, consumption over profit, wage dissaving or a trade surplus. This is precisely what happened from 1982 onwards: investment as a percentage of profits fell from 88% to 66% in just six years (figure 11). The reason: required profitability standards disqualified some investment projects (Auvray et al., 2015). But if investment slows down, capital per capita slows down, and with it, energy per capita. In this case, financialization accompanies the trend towards deindustrialization (Clévenot, 2023) and explains the slowdown in EMR.

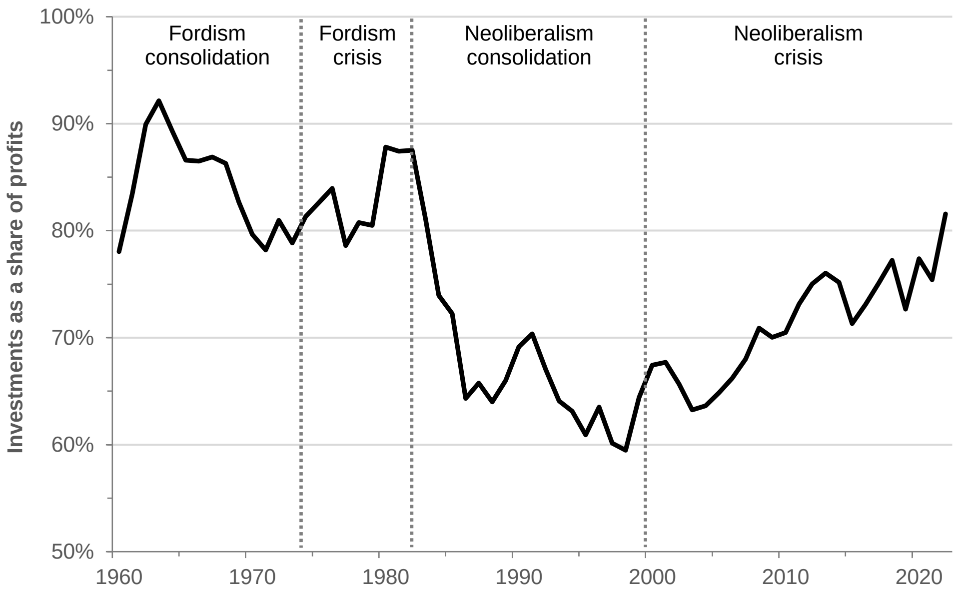

Figure 11. Investments as a share of profits in France (1960-2022). Source: authors, based on data from OECD (2024b).

The impact of financialization can also be seen in the dynamics of these sectors' value added in relation to GDP, and therefore on apparent labor productivity. For Durand and Gueuder (2018) and Basu and Foley (2013), we need to consider the evolution of the share of the financial, insurance and real estate sectors in GDP to measure the degree of financialization of an economy. In France, this share has grown steadily since 1970, rising from less than 10.9% of GDP in 1970 to over 16.2% in 2020 (OECD, 2024c). This share is largely driven by the real estate sector but has tended to stagnate since 2008. It should be noted that the increase in value added in these sectors is partly the result of new accounting conventions that have made these sectors more productive. (Christophers, 2011). As value added is increasingly created by low-energy-intensity sectors, and moreover based on accounting conventions that tend to treat previously unproductive income as productive, the result is a decoupling from EMR.

Beyond the financialization of added value, another related phenomenon is that of *transfer prices* used by the different subsidiaries of the same group. These prices can be set with the aim of inflating/deflating the added value generated by a company in a given territory, for purposes such as tax optimization. Take, for example, the extreme case of Ireland, where multinationals locate their parent companies because of the attractive tax rate on profits. This country has the highest apparent labor productivity in Europe. Everyone agrees that, through transfer pricing, resident companies repatriated the added value generated by subsidiaries abroad to Ireland. In Europe, this movement was made possible by the Single European Act of 1986, which authorized the free movement of capital.

Ultimately, far from being alternative explanations, these different phenomena further reinforce the case to account for the decoupling between apparent productivity and EMR as summarized in Figure 12. This relative decoupling of productivity gains and EMR is essential: it allowed France to begin reducing the burden of energy expenditure as early as 1983, four years before the oil counter-shock of 1986. The relative price of energy rose until 1985, before falling sharply by 23% to its 1960 level (Figure 6). It was only under the effect of this last variable that the weight of energy expenditure returned to its pre-shock level (the same applies to households). This easing of the energy constraint favored an upturn in the profit rate (figure 8).

Ultimately, in the face of the energy contradictions of Fordism, neoliberalism offered salvation by reconfiguring the productivity/EMR relationship. The return of relative energy prices to their 1960 level between 1986 and the early 2000s only reinforced this regime. This is borne out by the relative stability of the rate of profit and the weight of the bill between 1988 and 2002. As with the Fordist crisis, focusing on energy prices alone fails to grasp the importance of metabolic transformations in establishing neoliberalism.

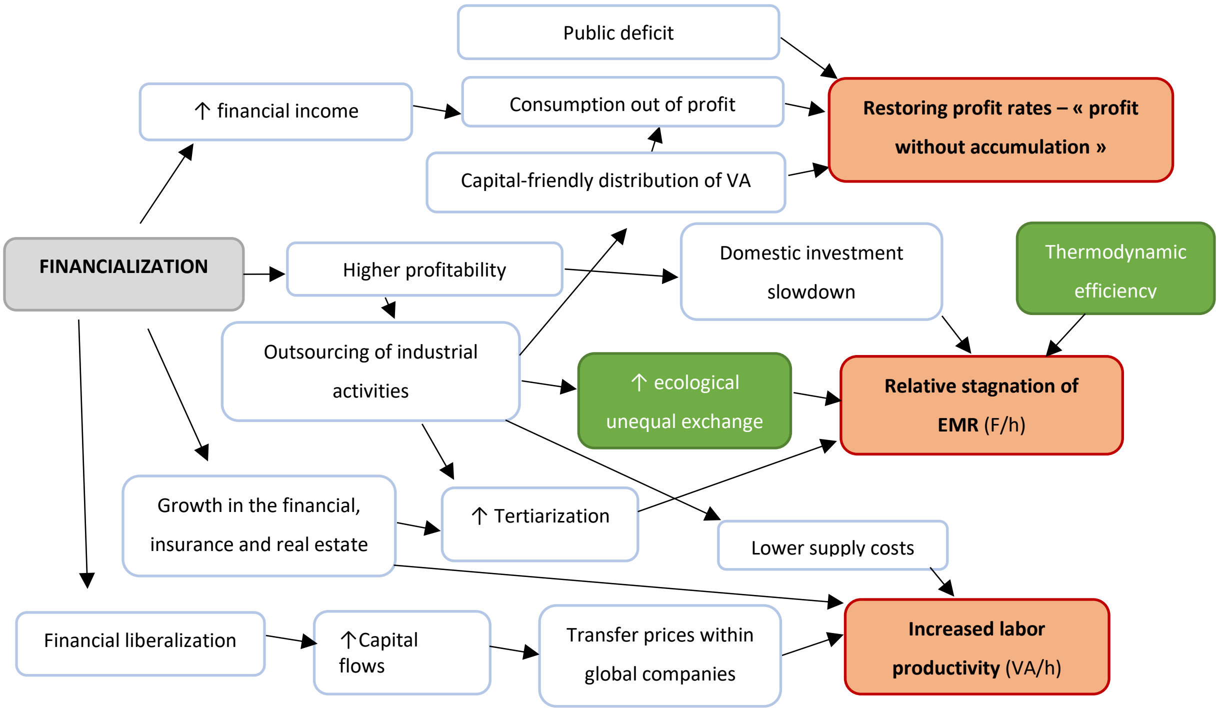

Figure 12. Neoliberalism and the decoupling of apparent labor productivity and EMR. Source: authors.

4. Discussion: neoliberalism on its last legs?

In the early 2000s, neoliberalism once again faced unstable energy conditions. From 1999 onwards, a new price shock appeared: the real price of energy rose by 46% over 20 years (1999-2019), and even by 76% if we extend the analysis to the specific context in 2022 (see figure 6). The intensity of this shock is comparable to that of the 1973-86 period (+54%). Energy expenditure, which had bottomed out in 1998 at 5.4% of GDP, began to rise. Symmetrically, the rate of profit, which had peaked between 1998 and 2000 (7.3%), began to fall steadily until 2019 (5%). While the neoliberal metabolic reconfigurations (deindustrialization, tertiarization, financialization) seemed to keep the weight of energy expenditure in check, the deepening of these trends created a destabilizing dynamic (excess financialization and trade deficit). Neoliberal regulation was failing, and the crisis was structural.

4.1. A decoupling between labor productivity and EMR that is becoming absolute

Neoliberalism's first reaction to this shock was to deepen past trends, namely deindustrialization. As Figure 3 shows, from the early 2000s onwards, there was a clear break in EMR dynamics, whatever the measure used (final or useful stage, national economy or productive sectors only). For example, at the useful stage, it fell by 18% between 2000 and 2020 for productive sectors. On an annual basis, EMR fell by 0.9% per year at the final stage, and by 0.4% at the useful stage for the national economy. China's entry into the WTO and the introduction of the euro at the same time undoubtedly contributed to this process. Concurrently, apparent labor productivity grew at an increasingly sluggish pace: 0.9% over the decade 2000, 0.8% over the decade 2010. Thus, whereas the first phase of neoliberalism (1980-1999) was characterized by a relative decoupling between apparent labor productivity and EMR at the useful stage, from 2000 onwards, the decoupling between these variables became absolute.

Initially, this movement was not sufficient to counter energy prices' effect on the weight of energy expenditure, which increased significantly: 5.6% in 1999, 10.7% in 2008, and peaking at 11.5% in 2012. From 2013 onwards, however, energy costs fall significantly, reaching 7.2% in 2020, before rising again sharply to 16.7% of GDP in 2021.

Other difficulties compound with this lightening of the energy expenditure burden. Firstly, the pursuit of financialization showed signs of exhaustion with the outbreak of the 2007 crisis: strategies to create value from financial assets led to the most serious financial crisis since 1929. Non-financial French companies saw their net financial income begin to decline after 2007 (Durand and Gueuder, 2018).

Then, offshoring industrial activities to counter the weight of energy expenditures was an appropriate solution at the firm level. But at the national level, this strategy generated a structural and growing trade deficit. At the end of the 1990s, France's trade balance, which had recovered under neoliberalism, began to deteriorate. A trade deficit appeared as early as 2004 for the balance of goods (2006 if services are included), and continued to grow until then, reaching 5.4% in 2022 (3.9% if services are included). As in the 1974 crisis, this deficit was driven by the increase in the energy bill, following the energy price shock, but not only. The non-energy trade balance is also deteriorating, probably as a result of the growing trend towards deindustrialization. So, despite a reduction in the energy bill from 2012 onwards, the non-energy trade balance continued to deteriorate.

Moreover, unlike in the past, this lightened energy expenditure burden did not coincide with a restored profit rate. In fact, average profit rate fell by 2.3 points compared to its 2000 level. Unlike the shock of the 1970s, capital owners were unable to pass on this shock to wages: the exploitation rate remained stable from 2000 to 2010 (at around 31%) and even fell from 2007 (-6 points). What's more surprising was the organic composition of capital, which increased by 22% despite the decline in technical composition over the period. In other words, the volume of machinery was falling significantly, but prices were such that its value increased relative to wages paid.

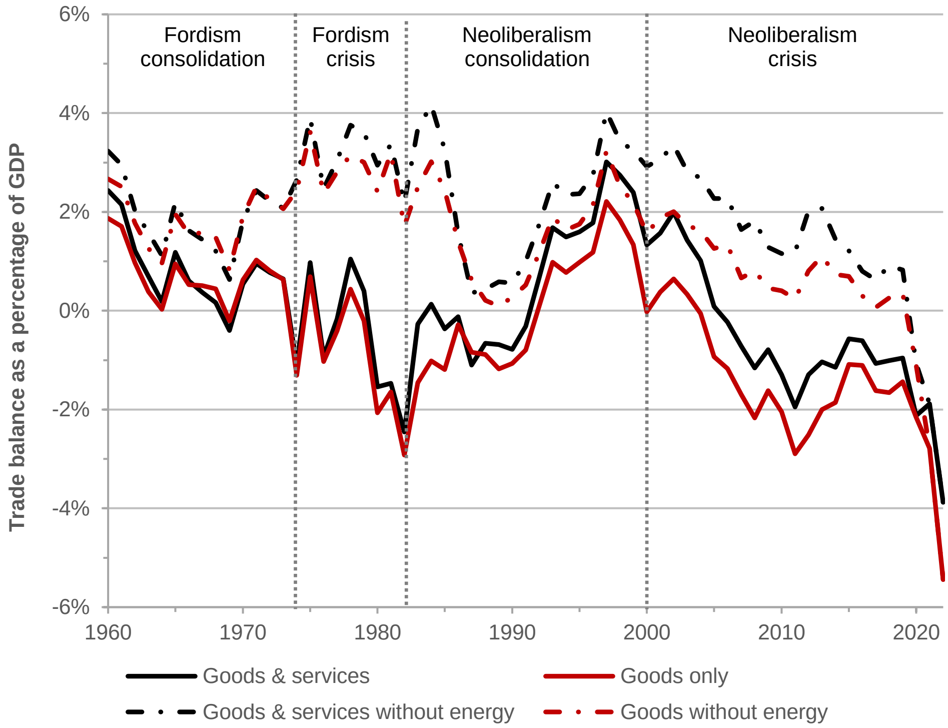

Figure 13. France's trade balance (1960-2020) as % of GDP. Source: SDES (2022) for the energy bill, and OECD (2024d) for the trade balance.

4.2. State aid to companies as an alternative to increasing the exploitation rate?

In 2010, when companies found themselves unable to pass on this profit deterioration to employees as they had done in 1983, they embarked on a massive relocation driven in the tailwinds of intense free-market globalization. Progress in energy efficiency (+10% between 2000 and 2022) could not compensate for the incentives toward international competition. Against this backdrop, successive governments made it their priority to reduce France's cost of labor (through exemptions from social security contributions since 1995, employment competitiveness tax credit, the Labor Law, freezing civil servants' wages, etc.): this is a strategy of complacency towards capital, which demands a return to a profit rate deemed "normal" and "necessary". For the time being, this strategy has not borne fruit: the wage bill continues to grow faster than profits, resulting in a drop in the exploitation rate (see figure 9).

But there's another lever that governments have been using since the 2000s to bolster profit rates: public aid policies for companies (figure 14). Introduced in the 1980s, they soared from the 2000s onwards to represent almost 10.2% of GDP in 2021, or nearly 42% of net profit! The concomitance with energy's sustained relative price rise is striking. Nevertheless, this public policy has been a failure for everyone – capitalists, workers, and taxpayers alike. In fact, despite their considerable volume, public subsidies to companies have only served to contain the fall in the rate of profit, without enabling a recovery to the desired level. On the other hand, this spending's contribution to deteriorating public finances is undeniable: in 2021, this aid represented over 17% of public spending and more than 1.5 times the amount of the public deficit (6.5% of GDP).

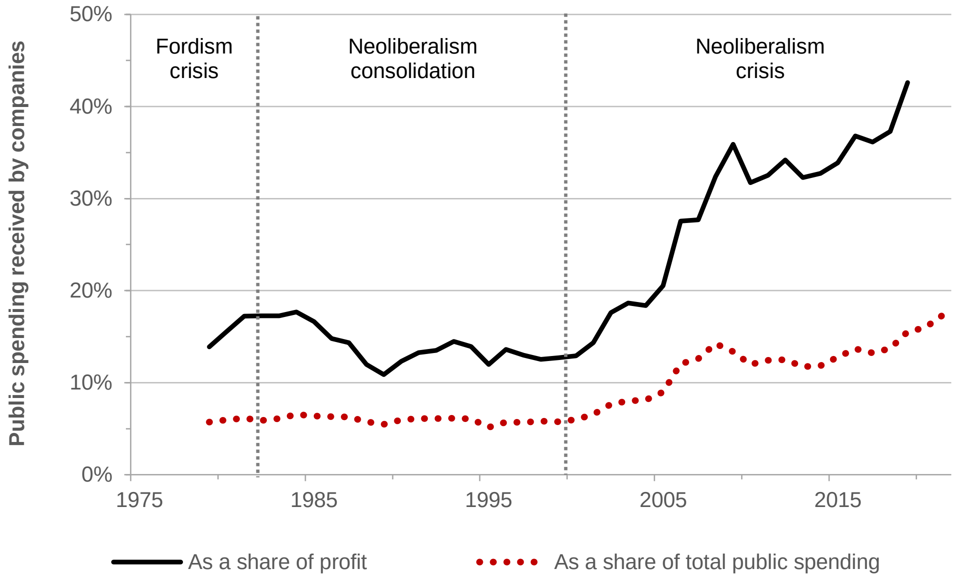

Figure 14. Public aid (including declassified aid) received by companies in France (1979-2019). Source: authors, based on Abdelsalam et al. (2022)

A post-Keynesian perspective helps us to understand this failure (see Appendix C). The rate of profit positively depends on the rate of investment (low), the public deficit (high) and trade in goods and services (structurally negative from 2006). Put another way, government efforts to raise the rate of profit via public deficit are hampered by the trade deficit.

Neoliberalism in France (and other rich countries) is therefore a mode of development that functions solely by maintaining unequal ecological exchanges with the rest of the world, extended financialization, and life-support drip for domestic companies, all of which are still not enough to restore profit rates and economic growth similar to those of Fordism. For the time being, central banks' active support for public and private debt is creating the illusion that this regime is sustainable, but for how much longer?

4.3. Central banks and the return of inflation

While neoliberal regulation has succeeded in temporarily containing an explosion in energy expenditure, this has gone hand in hand with the emergence of major contradictions. The deepening of financialization and deindustrialization/tertiarization, essential to decouple labor productivity from EMRs, have reached significant limits. The former has led to chronic financial instability, with the result that the financial system is now heavily administered by central banks. As for de-industrialization, it has led to a structural deficit in trade in goods and services, which has contributed to the fall in France's average profit rate. To counter this trend, which is reinforced by low investment rates, we need ever more public deficit (in particular to pay aid to companies) and private debt (employee dissavings). The new price shock from 2021 onwards therefore comes at a time when neoliberal regulation has already run out of steam.

At the time of writing this article, central banks are certainly in an uncomfortable position, torn between the desire to fight inflation (by tightening monetary policy) and that of guaranteeing financial stability, which implies not abandoning the guarantee of public debt. Furthermore, in the face of historically low profit rates, large corporations have finally decided to make households pay. This has not escaped the notice of either the European Central Bank or the IMF, since researchers at both institutions estimate that nearly half of current inflation is now driven by profits (Hahn, 2023; Zhou et al., 2023)[10]. Unless energy prices come down, the social sustainability of neoliberalism is at stake.

5. Conclusion and outlook: energy at the heart of neoliberalism's structural crisis

At a time when neoliberalism is undergoing a structural crisis, two interpretations of the role of energy are possible. The first, a minimalist one, is found among most orthodox economists, as well as regulationists, and consists in seeing energy only in terms of its price. Energy is no more than an exogenous shock, certainly capable of temporarily shaking up a regime, but the real determinants of the crisis are elsewhere (exhaustion of productivity gains

[10] Christine Lagarde, President of the ECB, did not hesitate to publicly relay this information: https://euobserver.com/green-economy/157196.

for Fordism, excessive financialization for neoliberalism). From this perspective, high energy prices may have contributed to the bursting of the subprime bubble in 2007, but this would remain a secondary factor compared to excessive financialization.

By enriching regulation theory with contributions from ecological economics, our article defends a second interpretation. We argue that energy is much more central to the constitution and demise of regimes of accumulation, as each regime of capitalism must manage a *metabolic constraint*. In concrete terms, each regime finds itself having to organize the progression of capital accumulation while containing the weight of energy expenditure. Focusing solely on the price of energy is insufficient, since we must also consider the fundamental relationship between EMR and apparent labor productivity, as highlighted by ecological economics. From this perspective, financialization and deindustrialization can no longer be analyzed as alternative explanations for the energy price shock (of the mid 1970s), but as a means by which neoliberalism has overcome the metabolic exhaustion of Fordism. The crisis of a regime cannot be understood without attention to its metabolic constraints. The financial contradictions of neoliberalism since 2007 also signal its failure to overcome its energy/metabolic constraint.

6. Appendices

Appendix A: Commonly accepted causes of the 2007 crisis

The *subprime* crisis of 2007, which later turned into the Great Recession, is considered the most serious economic crisis since the Second World War. Its causes and consequences are multiple and interconnected. A well-known key element of the crisis was the proliferation of *subprime* mortgages for borrowers with poor creditworthiness. These loans often carried variable interest rates, increasing the risk of default. The possibility of excessive *subprime* mortgage lending can be explained by a context of weak financial regulation, which allowed banks to broaden their lending criteria to reach a wider audience, while developing new financial products whose risks were difficult to assess (Arner, 2009; Mishkin, 2011). In particular, the practice of securitization, in which mortgage loans are bundled into complex financial securities to form a more liquid product, contributed to the spread of risk throughout the financial system as the quality of the underlying loans was camouflaged. The opacity of these structured financial products, based on these *subprime* loans, greatly contributed to the crisis.

The desire to make a quick profit by securitizing *subprime loans* also corrupted the risk management practices of major financial conglomerates and the credit review practices of rating agencies. Rating agencies assigned high ratings to many financial products containing *subprime loans*, misleading investors as to the real level of risk associated with these securities (Wilmarth Jr., 2020). The underestimation of the risks associated with these securitized products, combined with their widespread distribution in the financial system, led to rapid global contagion of the financial crisis that began in the United States in 2007. It affected financial institutions in Europe, necessitating major intervention by governments and central banks to stabilize the financial system (Jiang et al., 2022). Policy responses to the crisis, such as quantitative easing by central banks and fiscal support policies by governments, had mixed results. In the United States, massive support policies led to a relatively rapid economic recovery, while the more timid and short-lived policies implemented in Europe failed to prevent another crisis, that of public debt in the eurozone.

For some authors, this crisis is rooted in the US Federal Reserve's highly accommodating monetary policy during the 2000s, under the leadership of Alan Greenspan. This expansionary monetary policy is said to have contributed to an environment of low interest rates, encouraging indebtedness and risk-taking in the real estate and financial sectors (Leamer, 2009; Taylor, 2007, 2009). This analysis is not unanimous, however, as several econometric studies have shown that the Fed's monetary policy played a negligible role in the creation of the US real estate bubble (Dokko et al., 2011; Luciani, 2015)..

In short, the *subprime* crisis was the result of a complex combination of factors, including extremely risky credit practices, uncontrolled financial innovation, opacity regarding the risk of financial assets, lax monetary policy and global integration that facilitated the spread of the crisis. This episode highlighted fundamental flaws in the global financial system, which have not been fully resolved, and which therefore point to the strong likelihood of a new crisis. (aInternational Monetary Fund, 2023).

Appendix B: Characterization of development patterns in France since the 16th century

Table B.2. Development patterns in France from the 16th century to the present day. Source: authors, after Boyer (2016, p.65; 2023, p.34).

Development mode / Features	Ancien Régime (16th-18th centuries)	Large factory (19th century)	Taylorism (early 20th century)	Fordism (1945-1974)	Neoliberalism (since 1974)
Dynamics of the global output	Extensive, predominantly agricultural sector, strong dependence on colonies	Extensive, beginning of mechanization in urban factories	Intensive, start of assembly lines	Intensive, mobilizing returns to scale	Extensive trend: exhaustion of productivity gains and tertiarization
Composition of total demand	Peasantry, rising bourgeoisie, aristocracy (sustained war effort)	Peasantry, assertive bourgeoisie, public spending	Growing share of employee demand	Employee demand drives mass consumption	Salaried but stratified by income
Regulation	Administered	Competitive	Competitive	Administered	Competitive
Value-added sharing	Capture by the aristocracy	For the benefit of shareholders	To the benefit of capital owners, growing share for salaries	*Ex ante* stabilization of the wage-capital split	Reduction in the employee share, then stabilization
Cyclical crises	Meteorological hazards	Meteorological hazards, accumulation-related imbalances	Imbalances in accumulation not addressed by economic policy	Accumulation imbalances taken care of by economic policy	A succession of speculative bubbles
Structural crisis	Political conflict over the appropriation of wealth	Deflationary spiral and underemployment equilibrium		Stagflation	Financial system under central bank control

Appendix C: Kalecki's law

According to the post-Keynesian approach, making profits requires capital accumulation, and therefore investment. Known as Kalecki's law (1966)this relationship can be summed up by the following adage: "wage earners spend what they earn, capitalists earn what they spend". A brief presentation based on national accounting illustrates this idea.

Either P profit, W wages, C consumption, I investment, Q production, K capital stock and p unit price. It is assumed that there is no intermediate consumption, so that value added VA is equal to $p \times Q$that employees consume their entire wage and that capitalists only invest (no capitalist consumption). We can therefore write :

$$P = pQ - W \quad \text{(C.1)}$$

$$P = (C + I) - W \quad \text{C.2)}$$

$$P = I \tag{C.3}$$

$$P/K = I/K \tag{C.4}$$

In this stylized model, we see that profit comes from capitalists' investment spending, so the rate of profit depends on the rate of accumulation in accounting terms and over a period of time. From this perspective, the paradox of profit without accumulation is more salient: if capitalists invest less, they spend less, so they should have a lower profit. The question then arises: how do they manage to have a positive rate of profit, even though they invest less?

To understand this, all we have to do is add to the initial model the distinction between salaried consumption (C_w) and capitalist consumption (C_p), so that $C = C_w + C_p$.
In this case, we have :

$$P = C_p + C_w + I - W \tag{C.5}$$

$$P = C_p + I \tag{C.6}$$

and in the absence of investment, i.e., $I = 0$we obtain :

$$P = C_p \tag{C.7}$$

This fictitious example shows that, in a simple model, it's possible to make a profit without investment. Indeed, capitalists can make two types of expenditure: capitalist consumption or investment (accumulation of fixed capital). If profit consists essentially of capitalist consumption, there is no investment, and therefore no extended reproduction of capital: the economy cannot grow. It is therefore possible to have a positive rate of profit with a zero rate of accumulation, in this case, when capitalists consume the entire profit.
In a world where there are only capitalists and wage earners, this expenditure can only come from the capitalists themselves, either in the form of consumption or investment. However, by making the model more complex, it is possible to highlight other situations that produce this result. At least three such situations can be identified: public deficit, trade surplus and employee dissaving.

In the case of the public deficit, the State spends more than it takes from private economic agents. It therefore injects additional net demand into the economic circuit. Companies receive more than they pay out in wages, without capitalists having to invest or consume. Starting again from the national accounting equations and noting G public spending and T taxes, profit can be written as :

$$P = (Cp + I) + (G - T) \tag{C.8}$$

The case of the trade surplus follows the same logic, except that this net injection of additional demand is generated by the rest of the world. With Xexports, and Mimports, we can enrich our profit formula as follows:

$$P = (Cp + I) + (G - T) + (X - M) \tag{C.9}$$

Finally, employee dissaving behavior also influences the profit rate. It should be remembered that, in the initial model, employees had only their current wages at their disposal, which they consumed in full. In practice, however, it is more realistic to consider the possibility of employees spending more than their wages, either through a previously built-up stock of savings, or by taking on debt. In both cases, this behavior results in employee dissaving, i.e., a *negative savings flow*. Employee dissaving makes a positive contribution to profits and, conversely, when employees save, this reduces profits. Equation (C.9) can thus be completed with $S_w$which gives us the most complete equation proposed by Kalecki:

$$P = (\boldsymbol{Cp} + I) + (\boldsymbol{G} - \boldsymbol{T}) + (\boldsymbol{X} - \boldsymbol{M}) - \boldsymbol{S_w} \tag{C.10}$$

For convenience, the sum of the aggregates **in bold** will be called A in the following. A The sum of all cash flows that contribute positively to a given level of profit, but which are not capital expenditure. Our aim here is to distinguish capital expenditure (I) from other expenditure (A). By dividing by the capital stock (K), we return to the formula for the rate of profit:

$$\frac{P}{K} = \frac{I}{K} + \frac{Cp}{K} + \frac{(G - T)}{K} + \frac{(X - M)}{K} - \frac{S_w}{K} \tag{C.11}$$

$$\frac{P}{K} = \frac{I}{K} + \frac{A}{K} \tag{C.12}$$

An economy's rate of profit can therefore be decoupled from its rate of investment, provided that $\frac{A}{K} > 0$. It's the evolution of this term that we need to follow to measure the extent to which the rate of accumulation deviates from the rate of profit. Put another way, the gap between the rate of profit and the rate of accumulation can be explained by the positive contribution of A/K.

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