Chapter 2. Mechanism and Natural Law: From Physics to Economics

I. The laws of nature in physics: the Galilean revolution and the notion of mechanism

II. The importation of mechanism into the social world: political economy

- The question is that of the scientific status of economics. Economics claimed to be scientific by modeling itself on Galileo's classical physics. Galileo's physics states the natural laws of the physical world. Economics seeks to bring to light natural laws of the social world.

  i. Natural laws are expressed quantitatively, that is by using mathematics and by treating the differences between bodies (in economics, between goods or between agents) as not expressible qualitatively but quantitatively

  ii. Knowledge of natural laws, in physics as in economics, results from understanding the mechanisms at work in the social or physical world.

  iii. We reach knowledge of natural laws by turning away from sense experience and induction, and instead using fictions from which we reason by deduction.

- The importation of the notion of mechanism into the social world passes through political philosophy, first and foremost Thomas Hobbes (17th-century political philosophy). Hobbes's model is Galileo, his physics, the new science. He proceeds methodically, beginning by analyzing the "original condition of humanity," abstracting from the State. The state of nature is a thought experiment, as Galileo conceived them to theorize the laws of bodies. One must proceed as if society were dissolved, the way one takes apart a clock to observe its components.

- Mechanism is then expressed in economics: there exists a social order — political in Hobbes, economic in economic thought — which is expressed and understood as the physical order. Economic thought, from physiocracy to contemporary theory, has been built on the model of physics, even though there are also differences between the physical world and the social world, and disagreements among economists.

- As early as physiocracy, in the 18th century, the idea is stated that, on the one hand, the social order resembles the physical order, and, on the other hand, that economic science must discover the laws governing the social world by understanding the mechanism at its origin. Le Trosne, in *L'ordre social*, writes:

  > "The laws of the social order are established, by a necessary and evident deduction, on the laws of the physical order. [These laws] are "simple, evident, easy to grasp."

The social world is governed by arithmetic; economic science is founded on the evidence of calculations, not on observation.

Economic theory retains, to varying degrees, the three characteristics of classical physics:

i) Mathematization: the essential economic quantities are prices, which present themselves as numbers, as mathematical quantities.

ii) The notion of mechanism: it makes it possible to state natural laws.

iii) The fiction that accompanies the departure from sense experience.

1. Mathematization: prices and monetary flows

i) The fundamental economic quantities are prices.

Every economic theory contains a theory of prices (real prices or monetary prices): theories of value among the classicals, Marxists, neoclassicals, and neo-Keynesians; theories of monetary flows among the physiocrats and post-Keynesians (circuitists).

Remark on an essential difference between economics and the other social sciences: economics is not the only social science that uses mathematics. It is distinguished from the other social sciences not because it quantifies reality, but because its very concepts are quantities (i.e. numbers). This is the difference between statistics on suicide (Durkheim) and economic theories of prices: economic theories are mathematical even before any measurement of the real world. Suicide is not a mathematical object. Price is a mathematical object (even though it is not only a mathematical object).

ii) Rudimentary or elaborate mathematics

The specificity of economics does not come from economists using elaborate mathematics.

- Mathematics can be rudimentary. Smith, describing the primitive state of societies, prior to the appropriation of land and the accumulation of capital, writes:

> "If it usually costs twice the labor to kill a beaver that it does to kill a deer, a beaver will naturally exchange for, or be worth, two deer" (Wealth of Nations).

This is a mathematical theory of value, taken up by Ricardo: the exchange value of a commodity A relative to a commodity B depends exclusively on the ratio between the quantities of labor (direct and indirect) necessary to produce them. Va/Vb = La/Lb.

This theory of prices is mathematical because it can be stated through an equation. The equation expresses prices as ratios of quantities of labor embodied in commodities. The simplicity of the numerical examples does not change the fact that the theory of value must produce numbers (exchange values are numbers), and produces them through equations, explicit or implicit.

- Mathematics can be elaborate — in general equilibrium theory (micro- and macroeconomics), but not only there.

P. Sraffa, 1960, *Production of Commodities by Means of Commodities: Prelude to a Critique of Economic Theory*. A reformulation of classical thought. He solves a problem identified by Ricardo at the end of the first chapter of the *Principles of Political Economy and Taxation*: the labor theory of value only holds if the rate of profit is zero (which is awkward for explaining a capitalist economy, where capital must earn a return), or if the temporal structure of production (the ratio of direct to indirect labor at each period) is identical across all branches. Sraffa's reformulation leads, as in neoclassical theory, to prices determined by a system of equations. But these are not the same equations as in general equilibrium theory, and not the same mathematics is mobilized: linear algebra instead of the analysis and differential calculus used in marginalist thought.

iii) The mathematical character of the notion of value, Marx, chapter 1 of Capital.

> "Exchange value appears first of all as the quantitative relation, the proportion in which use values of one kind exchange for use values of another kind. (…) Let us take two commodities, wheat and iron. Whatever their exchange ratio, it can always be represented by an equation in which a given quantity of wheat is held equal to some quantity of iron, for example: 1 quarter of wheat = a hundredweight of iron."

- Economic analysis contains a mathematical moment, even though it cannot be reduced to mathematical analysis.
- Before the mathematical moment, Marx asks about its very possibility.

  Goods have a use value (UV) that is a concrete utility. Concrete utilities present qualitative differences. Goods do not have the same use. They are not quantitatively comparable.

  Goods also have an exchange value (EV) that is likewise concrete, observable. But exchange values present only quantitative differences.

⇨ How do the qualitative differences (differences in use value) between commodities ultimately reduce, on the market, to quantitative differences (differences in exchange value)? These commodities must, Marx says, have "something in common": they are the product of human labor, within a particular organization of society.

⇨ There is a moment in economic analysis that is not mathematical: the one that states that labor, in this society, is the cause of exchange value. There is then a mathematical moment: the one in which the value of one commodity, relative to another, is expressed through an equation.

iv) Walras: the mathematical character of the notion of exchange value:

> "Wheat is worth 24 francs per hectoliter. Note the mathematical character of this fact. This fact has so much the character of a mathematical fact that I am going to express it immediately by an equation, and thereby give it its true expression" (*Éléments d'économie politique pure*).

- The cause of exchange value is scarcity. Two senses:

- On the one hand, the greater or lesser scarcity of the quantities supplied: Va/Vb = Qb/Qa.
- On the other hand, scarcity in relation to consumers' expectations, expressed by marginal utility: supply and demand are derived from the maximization of satisfaction: Va/Vb = U'a/U'b for each agent.

v) Prices: observable mathematical quantities

The quantification of reality in physics concerns the notion of speed, i.e. distance covered in a given time, in order to characterize motion. This quantification replaces qualitative perceptions of motion (crawling, flying, walking, upward, downward, circular motion). Quantification in economics concerns the notion of price.

With this difference: speed in physics is not observed as a number — it must be calculated; it is not observable, because motion does not present itself to our senses in quantified form. Prices, by contrast, present themselves immediately in quantified form: prices appear on a price tag or in an exchange, as a ratio of quantities. It seems that one does not need to fictionalize the economic world in order for numbers to appear. The mathematical character of economic notions appears immediately.

2. Mechanism in economics

i) The movement of prices

- Mechanism vs. finalism

In physics, Galilean mechanism is opposed to Aristotelian finalism. Finalism attributes the motion of bodies to their purpose (reaching their natural place); motion stops once the purpose is achieved. Mechanism attributes the motion of bodies to an external cause. Finalism explains motion by its final cause (the 'why'), mechanism by its efficient cause (the 'how').

In economics, prices seem to result from the free intentions of agents. Yet laws constrain the movement of prices (the laws of supply and demand), which prevent individuals from manipulating prices as they would wish. Prices do not depend on agents' intentions but on blind forces. The social order is understood independently of individual wills.

- Theories of the price-variation process

Gravitation (classicals and Marx) and tâtonnement, or grouping (neoclassical). In both cases, agents have intentions, but these intentions have no effect.

- Gravitation: capitalist producers want to sell at the highest possible price. The mechanism of gravitation (a term borrowed from Newton) states that prices naturally tend, independently of anyone's will, toward natural prices.

  If the market price > the natural price, the rate of profit > the rate of profit in other branches, capital shifts, supply increases, and the price falls.

- Tâtonnement: suppliers want to sell at the highest possible price, buyers to buy at the lowest. Neither can. Exchange value is, for Walras, a natural fact, i.e. a fact whose origin is not "human will" but "the blind and inexorable forces of nature." Agents fail to manipulate prices in their favor even though it is they who set them and who want to manipulate them.

  > "The seller would very much like to sell at a higher price; he cannot, because wheat is worth no more, and if he refused to sell at this price, the buyer would find, right beside him, a number of sellers ready to do so. The buyer would ask nothing better than to buy more cheaply; this is impossible for him, because wheat is worth no less, and if he refused to buy at this price, the seller would find, right beside him, a number of buyers willing to agree to it." (Walras)

  If $p > p^*$, $S(p) > D(p)$. Law of price variation according to the gap between supply and demand. The price falls.

ii) Involuntary Keynesian unemployment

Keynes: the simplified IS-LM case

Psychological law of consumption: $C = C(Y)$, with $0 < C'(Y) < 1$. To simplify, the marginal propensity to consume is assumed constant: $C = C(Y)$ with $0 < c < 1$.

In the goods market, assuming (for simplicity) that public spending (G) and taxes (T) are zero, and that investment is independent of the interest rate (I, with $I'(i) = 0$), we have $Y = C(Y) + I = cY + I$.

The equilibrium level of output is determined without reference to the money market (since $I'(i) = 0$): $Y = I / (1 – c)$.

Nothing guarantees that this level of output ensures full employment. The under-employment equilibrium is desired by no one. It comes about outside anyone's will.

iii) The tendency of the rate of profit to fall in Marx

Marx establishes that the rate of profit, at a constant rate of exploitation, can only fall. This runs counter to the goal of capitalists, who want to maximize their profit.

Assumptions:

- The rate of exploitation (surplus value / variable capital) is constant: each worker produces a constant amount of surplus value.
- The organic composition of capital (constant capital / variable capital) is increasing: constant capital = machinery and raw materials. Capital per worker is increasing.

The rate of profit necessarily decreases:

$$\frac{profit}{K} = \frac{pl}{c+v} = \frac{pl}{v}\frac{v}{c+v} = \frac{\frac{pl}{v}}{\frac{c+v}{v}} = \frac{{}^{pl}/_{v}}{1 + {}^{c}/_{v}}$$

3. Thought experiments and frictions

i) Competition as a thought experiment

Competition may be a fiction that can never be observed in reality, like Galileo's frictionless machine. Yet it tells us the truth of a process that is always at work, even though it can be hindered by frictions.

Individual wills can assert themselves: a monopoly can keep prices durably above the competitive level; individual wills can combine to affect prices, as in a cartel.

These obstacles are similar to Galileo's friction: they produce results that differ from what would occur if they did not exist. Bodies stop because of friction. Prices settle at a non-competitive level because of monopolistic behavior.

But obstacles to competition do not always completely prevent competition, just as friction does not prevent the principle that explains motion by an external mover, nor the law of conservation of motion. From an explanatory standpoint, the fiction of competition is not sufficient to explain the level of prices: in certain circumstances, the intentions of actors alter the outcome.

On the other hand, from a normative standpoint, obstacles to competition can be seen as harmful. Their removal by public authority is a condition for the proper functioning of societies.

ii) Counter-tendencies to the falling tendency

Marx states the counter-tendencies.

- Absolute surplus value (lengthening the working day and intensifying labor).
- Relative surplus value: a fall in the value of labor power, due to the fall in the value of workers' subsistence goods.
- A decrease in the value of constant capital.

The counter-tendencies delay the fall, work against the mechanism, but do not cancel it.

III. Economics outside mechanism

1. Natural law and political will

Collective wills can be exerted through political power, i.e. the will of the legislator. What room does the idea of natural law in economics leave for politics? One might suppose, on this point, a difference between the classical political economy that Marx criticizes (the subtitle of Capital is A Critique of Political Economy) and neoclassical economic science.

- Yet political economy, like Marxism for that matter, claimed to be scientific and claimed to state laws: natural laws for classical economics, historical laws for Marxism.
- Likewise, economic science (since the marginalist revolution) has always also had a political ambition in a very broad sense: the economist wants to advise the statesman.

What is the relationship between the natural laws of physics (the law of conservation of motion, or the principle of inertia, the law of gravity) and the natural laws of economics? Physical laws are such that one is always subject to them: one commands them only by obeying them. This does not prevent action: it is not because the law of gravity holds that one cannot build bridges or airplanes. But they remain subject to the law of gravity.

The natural laws of economics delimit the domain in which politics can intervene, by distinguishing the domain where intervention is possible from the domain in which political decision either has no purchase or can only have a negative effect. This is where a dimension absent from physics enters economic theory: the normative dimension.

i) Intervening on prices

Competitive prices make it possible to reach a desirable equilibrium. This is why politics should not intervene on prices. This is the foundation of economic liberalism: prices must be left to vary freely under competition, because if they settle at the level established by the theory of value, a desirable equilibrium is reached — this is the idea of the harmony of interests.

If obstacles to competition prevent the competitive equilibrium from being achieved, the legislator tries to impose competition: competition policy.

In other circumstances (increasing returns to scale, public goods, externalities, etc.), the legislator must substitute for competition and set a price.

ii) Intervening on spending: the Keynesian multiplier

Under-employment equilibrium does not preclude political intervention. Knowledge of its causes grounds a policy aimed at a return to full employment.

Another mechanism makes it possible to escape under-employment: the investment multiplier.

We start from an equilibrium $Y1 = cY1 + I1$.

Investment is exogenously increased by the public authorities.

$Y1 < cY1 + I2$.

The goods market is in excess demand. It regains equilibrium through a rise in output.

$Y2 = cY2 + I2$.

A relationship is established between the change in output and the change in public investment:

$\Delta Y = Y2 – Y1 = cY2 – cY1 + I2 – I1 = c\Delta Y + \Delta I$.

So $\Delta Y = \Delta I / (1 – c)$.

Since $c < 1$, $1 – c < 1$, $1/(1–c) > 1$: the increase in output exceeds the increase in investment. If $c = 80\%$, $\Delta Y = 5\Delta I$. This is the multiplier effect.

An external mover (public investment), through the effect of the marginal propensity to consume ($c < 1$), has a multiplier effect on the level of output.

The multiplier does not run counter to the mechanism that determines the level of employment. It relies on knowledge of the mechanism; it manipulates an external mover in order to alter the mechanism's outcome. The economist must convince the statesman of the soundness of his science and the relevance of the goal pursued. But knowledge is necessary to assess the size of the expected gain.

iii) Hastening the realization of the mechanism: the falling tendency of the rate of profit

The counter-tendencies delay the collapse of capitalism. Announcing the crisis, by demonstrating the downward tendency that persists despite the counter-tendencies, hastens its realization.

⇨ For most economists, there remains room for political intervention: the possible harmony of interests does not mean that everything is harmonious. Politics can act. But it must not disregard the laws that govern the social order, and it must most often respect them, because otherwise it produces the worst outcome.

2. Natural law and history

Are economic laws universal and eternal, valid in every society, resulting from a human nature? Or are they historical? Economists debate this.

i) Marx's critique of political economy

Marx the economist establishes the laws of value. But these laws are only historical; they hold only for one stage in the development of societies.

Chapter 1 of Capital states that commodities have an exchange value and that it is the economist's task to determine its causes. But exchange value does not come from nature: it comes from a particular form of society, capitalist commodity society, founded on the private ownership of the means of production.

In other societies, when the means of production are collectively owned (in small-scale patriarchal production, in old Indian society, on Robinson Crusoe's island), there is no exchange value. The laws of value do not apply there. These laws hold within a given historical configuration, a moment in the historical development of societies, destined to be superseded.

Opposed to this view is not only classical theory but, above all, most neoclassical authors, for whom economics, even when developed from the imaginary situation of Robinson Crusoe, states a truth about every form of society.

ii) Classical theory: distribution and wage determination

The opposition between natural laws and historical laws is not the same as the opposition between supporters and opponents of (capitalist) commodity society, nor the same as that between liberals and non-liberals. The classicals, who were liberals favorable to capitalist market organization, incorporate historical elements into their analysis, particularly on the question of distribution.

In neoclassical theory, the wage equals the marginal productivity of labor (it results from the decisions of the producer who, maximizing profit, chooses a quantity of labor such that the real wage equals marginal productivity). Keynes indeed accepts this, calling it the first classical postulate.

This does not necessarily mean that the productivity of labor determines the wage, since the productivity of labor also depends on the quantities of labor and capital used. But the theory states that a market quantity (the real wage) equals a physical quantity (the marginal productivity of labor).

In classical theory, the natural wage is a subsistence wage. One might interpret it as a physiological given, but this interpretation is contradicted by Smith and Ricardo: the wage must allow the purchase of a basket of subsistence goods whose content is determined not physiologically (except that physiology sets a floor for this wage) but historically and socially.

> "The natural price of labour is that price which is necessary to enable the labourers, one with another, to subsist and to perpetuate their race, without either increase or

> diminution. It depends on the price of food, necessaries, and conveniences required for the support of the labourer and his family" (Ricardo, *Principles*).

The natural wage is given under given historical conditions. It varies slowly (upward) with the development of society.

> "The natural price of labour, even estimated in food and necessaries, is not absolutely fixed and constant. It varies at different times in the same country, and very materially differs in different countries. It essentially depends on the habits and customs of the people. An English labourer would consider his wages under their natural rate (…) if they enabled him to purchase no other food than potatoes, and to live in no better habitation than a mud cabin; yet these moderate demands of nature are often deemed sufficient in countries where 'man's life is cheap', and his wants easily satisfied. Many of the conveniences now enjoyed in an English cottage would have been thought luxuries at an earlier period of our history" (*Principles*, p.118).

The natural wage (unlike the market wage, which is only transitory and gravitates around the natural wage) results from something other than supply and demand, or productivity. It results from a social norm. The natural wage allows the wage earner to buy a basket of goods deemed necessary at a given time and place. For it to change, what is deemed acceptable must change, upward or downward. The subsistence basket may contain items considered superfluous at other times or in other places, but deemed necessary at a given moment in the development of society.

In the Sraffian formulation of classical theory, the wage is no longer given (there is no natural wage expressing a society's social norms) but variable. An economy is represented by a system of equations that determine the prices of goods, the wage, and the rate of profit. For k goods (and a numéraire), k+1 equations are set up, and there are k (real) prices of goods plus two distributive variables to determine: the wage and the rate of profit.

> "It follows from the fact that we are now treating the wage as variable that the number of these variables now exceeds by one the number of equations, and the system has a degree of freedom; so that if the value of one of the variables is fixed, the values of the others will thereby also be fixed" (*Production of Commodities*, p.17).

Moreover, if R is the maximum rate of profit, and w the share of the net product (the surplus) that goes to wages, the rate of profit is linearly dependent on the wage: $r = R(1 - w)$. The inverse relationship between wages and profit is represented as a straight line with slope –R.

There remains, then, in classical theory a natural law concerning distribution: the inverse relationship between wages and profit. Given the wage level, only one rate of profit can result.

Conclusion

Against Aristotle, Galileo founds a rationalist physics (resting on thought experiments, detached from sense perception) that proceeds by deduction from principles stated in an imaginary world (the frictionless machine), and that understands the physical world as a mechanism.

Political economy, or economic science as a whole, is not entirely rationalist. Some economists are empiricists, inductivists — i.e., they start from observation to induce general propositions.

But all of them retain from Galileo the notion of mechanism: a device in which movement (of prices, of monetary flows, of the volume of population and employment, of incomes) does not depend on the intentions, good or bad, of agents. The mechanism provides knowledge of economic laws.

Intentions are inserted at a second stage, on two levels: as frictions, when they emanate from individual agents and disturb the equilibrium; and as a means of instrumentalizing the mechanism.

Finally, laws have a restricted domain of validity. Outside this domain, historical and geographical conditions influence the social world.