



UNIVERSITÀ
DEGLI STUDI
DI MILANO

Course in Economic Geography (Prof. A. Vitale)
LLM in Sustainable Development, Faculty of Law

Economic Cycles

The Perspective of the Austrian School of Economics

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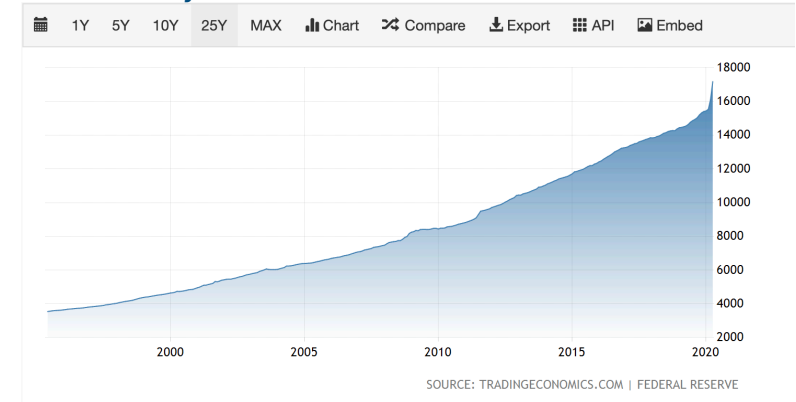
- In these lectures we'll discuss **inflation**: more specifically, the **artificial increase in the quantity of money and credit**
- It is a very actual subject: Covid-19 crisis; 2008 crisis; ...; 1929 Great Depression (Rothbard, 2000 [1963])
- Some graphs to give an idea of the **dimension** of artificial expansion of money and credit in the last decades

M2 money stock Euro (1995-2020)



Actual	Previous	Highest	Lowest	Dates	Unit	Frequency	
12955954.00	12774486.00	12955954.00	1070496.00	1980 - 2020	- EUR Million	Monthly	Current Prices, SA

M2 money stock US (1995-2020)



Actual	Previous	Highest	Lowest	Dates	Unit	Frequency	
17176.10	16103.90	17176.10	286.60	1959 - 2020	USD Billion	Monthly	Current Prices, SA



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- On the surface, it sounds like a cold and arid subject. However,
 1. It is about the **structure** of monetary systems (rarely questioned)
 2. linked to **all aspects** of economic theory and to most aspects of our **daily life**
 3. It is about **your future** and that of your children
 4. No discussion on **sustainable development** can make any sense if it doesn't address, from a scientific point of view, the monetary structure
- It is, however, a very **difficult** subject: systemic, complex, change of paradigm, also psychologically difficult



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- **Economic cycles** had been a problem for economists for a long time: why does the economic system have boom-and-bust phases? Why do many economic actors (across **different** economic sectors) end up doing the **same** mistakes, **all at the same time**?
- On the ground of the revolutionary works of Carl Menger (1840-1921) and Eugen von Böhm-Bawerk (1851-1914), the Austrian School of Economics, and in particular Ludwig von Mises (1881-1973), Friedrich von Hayek (1899-1992) and Murray Rothbard (1926-1995) discovered that **the cause of the economic cycles is the artificial expansion of money and credit**



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- Some (e.g. **Joseph Schumpeter**) believed that such cause was the inherent instability of the capitalist system
- The so-called **monetarist** school of thought (**Irving Fisher, Milton Friedman**) believes that economic cycles are due to random and exogenous “dances” of prices (so that the goal of the central banks should be to keep prices stable).
- **John Maynard Keynes** (whose theories inspire a considerable part of today’s monetary policies and institutions) did not even ask himself the question of “why” the cycles exist: he took them as a given
- The difference between all these approaches and the Mises-Hayek-Rothbard one is that, unlike the former, the latter takes into account **time** and the **capital structure**



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- In these lectures, I will discuss economic cycles **from the perspective of the Austrian School of economics**, which traced its causes to the artificial expansion of money and credit
- Why? Because it is the **only perspective** which, in my view, is **scientifically valid** as it is the only one which is **logically and methodologically consistent** (I'll explain later why)
- With few significant exceptions, you are unlikely to hear about this perspective anywhere else in academia or in mainstream media



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These lectures will be structured into 2 days, 5 sections:

On the **first day** we'll cover:

1. Some key aspects on **methodology**: why is it so important?
What is the methodology of economics?
 2. **Key elements**: Value; Spontaneous Order; Money; Interest;
Structure of Production
- This is the most difficult (and less fun) part because it will seem "**fragmented**": different elements which appear to be unrelated to each other
 - Unfortunately, it is impossible to understand the implications of inflation without first understanding these elements



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- However, once these 5 key elements are understood, the worst should be over
- On the **second day** will cover:
 3. The "**story**" of economic cycles (much more fun)
 4. **Other**, non-strictly-economic **aspects of monetary inflation**: justice/freedom, war, the arts, technology, the environment
 5. The most innovative answer offered by the free market to the problem of monetary inflation: **bitcoin**



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- Feel free to ask **any question** and to make **any comment** in **any way** you like: the more (**logically consistent**) criticism, the more successful these lectures
- Feel free from political correctness (I'm **not** an academic btw)
- The lecture should last approx. **1-1:10 mins**
- To have more time for **discussion (20-30 mins)**, I will try to be **as concise as I can** and I will even **skip** some slides (but the presentation will be made available to you and further readings are in the **bibliography** for who's interested)
- Again for reasons of time, I would ask you to keep **questions/ comments** at the **end** of each lecture



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1. Methodology



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- What is methodology?
- To understand it, please consider the following question:
 - **Other conditions being equal**, would a person buy a larger quantity of a product/service if its price was higher?
- To answer this question, you can
 - a) interview say 1.000.000 people, and then give an answer which has some **characteristics** (approach "A")
 - b) proceed by logical deduction, and then give an answer which has **different** characteristics, though **not** necessarily a different **result** (approach "B")
- Depending on the way you choose to answer, you adopt one methodology or another
- But, **quite independently from the result that you get**, only **one** of the two methodologies is scientifically correct



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- Methodology **gives validity to scientific work**: if some work is grounded on correct methodology, it can produce scientifically valid answers and it probably will. However, if it is grounded on incorrect methodology, it will produce scientifically invalid answers
- **How do we know** that a particular methodology is scientific?
 - **non-arbitrary**
 - **logical consistent** (not only “internally” but also “externally”)
 - **elegant** (simplicity and few laws)
 - **general laws**: ability to find **unity** in diversity of particular phenomena
 - **compatibility** with the **essential nature** of what is studied
- In short, **“beauty”**



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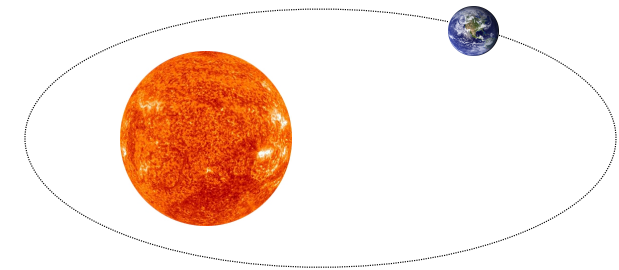
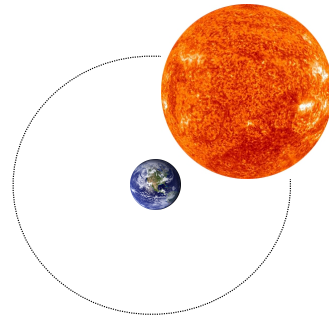
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- Typical example: the history of cosmology



- In **natural sciences**, there is a wide consensus on what the correct methodology is
- In **social sciences**, however, there is a great confusion and disagreement on methodology
- Broadly speaking, there are **two sides**, which are represented by approaches "A" (**quantitative** approach) & "B" (**qualitative** approach)



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1. **Quantitative** or **pragmatic** side (origins in Jevons, Walras):
approach "A"

- a) **ex post analysis** based on math./st. models (empirical data **can** validate or invalidate a theory; in fact, theory itself is impossible without empirical data)
- b) **no general, unchanging laws** (historicism: economic patterns are the result of social institutions)
- c) **method cannot** (and **should not**) be established a priori (last chapter: it depends on the problem one must solve)



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1. **Qualitative** or **scientific** side (origins in Menger): approach "B"
 - a) **a priori logical deduction**: empirical data **cannot** validate or invalidate a theory

The experience of a complex phenomenon - and there is no other experience in the realm of human action - can always be interpreted on the ground of various antithetic theories. Whether the interpretation is considered satisfactory or unsatisfactory depends on the appreciation of the theories in question established beforehand on the ground of aprioristic reasoning (Mises L., 1998 [1949], p. 41.)

- b) **general, unchanging laws** (no historicism)
- c) **method** can (and should) be established **a priori**



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- To the **quantitative side**, economics has become a **technique** to serve government policy /make particular predictions
- No methodological beauty:
 - arbitrary (empirical data can always be interpreted on the ground of antithetic theories)
 - logical inconsistent (e.g. macro vs. micro)
 - inelegant (complicated math. models)
 - no unity in diversity of particular phenomena (no gen. laws)
 - incompatible with the essential nature of what is studied (individual utilities cannot be measured)



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- To the **qualitative** side, economics is a **science**. More specifically, it is the science that studies the **structure** of **human action** (**not** its particular contents): a structure that is necessarily **exactly the same** and **unchangeable** for all human beings
- This implies that there are many things that economics **cannot** say (no pretense of knowledge) but also that what it can say it says with **apodeictic certainty**

- [Economics, ed.] *provides no more than an account of a process the outcome of which will depend on a very large number of particular facts, far too numerous for us to know in their entirety, and therefore does not lead to predictions about the future. We are in consequence confined to 'explanations of the principle' or to predictions merely of the abstract pattern the process will follow* (Hayek F.A., 1973, p. 24)

- Fulfills all criteria of methodological beauty



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These **methodological** differences are **structural** and **cannot be reconciled**:

«Menger understood the difference that separated him from the other “marginalists”, and did not hesitate to end his epistolary exchanges with Walras, arguing that “a conformity does not exist between us. There is an analogy of concepts in a few points but not in the decisive questions”» (Ferrero B., 2020)

- However, these two methodological approaches are **not** on an equal foot: one of them is “beautiful” (see earlier), the other one is not; one of them is correct, the other one is not



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Things that should start an alarm bell in your brain:

1. *"Empirical data/research demonstrate that..."*
2. *"in the past four years everything has changed"* (Draghi M., 2015)



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2. Key Concepts



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- Let me start this section with the following **question**: imagine that a professional sculptor has spent many years, working night and day, to create a sculpture that no one wants to buy, at any price
- Which of the following answers makes more sense to you?
 - a) that sculpture **is** worth something because a lot of work was put into it ("A")
 - b) that sculpture **is** worth something because it is beautiful ("B")
 - c) that sculpture **would** be worth something **if** some individuals had voluntarily chosen to exchange some of their own property (say money) for it ("C")



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- If "A" was true, making a hole in the ground and then covering it and continue doing it endlessly would be a very valuable activity, which is obviously absurd
- In addition, not all work is equivalent
- "B" is scientifically wrong because it is purely arbitrary: if economic value is **objective, who decides** whether something is valuable or not, and on the ground of which non arbitrary criteria?
- The answer is that economic value is **not** objective: it is **subjective**. It is in persons (in their individuality, history, preferences, situations, ecc.), not in things, nor in numbers
- Only subjective value is **non-arbitrary**, and therefore **scientific**



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- Subjectivity of value is the basis of economic science, which starts with its discovery
- In the history of economic science, the discovery of the subjectivity of value is equivalent to the Copernican Revolution in cosmology ("it is not man that revolves around value but it is value that revolves around man")
- This revolution is completed in year 1871, with Carl Menger's *Principles of Economics*



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- Like in cosmology (e.g. Aristarchus of Samos, c.310-c.230 BC), however, traces of the correct theory (and/or of its implications) were present already in ancient thinkers, e.g.: Lao Tzu (VI century BC); Democritus (c.460-c.370 BC); very partially and with strong inconsistency, Aristotle (384-322 BC); Saint Augustine (354-430);
- First important treatment: Pierre de Jean Olivi (1248-1298).
- Rediscovered by San Bernardino of Siena (1380-1444) two centuries later; spread far and wide by his disciple Sant'Antonino
- Then died.
- First systematic treatment: Turgot (1727-1781)
- Full systematic development: Austrian School of economics (second half 19th century)
- Then died again with modern collectivism and cult of "public interest"



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- The concept of economic value that was fashionable before Menger was the one that related economic value of something to the quantity of labour (or other resources) needed to produce it (Approach "A")
- This "labour theory of value" (and/or "cost-of-production theory of value") was upheld not only by Karl Marx but also by Adam Smith, who is commonly believed to be the "father of economics" and a champion of *laissez faire*:

Smith actually took the sound, and almost fully developed, proto-Austrian subjective value tradition, and tragically shunted economics on to a false path, a dead end from which the Austrians had to rescue economics a century later (Rothbard, 2006 [1995], p. xi)



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- Some economic implications of the subjective theory of value:
 - No equal value in exchange (exchange is not a zero-sum game)
 - Economic value can be created only by free exchange
 - > class conflict between those whose resources derive from free exchange and those whose resources derive from coercive appropriation (Oppenheimer F., 1908; Nordau M., 2006; Merlo C. ed., 2019)
 - Subjective value applies to everything, **including time pref.**
 - Marginal utility (value of each unit of a good) decreases when supply increases: no "paradox of value"
 - Market price is different from value (always \leq , never $>$)
 - However, the two are linked: e.g. if value increases, then also price does



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- Any coercive/arbitrary interference with prices is harmful: prices reveal value and value guides individual economic action across space and time
- If you tamper with prices (e.g. monetary policies of “price stability”; minimum wage; price fixing; etc.) or if the government owns the factors of production, then economic action (e.g. investments) is prevented from being guided by value and from adapting to changing conditions. In other words, economic value is prevented from being produced
- Impossibility of economic calculation under socialism



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The fundamental problem of socialism is the problem of economic calculation. ... [Where] there is no market, there are no [meaningful ed.] prices for the factors of production [e.g there are artificial or distorted ones, ed.]. [Without these prices,] The management of a socialist community would be in a position like that of a ship captain who had to cross the ocean with the stars shrouded by a fog and without the aid of a compass or other equipment of nautical orientation. ... It is impossible to make economic calculations within a socialist system. The choice for mankind is not between two economic systems. It is between capitalism and chaos (Mises, 1985 [1944], p. 57-8)



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Things that should start an alarm bell in your brain:

- "This or that is in the public interest", ...
- "1\$ for a rich guy is less important than 1\$ for a poor guy"
- Coercive redistribution of resources
- "Meritocracy"
- "John should be paid a lot because he has worked a lot"
- Price fixing
- Government intervention



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- In short, an order is a pattern

An order is “a state of affairs in which ... we may learn from our acquaintance with some spatial or temporal part of the whole to form correct expectations concerning [some fundamental characteristics of, ed.] the rest, or at least expectations which have a good chance of proving correct” (Hayek, 1973, p. 36)

(Very difficult) question: how many kinds of **social** order are possible?



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- There are **two** kinds of social order:

Positive order



- result of **both** human action **and** human design
- e.g.: business or organization; planned economy
- unitary hierarchy of ends
- prevalent use of centralized knowledge (also in relation to value)

Spontaneous order



- result of human action **but not** of human design
- e.g. the content of the internet; free market economy
- no unitary hierarchy of ends
- use of dispersed knowledge (also in relation to value)



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Positive order



Spontaneous order



- Positive order and spontaneous order are not incompatible



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Positive order



Spontaneous order



- Positive order and spontaneous order are not incompatible, on the contrary



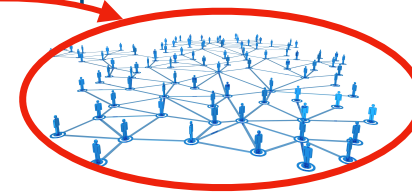
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Positive order



Spontaneous order



- Problems (of liberty and economic) arise when ***the economic system itself*** (i.e. **as a whole**) is treated as a positive order (e.g. planned economies; government interventionism)
- These problems arise because successful economic planning requires the use of **knowledge** which is **dispersed** among individuals and **cannot** be available to any central authority



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The curious task of economics is to demonstrate to men how little they really know of what they imagine they can design (Hayek, 1991 [1988], p. 76)

Good order results spontaneously when things are let alone ... There has been such a thing as letting mankind alone; there has never been such a thing as governing mankind [with success] (Chuang Tzu, 369-c.286 BC)



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Things that should start an alarm bell in your brain:

- Government
- Taxation, regulation, government intervention
- Central Banking - Government Fiat Money (CB-GFM)



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- assume that you could **choose** to be paid with money whose purchasing power you know for sure that it will **decrease** over time **or** with money whose purchasing power you know will **increase** in time: **which** money would you prefer to be paid with?



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- assume that you could **choose** to be paid with money whose purchasing power you know for sure that it will **decrease** over time or with money whose purchasing power you know will **increase** in time: **which** money would you prefer to be paid with?
- why aren't you allowed to choose which money you want to use? That is, why is the free exchange in the sector of money forbidden?
- **Why** is it that no one, except the government, **today** is allowed to issue money?
- What are the consequences of this absence of free market in the money sector?



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- In these lectures we'll try to answer these questions. To do it, we must first answer the ambivalent one: what is money?
- To answer this question, we may start noticing that there is a difference between what we see today:
 - money as a piece of paper issued by a privileged authority and not representative of anything else but this authority's arbitrary and coercive decision
- And what science and the history of money say:
 - money is the medium of exchange/reserve of value selected by the free market as **the most marketable commodity** (i.e. a **spontaneous order**)



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- Barter had a big problem which enormously limited exchange (and therefore the creation of value): double coincidence of wants
- Spontaneously, some goods many people wanted in the free market started being selected as mediums of exchange
- Such spontaneous selection process was made on the grounds of an evolving set of criteria:
 - scarcity
 - durability
 - portability
 - divisibility
- The commodity finally selected by this spontaneous process was gold



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- These criteria had already been identified by Jean Buridan de Bethune (1300-1358)
- Buridan is starting point of modern (scientific) theory of money (which will be completed by Ludwig von Mises in 1912). He was the first to understand that:
 - **money is a market commodity**: price of money is formed following the same principles of utility that determine the price of any other good
 - regression theorem: money must be made of a material which, **before becoming money**, had market value on its own
 - Gresham Law: **if** the purchasing power of two currencies is legally fixed in relative value by the government, then the money overvalued by the government will drive the undervalued one out of circulation



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- fundamental law of scientific monetary theory: *any **fixed** quantity of money is **optimal** for an economic system, provided it is sufficiently divisible and freely exchangeable* (Rothbard, Mises)
- It's not the quantity of money that matters, but its purchasing power
- Why?
- Because quantity of money does **not** reflect subjective value (distributed knowledge), while the purchasing power of money **does** reflect it



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- In other words, if you arbitrarily change the quantity of money, you prevent the spontaneous order of the market process to be guided by value
 - this happens because you replace the dispersed knowledge whose use is necessary for a spontaneous order to function (e.g. the knowledge about individual time preferences), with the arbitrary decision of some authority: that is, because you **waste vital knowledge**
- On the contrary, if you let quantity of money fixed and let its purchasing power vary, you let the market process be guided by value
 - this happens because you **don't** prevent the dispersed knowledge from being used



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Things that should start an alarm bell in your brain:

- Government's *fiat* money
- Central banks
- Central banks' explicit objective of price inflation
- The fact that you can't choose which money to use
- Public debt



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- Interest rate has been not understood for a long time (and many people today still don't understand it)
- This has caused a lot of pain and economic damage (today much more than in the past)
- Together with that of the concept of the structure of production, its understanding is vital in order to understand the economic cycle



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- Aristotle believed that interest rate was the compensation for something (money) which, even though very useful in and of itself as medium of exchange, is “unproductive” (the concept of *capital* will have to wait for Olivi, 13th century). Since he wrongly assumed that the interest rate implied a direct productivity of money, he claimed that it was “**unnatural**” and as such it should be prohibited
- Gospels (Matthew 25:14-30) seems to justify interest on **commercial** loan. However, in year 325 Nicea council prohibits **clergy** from charging interest on a loan
- Prohibition of all usury enters secular legislation for the first time with Charlemagne in 789. Charlemagne prohibited usury to everyone in his realm, **lay and cleric alike**



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- Even though lending at interest is more and more prohibited, the basis of prohibition changes over time
- During early Christian era, the basis is **avarice** or **lack of charity**
- In XI, as trade began to revive, the basis became '**theft**' (St. Anselm).
- In XII canon lawyer Gratian also considers usury as theft and extends its prohibition to **loan of goods** as well as money
- Pope Alexander III (XII century), though in favour of free market in other areas, deepened and extended the ban on interest rate
- Still in XII, Urban III declared charging interest a **mortal sin**
- Great economic thinkers of the time who had understood the subjective nature of economic value such as Olivi and San Bernardino da Siena) were fiercely against lending money at interest (which is logically implied by the subjectivity of value)



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- The process of thought that brought lending money at interest (“usury”) from being a crime and a mortal sin to being a business like any other lasted approximately 700 years (from the end of 12th century until the second half of 19th century)
- Fundamental reading to learn this process: Rothbard M.N., 2006 [1995], *Economic Thought Before Adam Smith* (Ludwig von Mises Institute, Auburn)
- The main champions of this development were: the canon lawyer Huguccio from Pisa (c.1140s-1210); Cardinal Enrico da Susa (Hostiensis; 1210-1271); Gabriel Biel (1430-95); **Conrad Summenhart** (1465- 1511); **Cardinal Cajetan** (1468-1534); Canon lawyer Azpilcueta Navarrus (1493-1586); The Franciscan Juan de Medina (1490-1546); John Calvin (1509-1564); **Leonard Lessius** (1554-1623); **Salmasius** (1588-1653)



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- The main arguments that were used as stepping stones for this process were: **lucrum cessans**, i.e. opportunity cost (Enrico da Susa, Summenhart, Cajetan, Azpilcueta Navarrus, Lessius, Calvin, Salmasius); compensation for **risk** (Enrico da Susa, Medina, Lessius, Calvin, Salmasius); penalty for **delayed payment** (Enrico da Susa); **census** - i.e. annuity (Biel, Summenhart, Lessius, Salmasius); **foreign exchange** & volatility of money's purchasing power (Biel, Cajetan, Lessius, Salmasius); **freedom of use** (Summenhart)
- These arguments were not used in general but in relation to particular **categories of loans**, e.g.: Summenhart's *lucrum cessans* argument only for charity loans; Cajetan's *lucrum cessans* argument also for business loans; Azpilcueta Navarrus's *lucrum cessans* argument for any loan (though he was more conservative in other aspects of interest)



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- This process of thought brought the charging of interest on a loan from being a crime to being a business like any other
- This explained some **accessory** elements of interest (credit risk and loss of money's purchasing power)
- However, **the question "what is the interest rate?"** was still unanswered and remained so until the second half of 18th century with Turgot (1727 - 1781); and was completely elaborated only in the middle of the 19th century with Böhm-Bawerk (1851-1914)



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- To understand what interest is, it is crucial to understand the concept of **time preference**
- Time preference (TP) is the preference between present (consumption) and future (saving)
- The higher the TP (i.e. the higher is consumption in relation to saving), the less “loanable funds” (i.e. financial resources available for investments: savings), the higher their price (interest rate)
- And vice-versa



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- **No value judgement** on time preferences: TP is purely individual; only the individual can know what, **at any moment and place**, is **his** TP (market interest rate is a spontaneous order)
- **Risk** and **loss** of purchasing power of money (PPM) are important but **accessory** elements of the market interest rate because (at least theoretically) one can conceive of a situation without risk and loss of PPM. However, a situation without TP is inconceivable
- Interest rate is primarily the **price of time preferences**



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Things that should start an alarm bell in your brain:

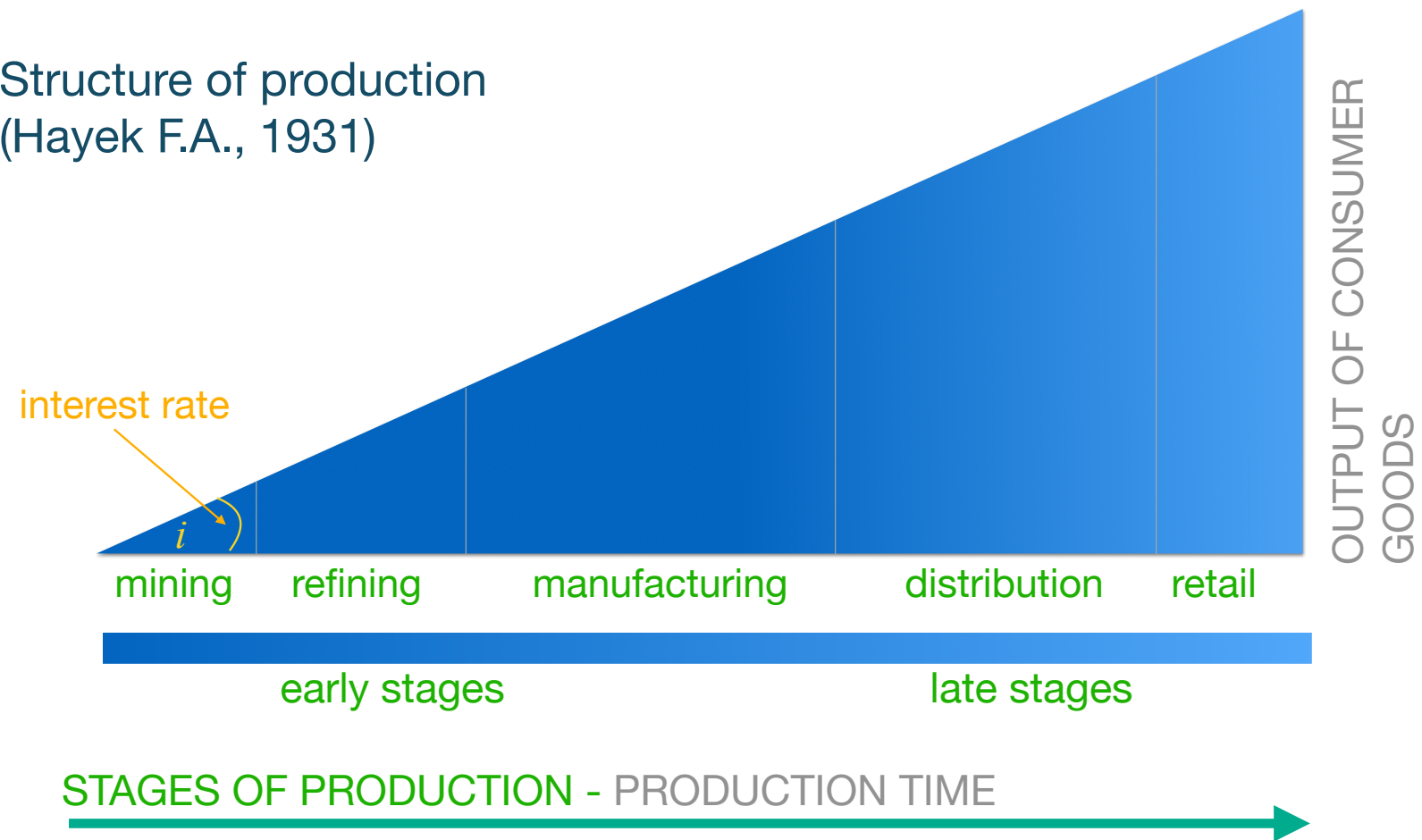
- Interest rates arbitrarily fixed by central banks
- Negative interest rates



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Structure of production (Hayek F.A., 1931)





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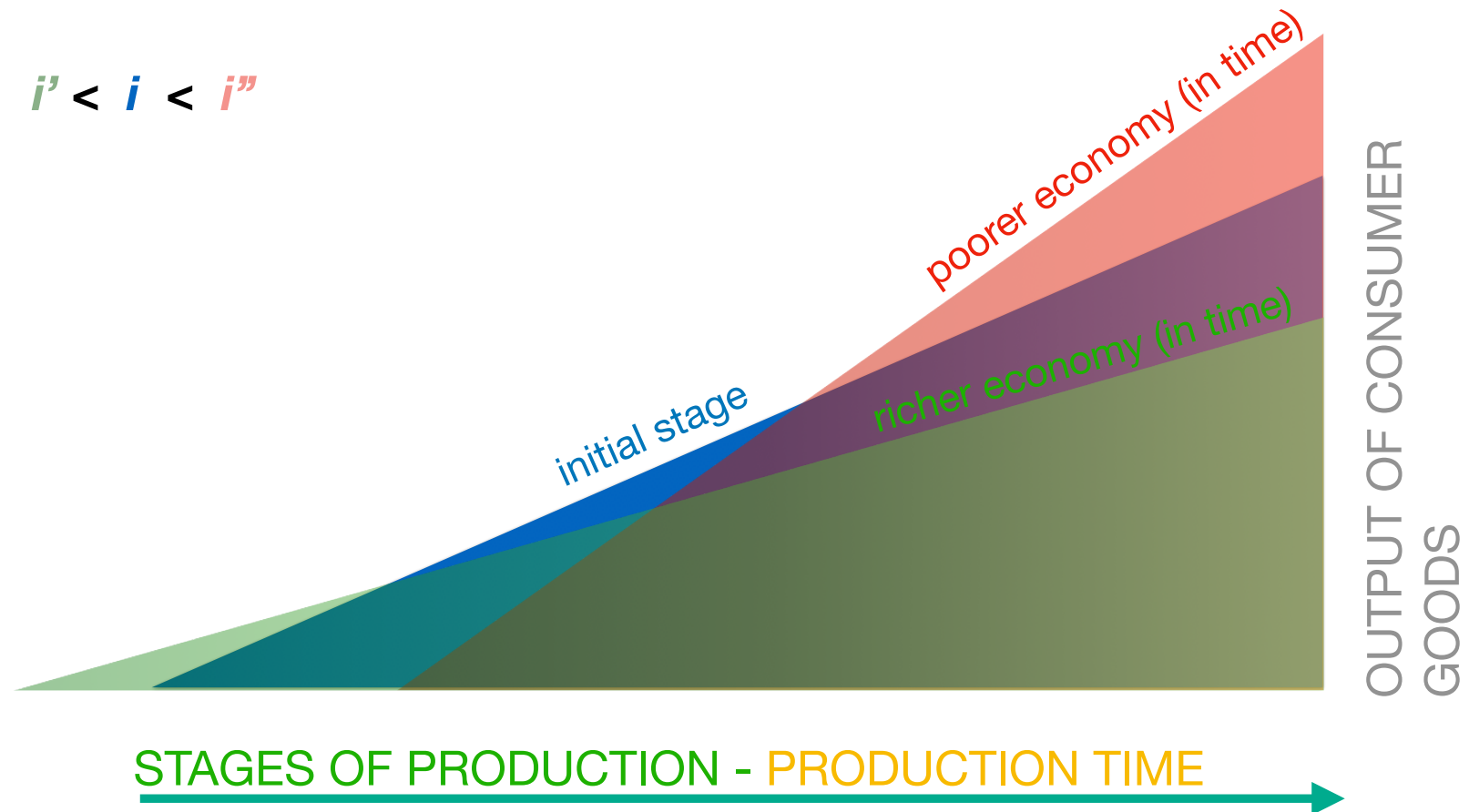
- in time, lower time preferences $>$ higher savings = less consumption $>$ lower interest rates will allow
 - longer term, sustainable investments
 - longer and more complex productive structure
 - more sophisticated, capital intensive products/services
 - i.e., structural growth (an economically sustainable increase of productive capacity)
- and vice-versa: higher time preferences $>$ lower savings = more consumption $>$ higher interest rates will produce
 - shorter term, sustainable investments
 - shorter and less complex productive structure
 - less sophisticated, capital intensive products/services
 - i.e., less structural growth (if there are net investments)
 - (if the investments are not enough to maintain the economic value of existing productive capacity there's capital consumption and therefore negative growth)



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Things that should start an alarm bell in your brain:

- “Consumption has to increase in order to create growth” / “Savings are bad for growth”
- Artificially low interest rates



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- I started and closed the previous lecture by saying that inflation, and more specifically the artificial expansion of money and credit by the authorities that control the current monetary structure, has a tremendous impact on your **future** and on that of your children
- Here we'll try to understand **what kind** of impact
- We have already noticed that, when you wake up in the morning and buy a coffee, you're forced (ultimately at gun point) to use **government fiat money (GFM)**, i.e.:
 - a) paper or digital money created and managed in a regime of **legal monopoly** by an "independent" organization (the central bank) privileged by the government and whose "governors" are nominated by the government
 - b) money which is **not anchored to any commodity** and therefore is **infinitely** and **arbitrarily** inflatable
- We have also mentioned that "**a**" and "**b**" are **linked**: government wants legal monopoly on money because it wants to inflate freely



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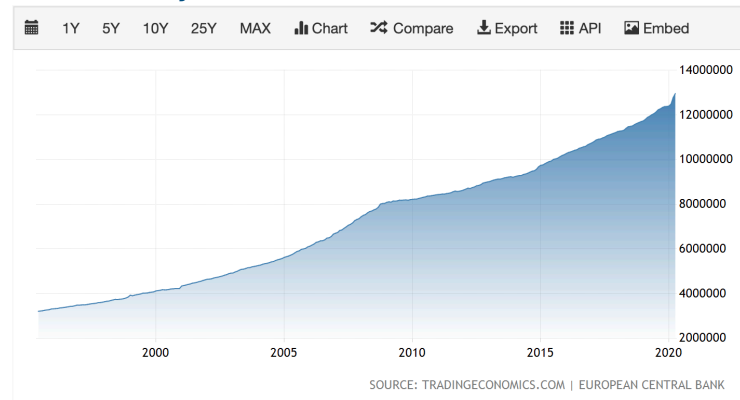
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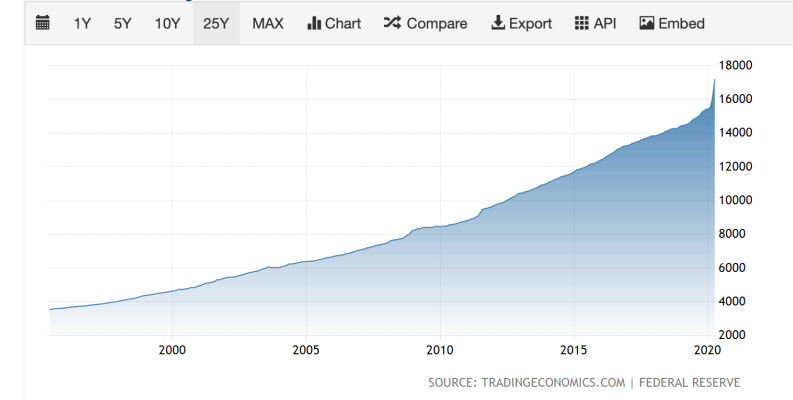
- We have also seen some graphs that gave us a (still incomplete) idea of the dimension of inflation by central banks

M2 money stock Euro (1995-2020)



Actual	Previous	Highest	Lowest	Dates	Unit	Frequency
12955954.00	12774486.00	12955954.00	1070496.00	1980 - 2020	- EUR Million	Monthly Current Prices, SA

M2 money stock US (1995-2020)



Actual	Previous	Highest	Lowest	Dates	Unit	Frequency
17176.10	16103.90	17176.10	286.60	1959 - 2020	USD Billion	Monthly Current Prices, SA

"NYTimes 09/Apr/2020 **With \$2.3T Injection, Fed's Plan Far Exceeds 2008 Rescue**" (un-deletable message on the last block of bitcoin blockchain with 12,5 BTC block reward)



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- Why this inflation?
- Short answer:
 1. parasitic interests
 2. economic ignorance
 3. "having your cake and eating it too" syndrome
- Here we'll develop the long answer



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1. PARASITIC INTERESTS

- As we have mentioned at the beginning of the first lecture, **one** effect of inflation (other conditions being equal) is the loss of PP of money (PPM)
- Actually, the official objective of central banks is a 2% loss of PPM/y
- 2% a year may not seem much to some, but it means **33%** of loss of PP in 21 years; **50%** in 36 years; **88%** in 107 years
- In the last 107 years (since the establishment of the Fed: i.e. since my grandfather was an adolescent) the USD has lost more than **98%** of PP
- In the last **18 years alone**, the euro has lost **33%** of its PP (De Luigi A., 2020)
- In addition, **public sector inflation**: absence of market prices for “public” services (no info on value); in time, they cost more but have lower quality/quantity (De Luigi, 2020)



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- **Why** do central banks want loss of PPM?
- **Who benefits** from it?
 - First of all, the **debtors**:
 - if you borrow \$1000 the 1st of January for 1 year, and during that year there is 10% loss of PPM, nominally at the end of the year you give back \$1000 (plus interest), but in real terms you give back **\$900**
 - **Loss of PPM is first of all a coercive transfer of resources** from some groups (e.g. consumers, creditors) to other groups (e.g. debtors)
 - And **who is the greatest debtor of all?** The government, who nominates the management of “independent” central banks
 - Loss of PPM is **additional** and **silent taxation**



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- Second of all (but not in order of importance) those who benefit from the loss of PPM are the **parasitic groups** (individual and businesses) close to the government
 - This has to do with **the way** in which new money enters the economic system
 - If new money was an **instantaneous gift to all in the same proportions**, then nothing would change: you would have more money but very soon prices would adjust. In this case, inflation would be just a costly, useless game
 - However, new money is **not** an instantaneous gift to all in the same proportions: it enters the economic system at **specific, privileged access points** (individuals and businesses close to the government: e.g. banks) and it takes **time** to spread to economic system and to make **prices rise**



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- The result is that loss of PPM produces a **further** transfer of resources from those who receive the new money **earlier** (who buy before prices rise) to those who receive it **later** (after prices have already risen: "forced saving")
- This **coercive** and again **silent** transfer of resources also produces great distortions in the structure of production, making it unsustainable (see later)



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2. ECONOMIC IGNORANCE

- When you expect PPM to increase (as it tends to do with free market money), you are **discouraged from consuming** (i.e. encouraged to save, that is to have **lower time preferences**): in fact, in this case, when you buy your partner a dinner out, you have **two prices**, not one:
 - the first price, is the one displayed on the menu
 - the second price, is the **opportunity cost**: if you **wait** (i.e. save = abstain from consuming), PPM will increase and you'll be able to buy your partner a dinner in a better restaurant
- Vice-versa, when you expect PPM to decrease (as it inevitably does in a regime of monetary socialism: i.e. GFM+CB) you are **encouraged to consume** (i.e. discouraged from saving, that is from having lower time preferences): in fact, in this case, **the opportunity cost is reversed**: if you wait, you'll be able to buy your partner a dinner at a **worse** restaurant, so better consume today



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- Now, popular thinking (shared/fostered by central banks and mainstream media, as well as by most universities of economics) is that if people “abstain from consuming” (i.e. if they **save** relatively more, which is what they are spontaneously encouraged to do when they expect PPM to rise) they **“prevent the economy from running”** and therefore “create economic crisis”
- From the previous lecture (sections 1, 2.a, 2.b and especially 2.e) we know that this is scientifically, objectively, logically, totally **false**:
 - there cannot be logical consistency (i.e. scientific validity) when **micro** and **macro** are in contradiction (if, for an individual who is in economic difficulty, consuming more would be a folly, so it is for the economic system as a whole)
 - sustainable investments (and therefore a rich and complex structural growth) can come **only from saving**: the more you consume (the higher is your **time preference**) the shorter and steeper will be the **structure of production**:



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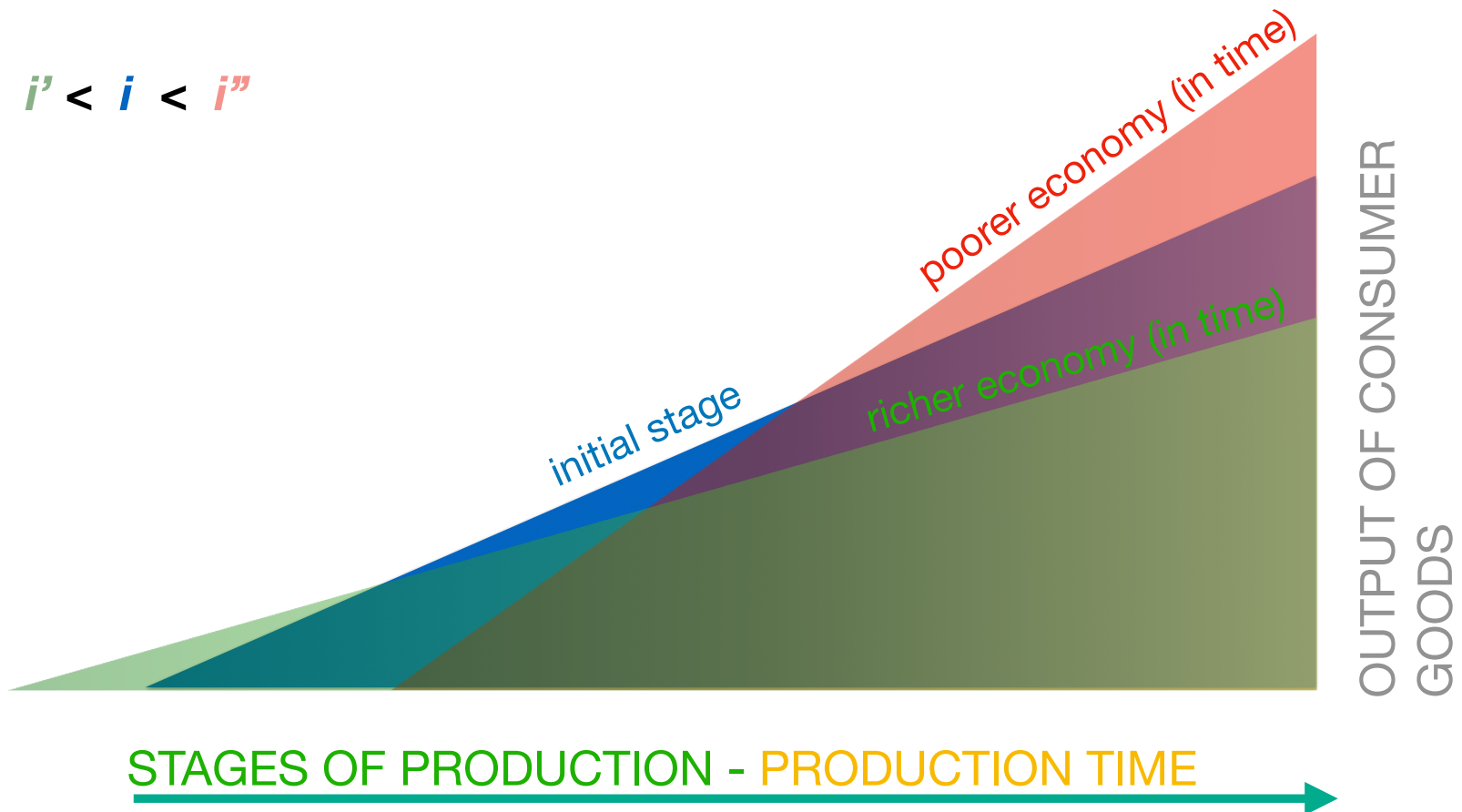
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3. HAVING YOUR CAKE AND EATING IT TOO

- This is an element of the previous part of the answer: the economic ignorance meticulously fostered by most universities of economics and by the mainstream media
- And this is where we enter the core of **economic cycles**
- This part of the answer to the question “Why inflation?” is relative to the effect of the **distortions** in the structure of productions produced by inflation
- In order to appreciate these distortions, it is useful to consider first the case of absence of arbitrary expansion of money and credit (“a. Structural growth”); then the economic cycle produced by them (“b”); finally, to give a brief account of how the artificial expansion of money and credit works: how it happens



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- Let's assume that in a **free market economy (free market money, no central banks, ecc.)** there's a lower time preference (more savings and less consumption than before)
 1. As we have seen, this implies a lower interest rate (i)
 2. A lower interest rate induces
 - a. longer term investments: i.e. higher demand of **capital goods** (goods produced in **early stages of production**); thus, higher prices of these goods
 - b. lower demand of **consumer goods** (goods produced in the **late stages** of production), and thus lower prices of these goods
 3. because of 2a & 2b, it becomes less profitable to invest in the production of consumer goods (late stages) and more profitable to invest in the production of capital goods (early stages). There is therefore a **transfer of resources (including labour) from late stages to early stages**



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4. There's **no increase in nominal wages**: less demand for work in late stages is **compensated** by higher demand for work in early stages
5. However, **real** wages have **increased** because of lower prices of consumption goods (**increase of PPM**)
6. When the dust settles, there's a **longer and more complex (richer) productive structure, more capital-intensive goods, higher real wages**: the process is **virtuous** and economically **sustainable**

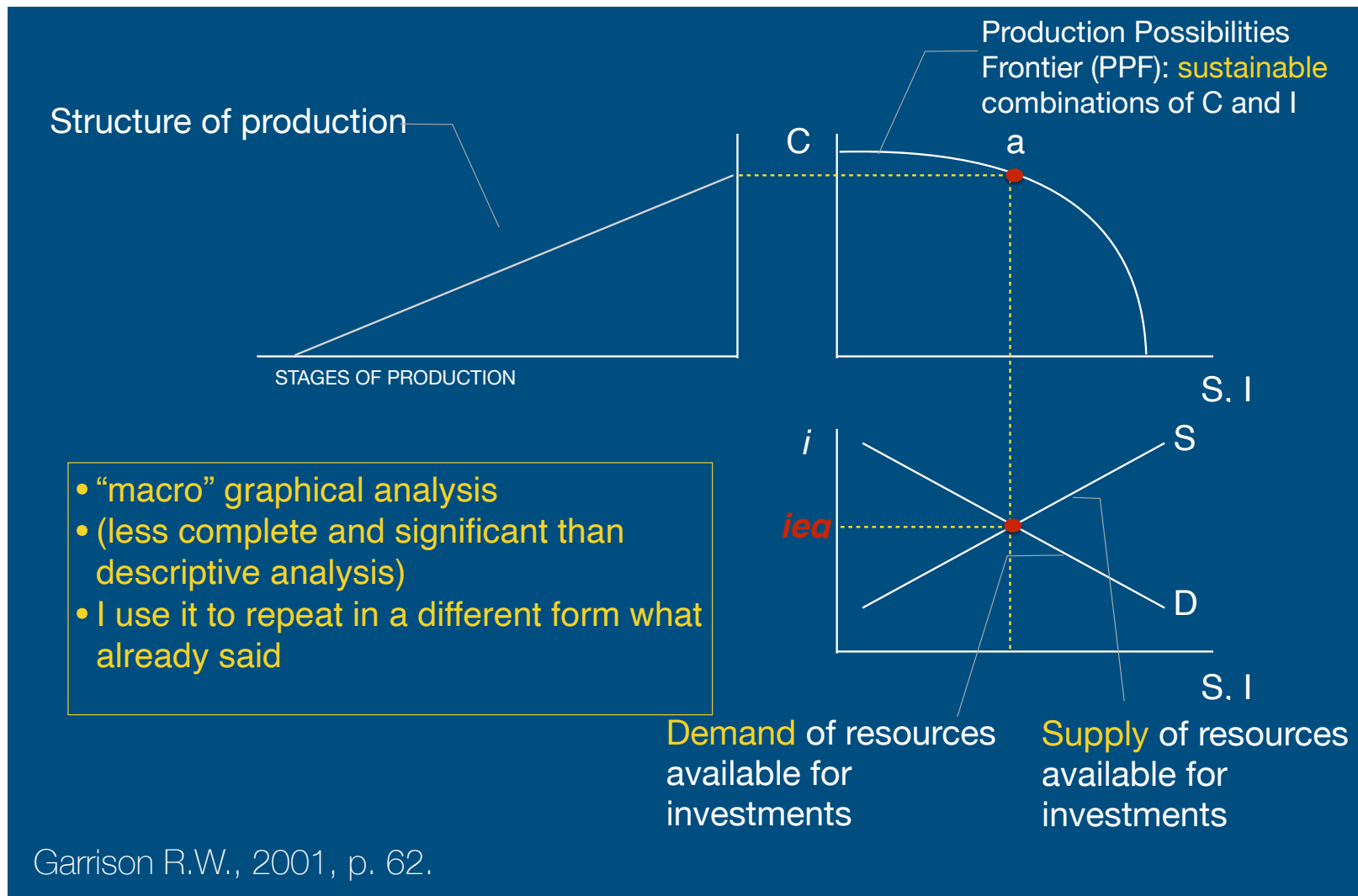


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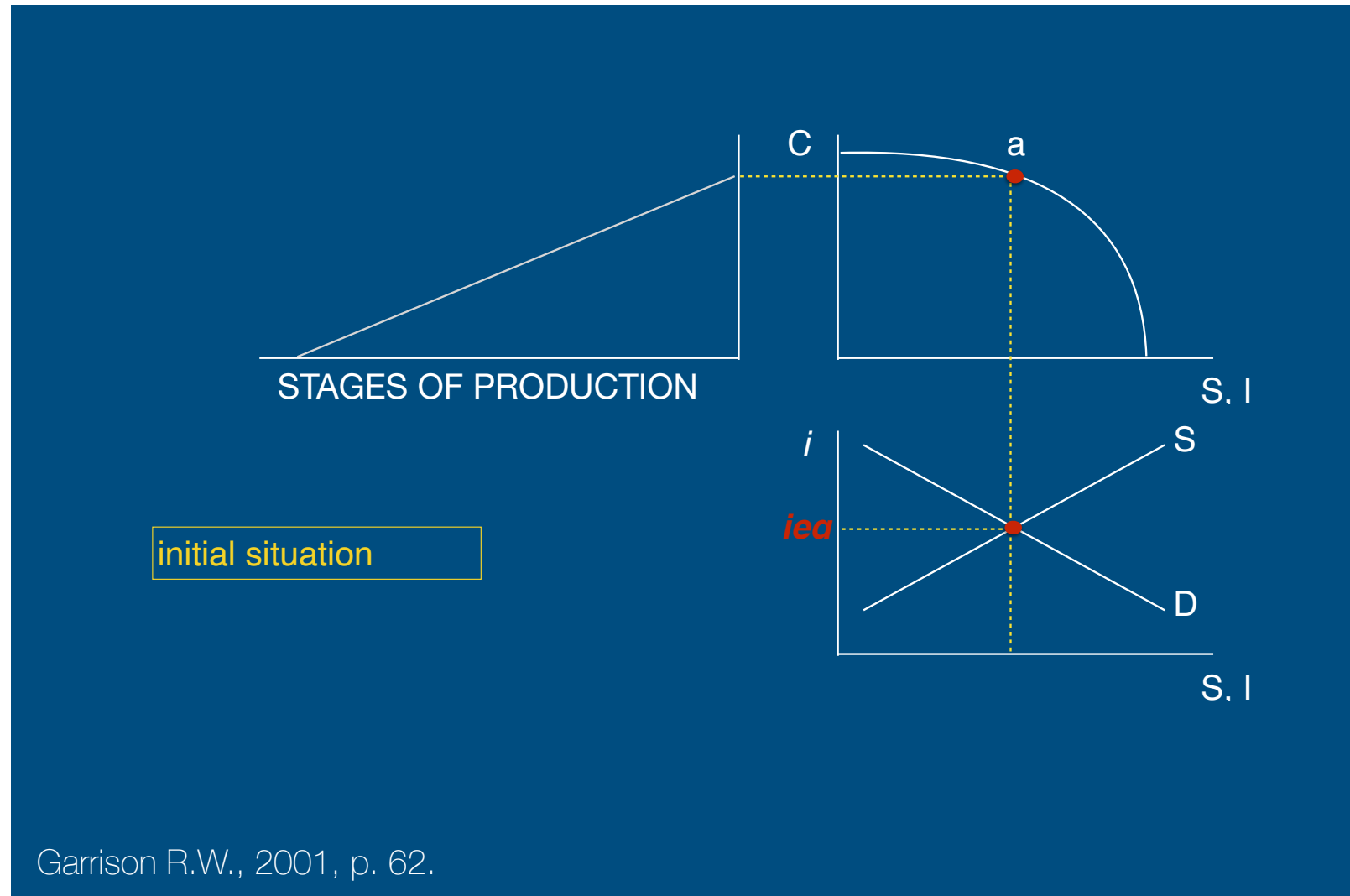


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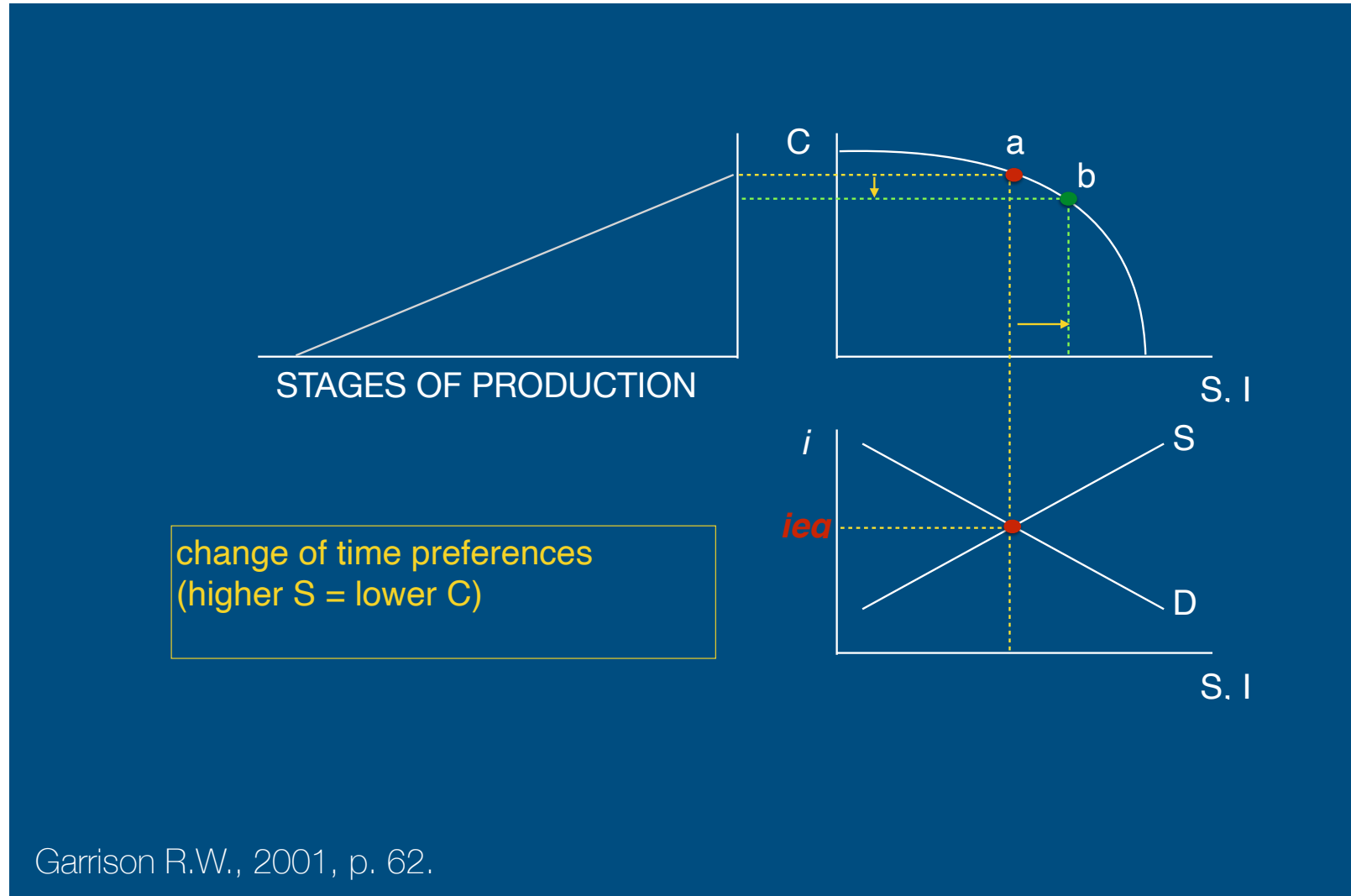
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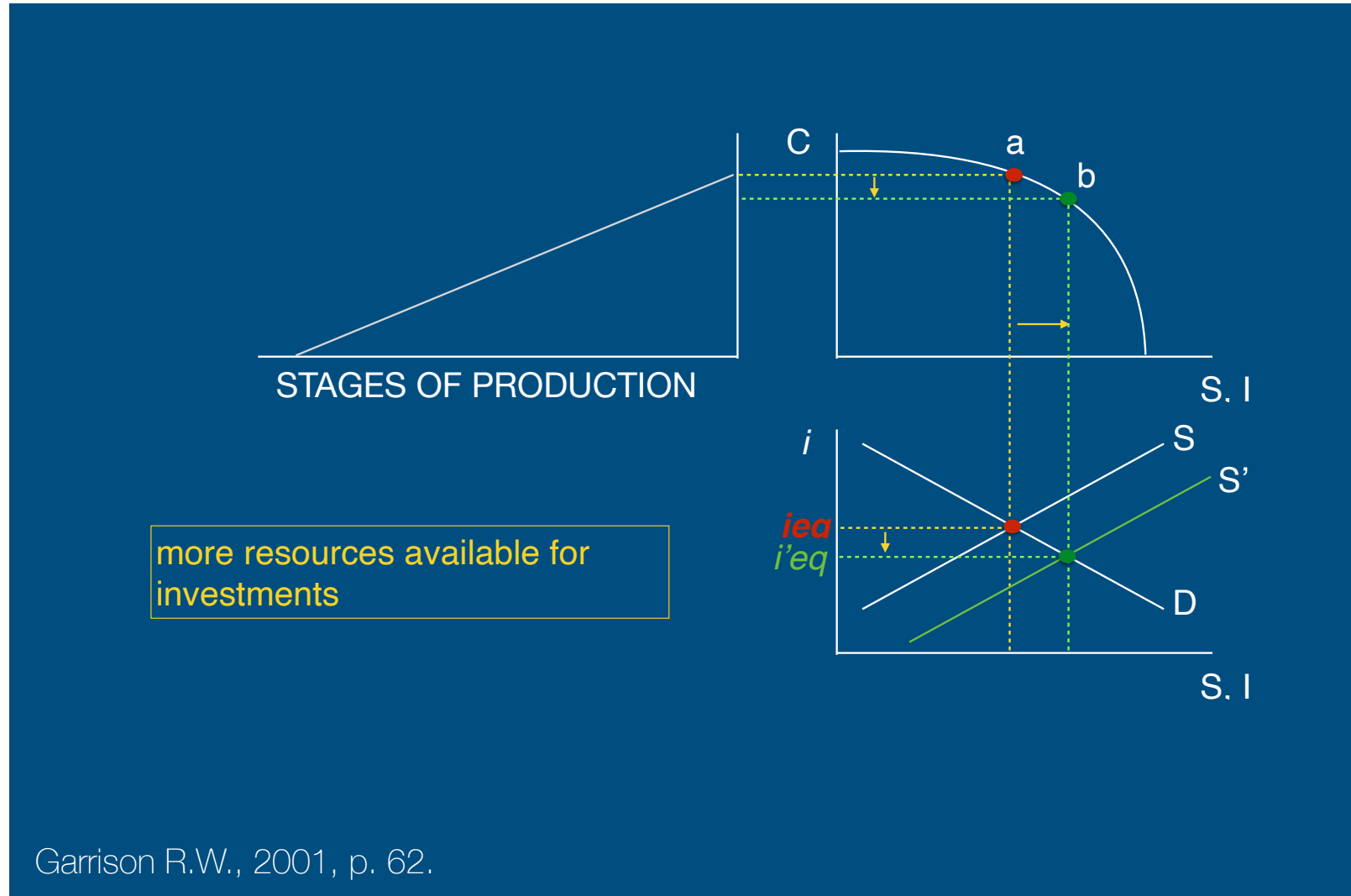
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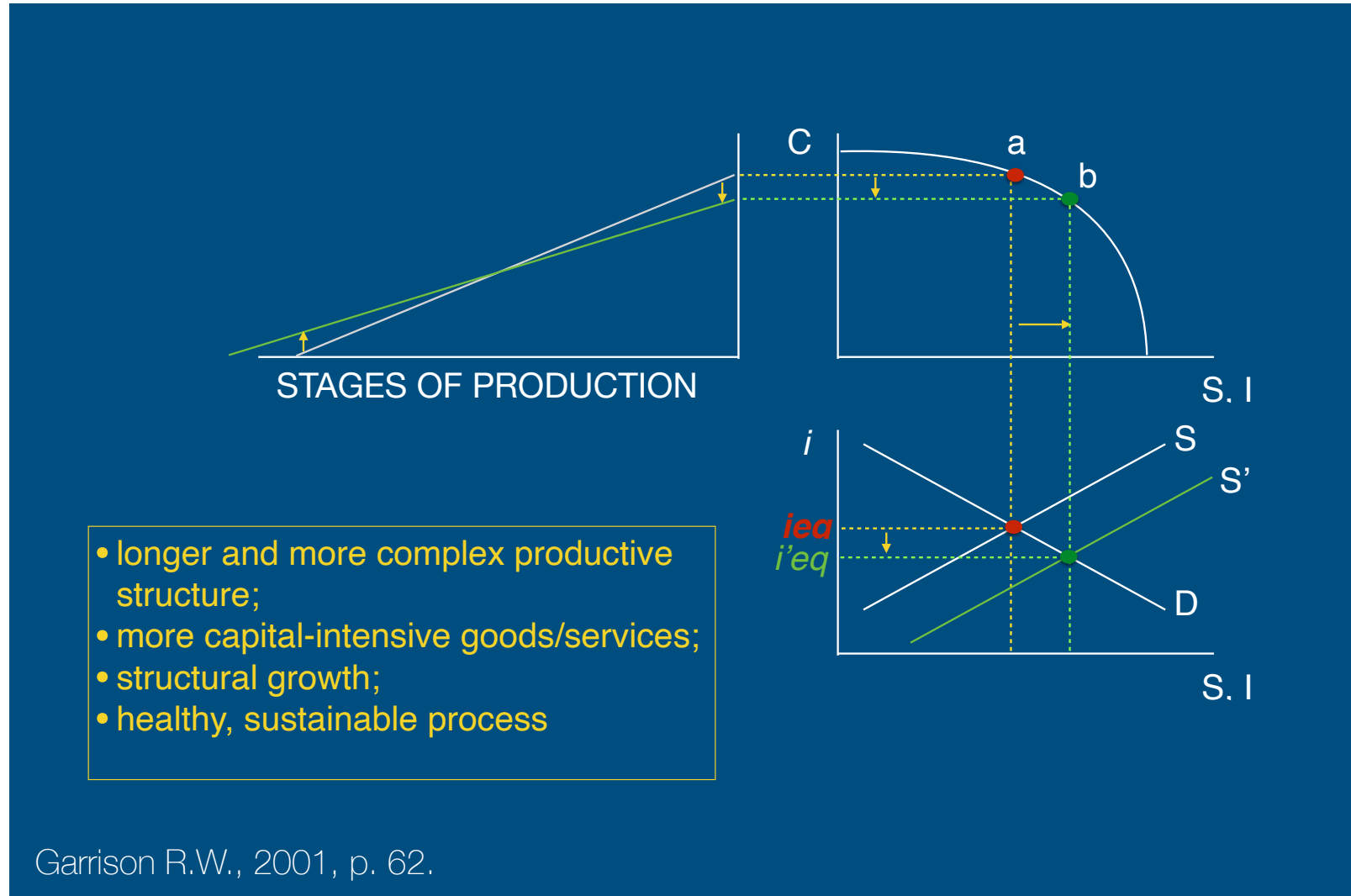
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- Now, let's assume that the benefits of a lower interest rate want to be attained **not** via lower time preferences **but** via **artificial expansion of money and credit (monetary inflation)**
 1. **As before**, artificially **lower interest rates** encourage **long term investments**: i.e. higher demand of capital goods (goods produced in early stages of production); thus, higher prices of these goods
 2. **However**, in this case (**unlike the previous one**) savings have **not** increased (i.e. **consumption has not decreased**). On the contrary, (**artificially**) lower i has **discouraged** savings and thus **further encouraged** consumption (overconsumption). Therefore there is **also, at the same time**, a higher demand for goods produced in the **late** stages of production



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3. Such higher demand of consumption goods determines higher prices for these products, and these higher prices create an incentive for more investments in late stages (closer to consumption)
4. Even though the resources available for investments have **decreased**, investment **increases**; and it does so in **both** the early **and** late stages of production
5. Unlike in the previous case, new demand for labour in early stages of production is **not compensated** by less demand for labour in late stages: nominal wages rise ("boom" phase)
6. However, since (again unlike the previous case) prices of consumption goods have increased, **real** wages have **decreased**
7. The situation is **unsustainable**: when the scarcity of resources becomes evident, there starts the crisis ("bust" phase)



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8. Paradoxically, the crisis is **not** something only bad: it's the economic system trying to get rid of the malinvestments (unsustainable investments) induced by the artificially low interest rate
9. The artificially low interest rate is attained by artificial expansion of money and credit. Therefore, **the more massive and extended the expansion, the deeper and longer the crisis**
10. Trying to "cure" the crisis with higher doses of the same drug that produced it in the first place, delays the problem by **extending** and **deepening** the crisis in the long run, and **adding** a boom & bust cycle to another





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“To combat depression by a forced credit expansion is to attempt to cure the evil by the very means which brought it about; because we are suffering from a misdirection of production we want to create further misdirection” (Hayek F.A., 2012 [1931], p. 55)

- More in general, **any** legal impediment to the free market process will limit, hamper or prevent this spontaneous self-cure of the economic system and will contribute to make the crisis longer and deeper:

“In fact, if we list logically the various ways that government could hamper market adjustment, we will find that we have precisely listed the favorite ‘anti-depression’ arsenal of government policy [...]: Prevent or delay liquidation [...]; Inflate further [...]; Keep wage rates up [...]; Keep prices up [...]; Stimulate consumption and discourage saving [...]; Subsidize unemployment” (Rothbard M.N., 2000 [1963])

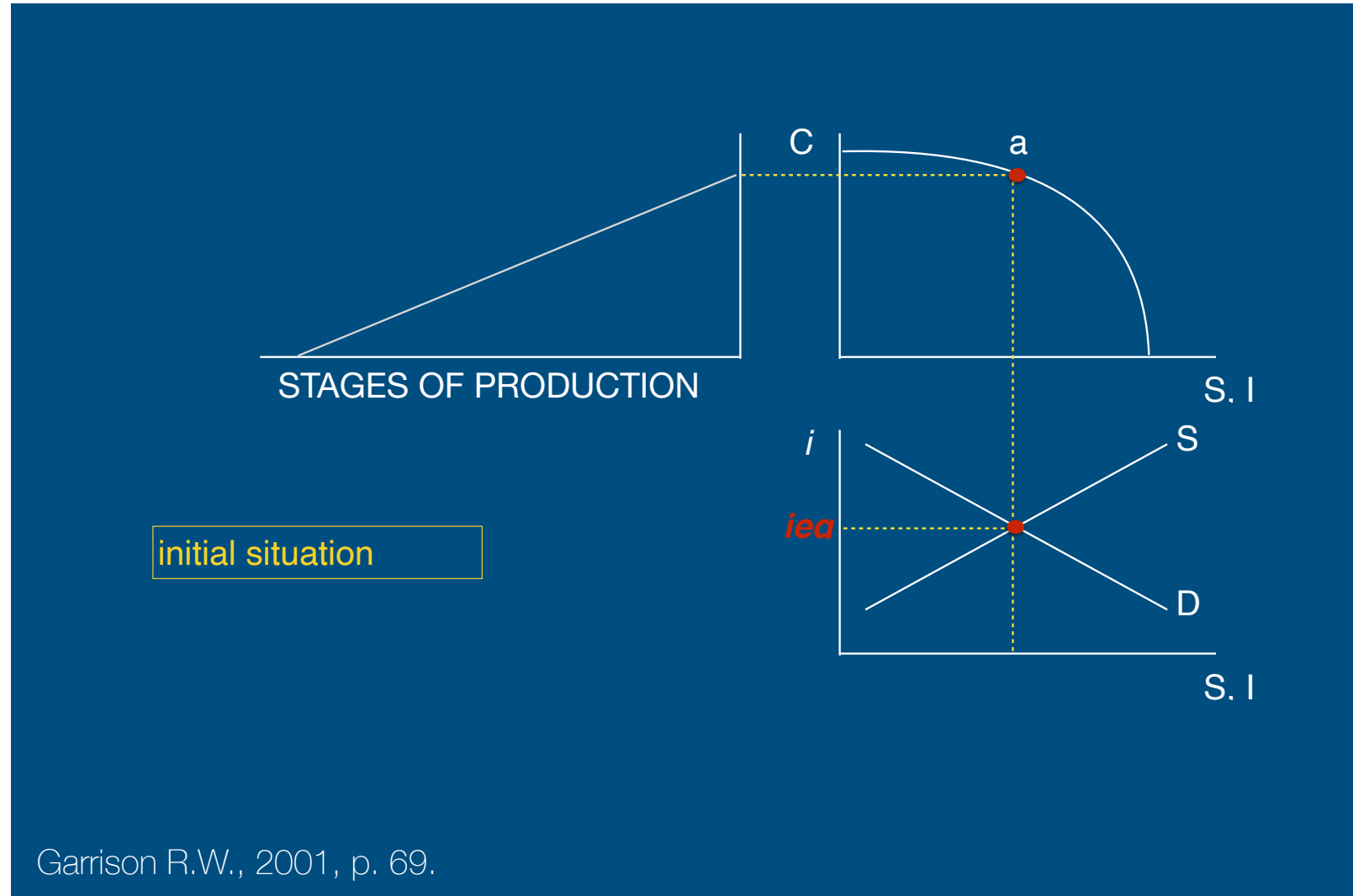


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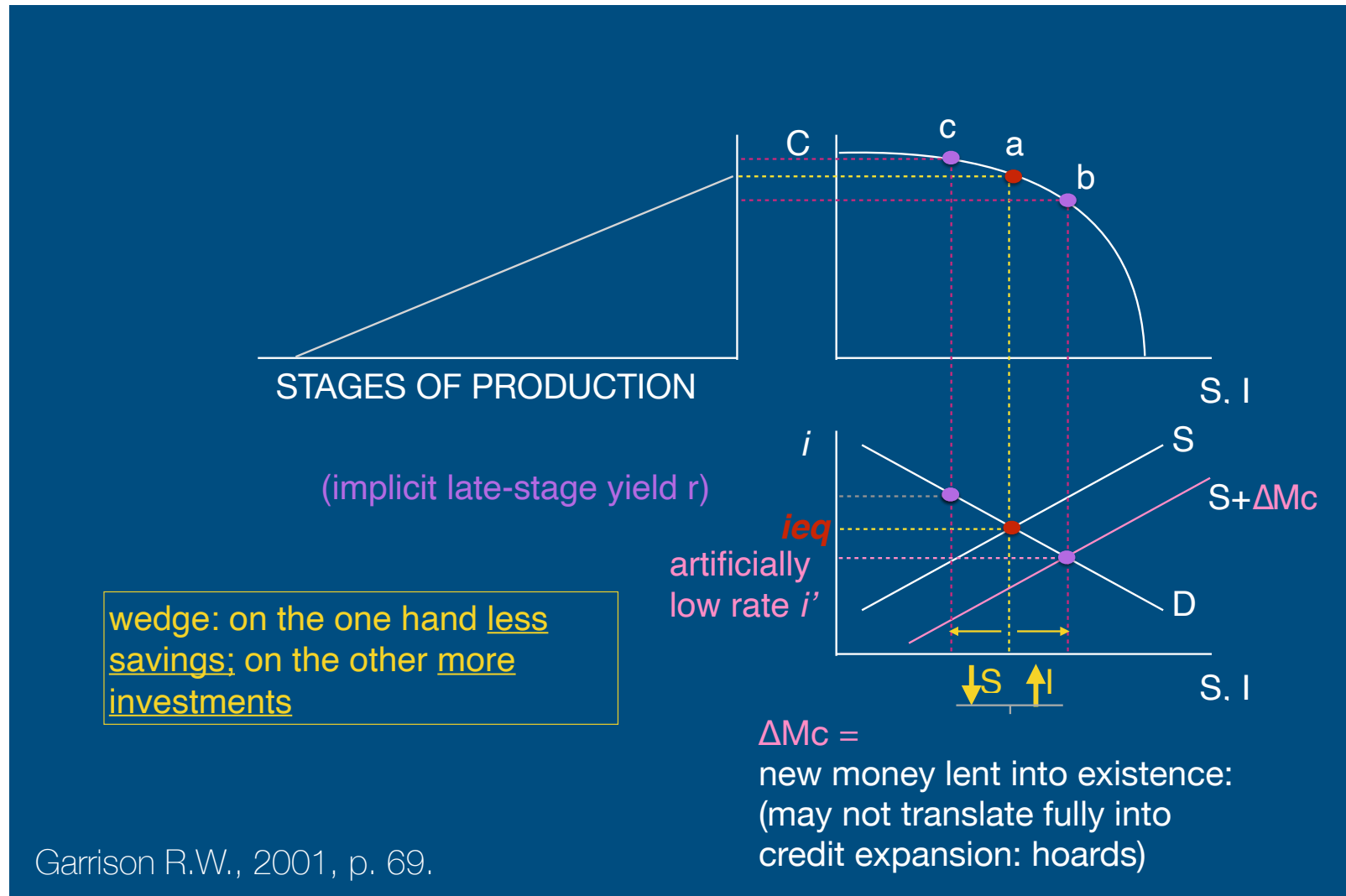
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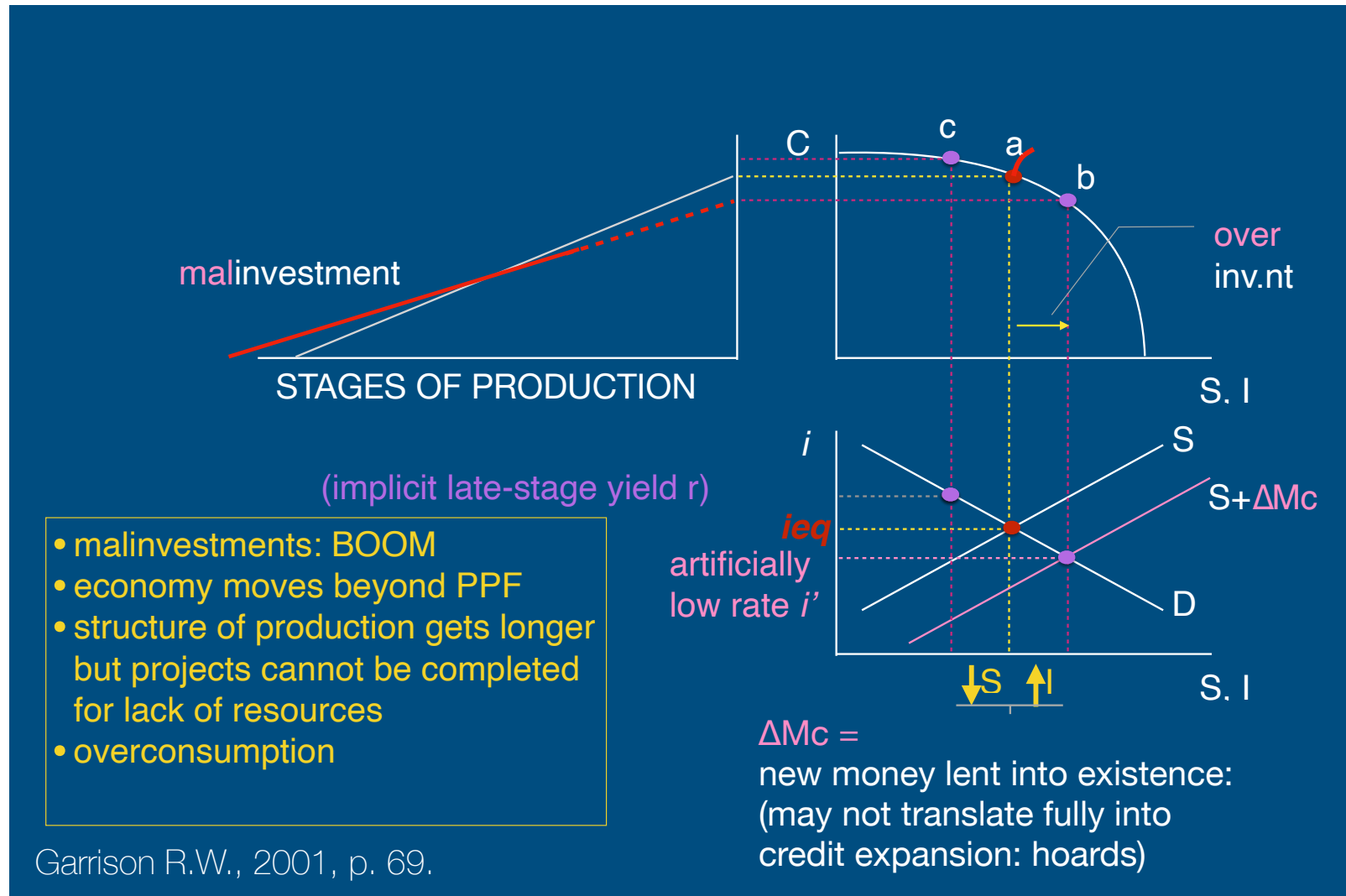
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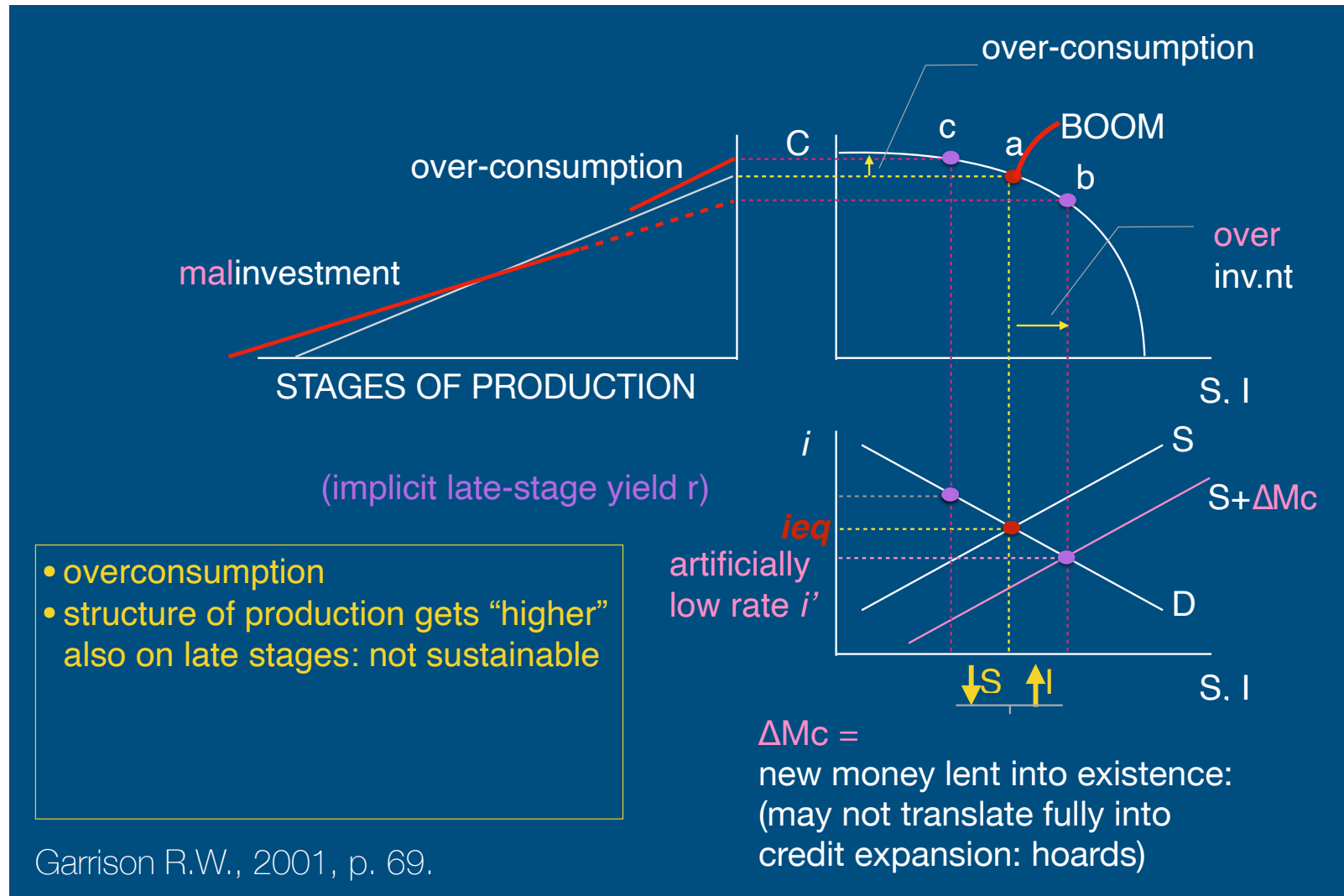
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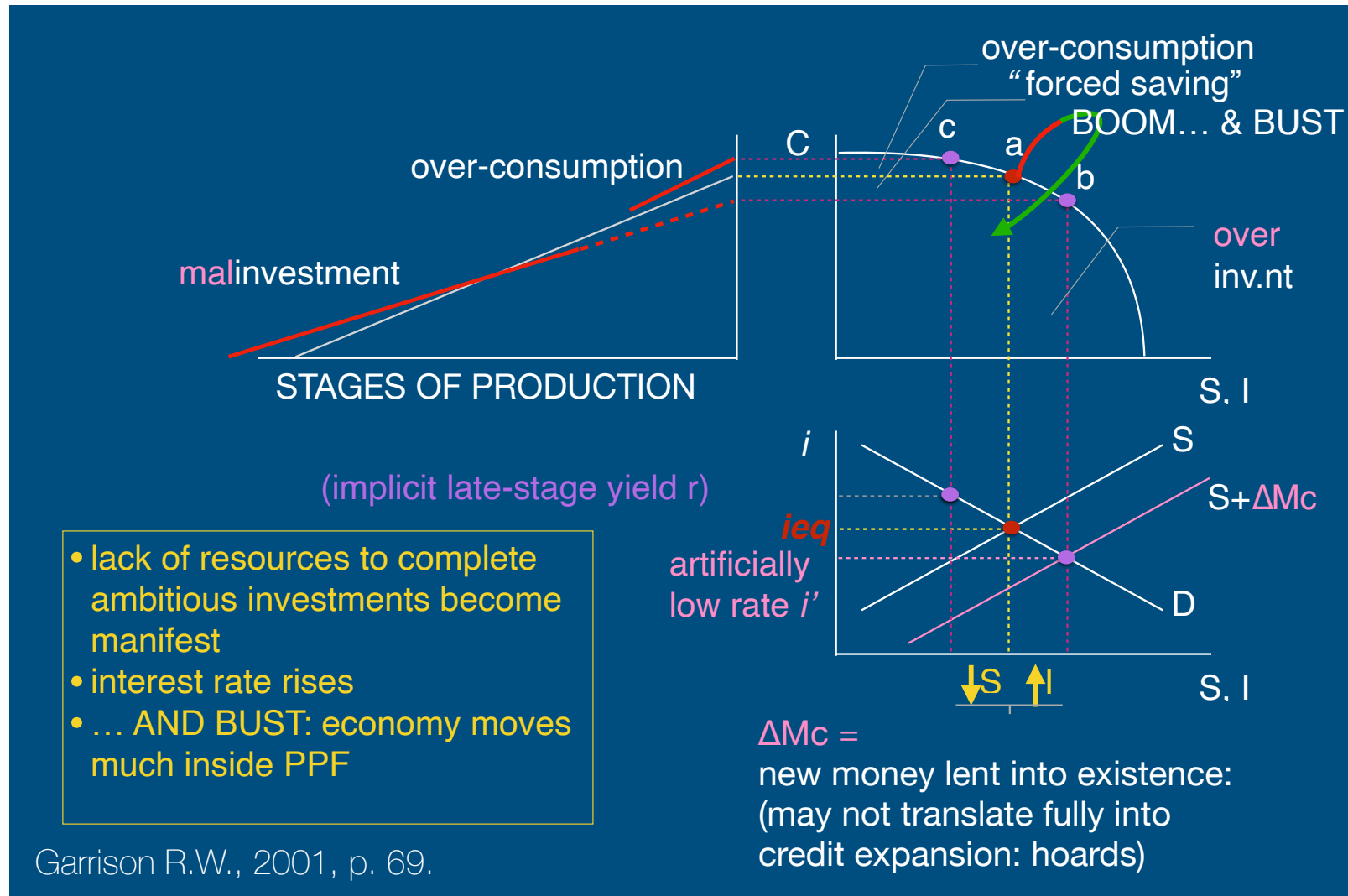
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- How does the **artificial expansion of money and credit happen?**
- In short, such an expansion happens by replacing, in the money sector, the spontaneous order of free market with the positive order of pure socialism
- Three main (interrelated) channels:
 1. COMMERCIAL BANKS:
 - a) fractional reserve banking
 2. CENTRAL BANK:
 - a) lender of last resort
 - b) loans to commercial banks
 - c) arbitrary reduction of the interest rate on "b"
 - d) open market operations (OMO), such as "QE"
 3. GOVERNMENT:
 - a) legal privileges to commercial banks & central bank
 - b) government *fiat* money
 - c) limiting/abolition of cash



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1. COMMERCIAL BANK: (a) Fractional Reserve Banking (FRB)

- **Loan** implies **loss of availability** (e.g. you lend me your watch)
- **Deposit** implies **full availability** (e.g. a watch in a bank's safety box)
- If the bank director uses the watch that you placed in the safety box to be cool at a party he commits a crime (misappropriation)
- A "**distinguishable deposit**" is one where what remains available to you is a particular item (e.g. a watch)
- An "**indistinguishable deposit**" is one where what remains available to you is the same quality and quantity of what you deposited or *tantundem* (e.g. rice in a silo, or **money in a current account**)
- Of course, the **logical** difference between loan and deposit **does not change** when we consider indistinguishable deposits rather than distinguishable ones



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- Modern banking systems are based on a **voluntary confusion** between loan and deposit: this voluntary confusion is called “Fractional Reserve Banking” (FRB)
- Under FRB, when you **deposit (!)** 1.000 dollars in a bank, the bank keeps a **fraction** of this money (currently 1%) as **reserve** and **lends (!)** the rest
- As a matter of fact, under FRB the same money is **at the same** time available **both** to you **and** to the bank, which of course is logically **impossible** (your car can't be available to you if you lent it to me)



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- Main consequences of FRB:
 - Banks are all implicitly bankrupt: in case of **bank run**, bankruptcy
 - Artificial expansion of money and credit:
 - "A" deposits 1.000\$ in Bank X
 - Bank X keeps 10\$ as reserve (1%) and lends 990\$ to "B"
 - "B" deposits 990\$ in Bank Y
 - Bank Y keeps 9,9\$ as reserve (1%) and lends 980,1\$ to "C"
 - ...
 - At the end of the process, with 1% reserve, from a deposit of 1.000\$ the commercial banking system as a whole creates 99.000\$ **out of thin air** (artificial expansion of money and credit)
- Legally, RB is made possible by a little "law", present in every country, very few people are aware of: this "law" states that when you deposit your money in a bank, **you officially transfer the legal property of that money to the bank**



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2.a. CENTRAL BANK: Fractional Reserve Banking (FRB)

- By making the bad banks (as well as their clients) bear the full consequences of their choices, the free market would spontaneously select the banks that do not recur to FRB and therefore prevent (or at least significantly limit) artificial expansion of money and credit via FRB
- The central bank, however, is there not only to make sure that such expansion happens, but to multiply it
- With a central bank acting as lender of last resort (lender of legal-tender *fiat* money whose exclusive use is coercively imposed on individuals by the government and which the central bank can create out of thin air) the negative incentive to practice FRB is transformed into a positive one
- In addition, the progressive limitation/abolition of cash by the government eliminates the very possibility of bank runs (last bit of monetary freedom)



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2.b. CENTRAL BANK: Loans to commercial banks

- The loans that the central bank (the bank of banks) concedes to banks has not only the effect to **protect FRB from the free market process**, but also that of **multiplying its effects**
- In fact, central bank's loans to banks increase bank reserves (which allow for further FRB expansion)
- In theory, such increase is **temporary** (it ends when commercial banks pay back the loans). However, since central banks **constantly** lend money to banks, such increase in reserves is **permanent**
- We have seen that, in case of commercial banks' FRB, 1.000\$ deposit at 1% reserve ratio produces up to 99.000\$ of expansion. If, for the bank's "bank account" at the central bank, we assume a 10% reserve ratio, **starting from the same 1.000 \$ initial deposit**, the expansion is up to **990.000\$**: "FRB2 expansion" (Vedi Phillips C.A. et al., 2007 [1937], pp. 24-8)



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2.c. CENTRAL BANK: Arbitrary reduction of the interest rate of loans to commercial banks

- A lower interest rate practiced by the central bank to commercial banks will incentivize the latter to ask for loans
- The higher the central bank's loans to the banks, the higher the FRB2 expansion
- If the interest rate the central bank asks the banks (i') was higher than the interest rate banks ask their clients (i), FRB2 expansion would be possible but discouraged. However, $i' < i$ (constant incentive to FRB2 expansion)



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2.d. CENTRAL BANK: Open market operations (OMO)

- This is the most powerful weapon central banks have to expand credit and by far the most used one (especially in latest decades)
- OMO = central bank's purchase of assets (usually public debt) from other subjects (usually commercial banks)
- Instead of giving money to banks in the form of loans (2.c) the central bank gives money to banks by purchasing from them government bonds: the expansionary effect (FRB2) is exactly the same
- With one fundamental difference: while loans from central bank to commercial banks are limited by central bank's reserve ratio, OMOs are **unlimited**
- In other words, there's is no limit to how much (physical or digital) paper the central bank can print to artificially expand money and credit



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3. GOVERNMENT

- The functions of government in artificial expansion of money and credit have already been addressed but will be recapitulated here:
 - a) legal privileges to commercial banks & central bank (those that allow the former to do FRB and the latter its monopoly)
 - b) government *fiat* money (abolition of free market - and therefore of freedom of choice - in the money sector)
 - c) limiting/abolition of cash:
 - abolition of the last remaining limit to artificial expansion of money and credit: possibilities of bank runs
 - coercive increase of banks' reserves (non-coercive increase happens with credit cards)



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4. Other aspects of inflation



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- Each one of the following subjects would demand at least a book to be properly addressed
- The purpose of this section is **not** to give a satisfactory account of the subjects treated here (Freedom, War, etc.) and of their relation with inflation but only to provide **a very superficial and incomplete hint**
- Further readings are in the bibliography for who's interested



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FREEDOM

- Not only does artificial expansion of money and credit greatly and directly reduce freedom, but it is itself possible thanks to the structural violation of freedom which characterizes the modern state
- Of course, labels (such as "freedom", "justice", ecc.) are dangerous as they are often used to refer to very different and indeed opposite concepts, if any (they're often used also casually, without reference to any particular idea)
- In order to avoid this danger, one should first define these concepts
- There are many definitions of freedom (and opinions about *how important freedom is*, however one may define it): anyone can have his own



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- However, provided that we label
 - **“coercive rules of conduct”** (or **“laws”**) those rules whose violation justifies, from one’s point of view (whatever it may be), the use to coercion, and
 - **“aggression”** the coercion against a peaceful individual (more precisely, the initial violation of his private property by means of physical violence, threat thereof, fraud, violation of business agreements, lack of refund in case of culpable damage, and others)
 - **If** we agree with the **principle of equality before the law*** (according to which the same coercive rules of conduct should apply to anyone, without exception), **then** there can be **only one** rule of coercive conduct which is compatible with the principle of equality before the law
 - That rule, we call **“non-aggression principle” (NAP)**, or **“Law”**
 - And we call **“liberty”** or **“freedom”** the rule of Law
- (*) Principle of equality before the law is opposite to **legal inequality** (i.e. treating equally individuals which are grouped in the same category but differently those which are grouped in different categories)



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(* Principle of equality before the law is opposite to **legal inequality**

- legal inequality: treating equally subjects which are grouped in the same category but differently those which are grouped in different categories, e.g.:
 - taxation
 - progressive taxation
 - government fiat money
 - banking privileges
 - central banking privileges
 - racial "laws"
 - government regulation
 - etc. etc.



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- Some implications of freedom thus defined:
 1. freedom is a **scientific** concept:
 - no arbitrary concept was used in this definition, only logical ones
 - the NAP, on which freedom is based, is a scientific rule because it is compatible with the principle of equality before the law (as any scientific rule must be)
 2. logically, there's **no possible "third way"** between freedom and its violation. (though the latter may have different degrees):
 - short explanation: there's no "third way" between stealing something and not stealing it (but you can steal more or less of it)
 - logical explanation: any "third way" logically implies that one selects in which cases the principle of equality before the law is respected and in which cases it isn't. But the very authority to establish this implies the potential arbitrary violation of this principle in **any** (or even **every**) field: i.e. **unlimited legal coercion**
 - In addition, such arbitrary violation cannot be compensated or "justified" by any "collective good": value is only subjective



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- Of course, one can reject the idea of freedom here defined
- However, given that any other idea of freedom implies the arbitrary and legal violation of the principle of equality before the law, one cannot do it without granting someone (e.g. the state) unlimited legal coercive power; in other words, without avoiding **totalitarianism**
- The modern state is based on **legal positivism**, which is the idea of law opposite to freedom: arbitrary and particular command of authority, valid as long as it is the result of a legal procedure
- While scientific Law is the non-arbitrary **limit** to any coercive power, legal positivism is the **instrument** of arbitrary coercive power
- By definition, legal positivism gives **the state** (whether democratic or not), **not** the government, an **arbitrary** and **unlimited** coercive power
- The monetary structure that produces a continuous artificial expansion of money and credit can exist, in violation of the scientific law of freedom, only because of this arbitrary and unlimited coercive power legal positivism gives authority



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WAR

- **Data** on war finance: Friedman M., Schwartz A.J., 1993, *A Monetary History of the United States, 1867-1960* (National Bureau of Economic Research, Washington DC)
- **Analysis** of war finance: Rothbard, Rothbard M., 2005, *A History of Money and Banking in the United States: The Colonial Era to World War II* (Ludwig von Mises Institute, Auburn).
- War has always been extremely expensive
- However, these costs have exponentially escalated with **“modern war”** (from WWI onwards): the war on a systemic scale with modern technologies
- More importantly, these costs have been **more and more financed with inflation and debt rather than with taxes**, e.g.:
 - in the US, 75-78% of WWI costs covered by monetary inflation and debt. To give a comparison, for Napoleonic wars it was 35%
 - monetary inflation covered 25% of war costs, debt 53%



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- In particular, monetary inflation became very popular among governments as a way to finance wars (Ebeling R.M. , 2015), e.g.:
 - money supply in the **UK: £28.7 bln** in 1913 (before WWI); **£54.8 bln** in 1918 (end of WWI) [+90%]; **£127.3 bln** in 1921
 - money supply in **France: 5.7 bln francs** in 1913; **27.5 bln francs** in 1918 [+382%]; **38.2 bln francs** in 1920
 - money supply in **Italy: 1.6 bln lire** in 1913; **7.7 bln lire** in 1918 [+381%]; **14.2 bln lire** in 1921
 - money supply in **US (participated only in the last year of the war): \$20.7 bln** in 1916; **\$35.1 bln** 1918 [+70%]



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- Of course, **monetary inflation and debt are linked via the central bank** (which prints money to buy government bonds):

The Federal Reserve became to all intents and purposes the bond-selling window of the Treasury, using its monetary powers almost exclusively to that end (Friedman, 1992: p. 216)

- Why is it that governments recur more and more to monetary inflation to finance wars (and more in general to face crises)?
- Mainly because monetary inflation does not have a political cost
- The Gold Standard was abolished by belligerent countries in 1914 to finance WWI: it is reasonable to say that if the Gold Standard had not been abolished WWI (and WWII) would not have been possible



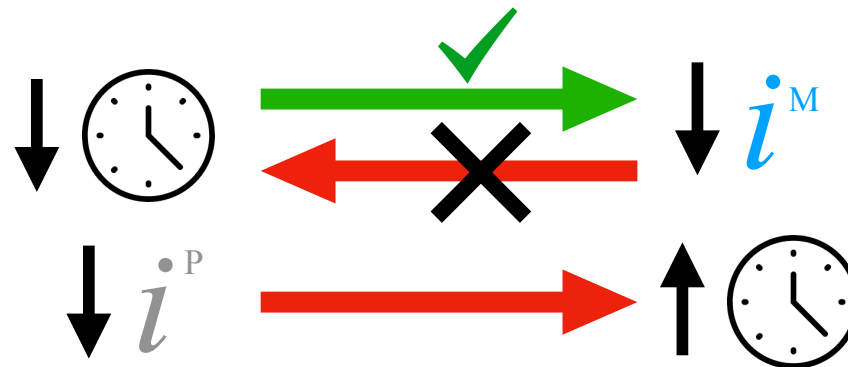
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SECONDARY ASPECTS

- THE ARTS

- It has been suggested (Ammous, 2018) that monetary inflation has an influence on the arts via time preference ⌚
- As we have seen, lower time preference produces a lower market interest rate i^M
- However, the reverse is **not** true: an **artificially** lower interest rate i^P discourages saving (i.e. it encourages consumption): therefore it produces **higher** time preference)

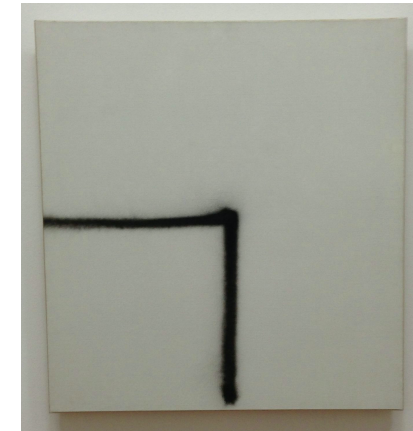




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- The higher the time preference, the less individuals will embark in long, ambitious projects: they will tend to want “everything now”
- In the arts, this translates into less ambitious projects with fastest returns:
 - e.g.: in music: less Mozart, more “instant music”
 - in architecture: less buildings whose beauty remains (and even increases) in time (which take a long time to build) and more buildings whose beauty is temporary (and take less time to build)
 - in paintings:
 - less of this
 - ... and more of this





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The Baroque, Neoclassical, Romantic, Realistic, and post-impressionistic schools were all financed by wealthy patrons holding sound money, with a very low time preference and the patience to wait for years, or even decades, for the completion of masterpieces meant to survive for centuries. The astonishing domes of Europe's churches, built and decorated over decades of inspired meticulous work by incomparable architects and artists like Filippo Brunelleschi and Michelangelo, were all financed with sound money [i.e. money that cannot be arbitrarily inflated, such as gold] by patrons with very low time preference. The only way to impress these patrons was to build artwork that would last long enough to immortalize their names. (Ammous, 2018 p. 99)



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TECHNOLOGY

- “Zero to One” vs. “One to Many” phases of innovation (Peter Thiel)
- The structural, fundamental part of innovation (e.g. in technology) happens in “Zero to One” phase (e.g. electricity, internal combustion engine, etc.)
- The “One to Many” phase is “*a matter of scaling, marketing, and optimization*” (Ammous, 2018, p. 97)
- Most of the technology that we use today, is in the “One to Many” phase of innovations whose “Zero to One” phase was in the 19th century
- This is no coincidence as at that time there was the gold standard, which implied lower time preferences and therefore, as we have seen earlier, a longer and more complex (and sustainable) structure of production



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THE ENVIRONMENT

- Environmental sustainability (even the very simple action of planting a tree) requires low time preference (TP):

*I am reminded of a conversation I had with an old man who grew plants in my country. I asked him to sell me a big tree for my private garden. He replied, “Everybody now wants big trees. People want them immediately; they do not bother about the fact that trees grow slowly and that it takes a great deal of time and trouble to grow them. Everybody today is always in a hurry,” he sadly concluded, “and I do not know why”. Lord Keynes could have told him the reason: [as he famously said,] *in the long run we will all be dead* (Leoni B. 1991 [1961], p. 80)*

- If today's environmentalists knew about economics, they would probably demand free market (first of all in the money sector) rather than protesting against it and invoking more government intervention (which as we have seen makes makes everything possible to **increase** TP)



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- The free market approach to the environment is particularly complex and could not be discussed here (some texts are included in the bibliography)
- Two important scientific facts on which it rests are the following:
 1. Sustainable protection of the environment depends on respect of **private property (tragedy of the commons)**, and therefore on the **free market (no GFM, CB, etc.)**:
 1. e.g. in the US, buffalos were nearly extinct because they did not belong to anyone (**incentives to kill as many as possible as fast as possible**: Buffalo Bill); whereas cows, on the contrary, being private property (capital) enormously increased in number (**incentives to preserve and multiply capital**)
 2. Sustainable protection of the environment requires very complex technology, i.e. very **low time preferences** (lots of saving, long structure of production): while government action in general, and monetary socialism in particular, **increase** time preference



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- In section 4.d. I mentioned that most of the technology that we use today is in the "One to Many" phase of innovations whose "Zero to One" phase was in the 19th century
- Even though it is a quite complex and interdisciplinary technology, bitcoin, like the Internet, is an example of an innovation which happened today **and** which, in part, is in its "Zero to One" phase
- Even though it happened during an historical period of high time preference, this innovation goes to the opposite direction
- Bitcoin is **even sounder (quasi-)money than gold** mainly for 4 reasons:
 1. scarce in **absolute** terms (like **time**), **not** relative ones
 2. **adaptive "extraction difficulty"**
 3. **no FRB**: not only (quasi-)money but also distributed banking & electronic payment system
 4. **decentralization** and **ensorship resistance**
- **Regression theorem, if** correctly understood, **is valid for bitcoin** (Block W., Davidson L., 2018)



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- We have seen that the main selective criteria of free market money included: scarcity, durability, portability, and divisibility
- It can be argued that monetary socialism has changed some of these criteria; i.e. that an **evolution of money is under way** and that it's ignited by monetary socialism
- On the one hand, via government *fiat* money (GFM) and the FRB-central-banking (FRB-CB) system, monetary socialism has **eliminated scarcity (though only for the authorities controlling money)**
- In some cases (e.g. 2016 India banknote demonetization) it also has eliminated durability
- Systematic military attack against free market money (gold) has created a **new** criterion for the success for it: **ensorship resistance** (which comes in great part from **decentralization**, but also **privacy**)
- Bitcoin is the first (and by far the most serious and high-quality) element of this evolution. It's the free market response to monetary socialism

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APPENDIX: A brief introduction to bitcoin

You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete” (Fuller)*



(*) Official loss of ownership



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- bitcoin is a distributed and censorship-resistant **system of certification** (whose only “Zero to One” innovative technological element is called “blockchain”)
- this system works thanks to a structure of free-market **incentives** provided by a scarce and non-physical asset (bitcoin)
- Bitcoin is *fiat* money but, unlike GFM, it cannot be arbitrarily inflated

- the **blockchain** is a complete ledger of bitcoin transactions
- its called “blockchain” because the transactions are registered in consecutive “blocks” (each block being like a page of the ledger)
- this ledger is not centralized. On the contrary is decentralized: more precisely, it is distributed among dispersed “nodes”, each one of them having a ledger identical to the others
- anyone can be one of these nodes by downloading the necessary software



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- the ownership of the bitcoins referenced to in the blockchain is uniquely determined: not via government IDs but via cryptography
- thus bitcoins are scarce and always private property of someone
- the great innovation of the blockchain lies in the fact that it certifies that the information included into the different ledgers is **exactly the same everywhere** (the blockchain prevents the 'double spending' of the same bitcoins)
- this result, which would be **very easy** to obtain with a **centralized** ledger (i.e. of distributed copies of a single centralized ledger), is **"mechanically" impossible** to obtain in a **distributed ledger**
- the blockchain obtains this result not "mechanically" but through a **structure of incentives**, that is through a **free-market process**
- all those who first update a copy of the ledger (the "accountants" or "miners") have an economic incentive that all the others have exactly the same info on their ledger, and vice-versa



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- this economic incentive is given:
 - by the commission on the bitcoin transaction
 - by the new bitcoins that are given to the miners as compensation for their work (registration and verification of one block of transactions).
This is how new bitcoins enter the market
- since the total amount of bitcoins is fixed (see later), these new bitcoins can be given to the miners ("extracted") only as long as the maximum amount of bitcoin "in circulation" has not been reached
- the amount of bitcoins given to the miners per block registration is cut by half every 210.000 blocks (4 years approximately). It was 50 BTC in 2009; at the time of writing it was 6,25
- who gives the miners these new bitcoins? not a company or a person, but an open-source, software protocol
- this protocol is constantly updated by a community of developers and cannot be arbitrarily modified, not even by who invented it



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- the quantity of bitcoins that the protocol can give to miners is 21 million, not a cent more. Each bitcoin is currently divisible until the 8th decimal digit
- in order to verify the transactions and thus get these new bitcoins, miners must resolve complex problems of calculus by using computer machines
- the difficulty of these problems increases with the amount of “computing power” dedicated to their solution (and vice-versa)
- this is to make sure that, in normal conditions, the registration time for every block is about 10 minutes (the last bitcoin will be “extracted” in the year 2140; 99% of bitcoins will be extracted by 2030: at the time of writing 18.3mln [87,14%] of bitcoins have been extracted
- this is an important fact that economically distinguishes bitcoin from gold: when demand for gold increases, other condition being equal its price increases. This creates an incentive for more powerful extracting technology that decreases the difficulty of extraction. The effect is an increase of the supply of gold: this slows the gold price increase



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- on the contrary, in the case of bitcoin the difficulty of extraction is adjusted approximately every two weeks with the variation of mining power on the network (e.g. it increases if the mining power increases). Thus, unlike the case of gold, the supply of bitcoin does not increase as a result of an increase of its demand (in the long run, its price tends to rise instead) and the trend of that supply tends to be much more predictable in time than that of the gold supply



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