The cost of infrastructure capital, present and past

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Ecole Polytechnique

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Intro

- MM ex infrastructure finance banker, now advisor in sustainable finance
- Disclaimer: No funding for this conference, Speaking in own right, not representing any person or entity, No conflicts of interest.
- Quick tour around with questions and assumptions– some of the research is done, see bibliography, but not all.
- Adopting a scientific approach: assumption versus assertion, demonstration vs authority, rationality vs bias/opinion.

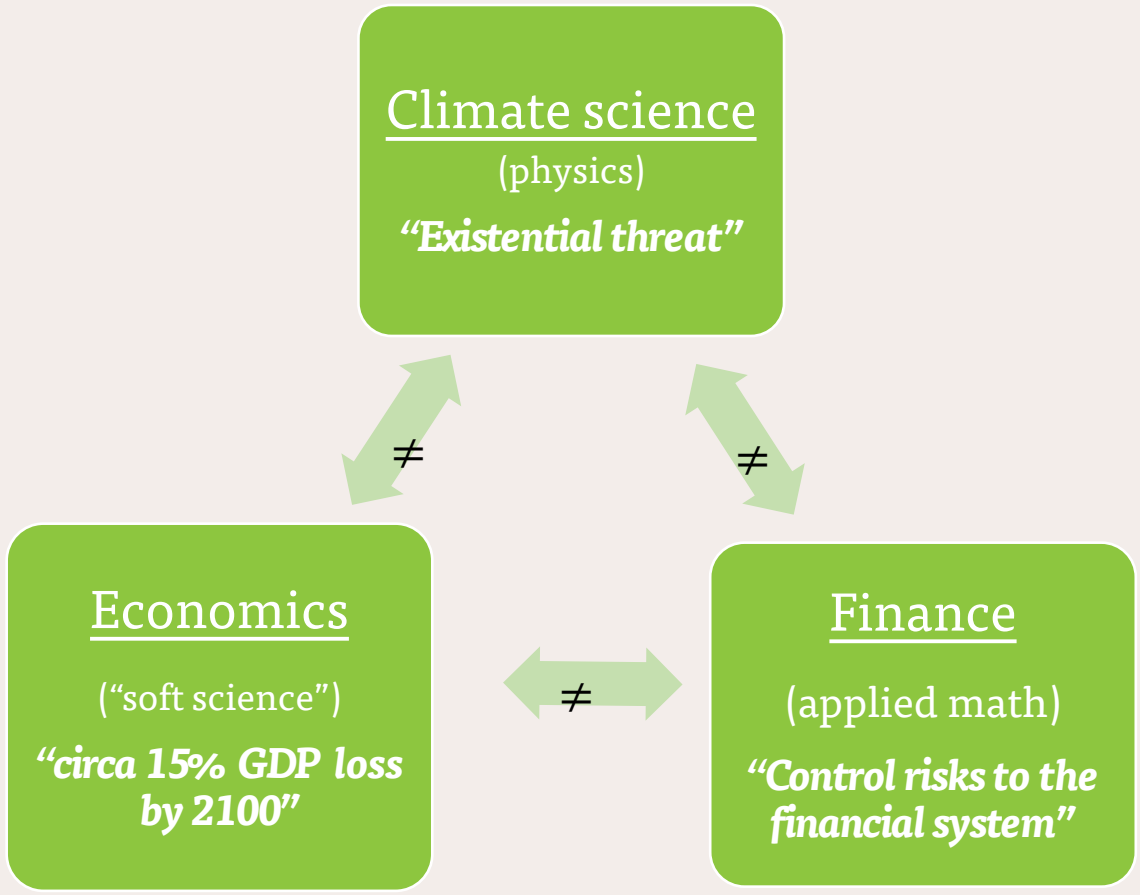
Agenda

Introduction

1. There is an infrastructure gap /even more so for climate investment
2. By contrast, the 1948-1973 period produced a boom of infrastructure investment
3. The present cost of capital is high, making investment in infrastructure scarce
4. Before 1973, a different financial system was enabling a lower cost of capital for infrastructure.

Bibliography

Physics, Economics, Finance: three worlds apart – the example of climate science.



- Models are heterogeneous – no nature, no banks, no debt in economics – more integration is needed.
- More, « harder » science is needed in both Economics and Finance.
- Economics and Finance are not neutral – they shape societies.
- Finance is increasingly a (the) primary decision driver

Alain Grandjean, Comparaison des modèles économiques et climatiques.

1. Energy infrastructure – and not only

Energy:

- Power plants
- Grid

Also:

- Transport (rail, highways, ports, airports)
- Water utilities
- Health and Education facilities
- IT and tech: data centers, networks, satellites,…

Focus on the “large stuff” :

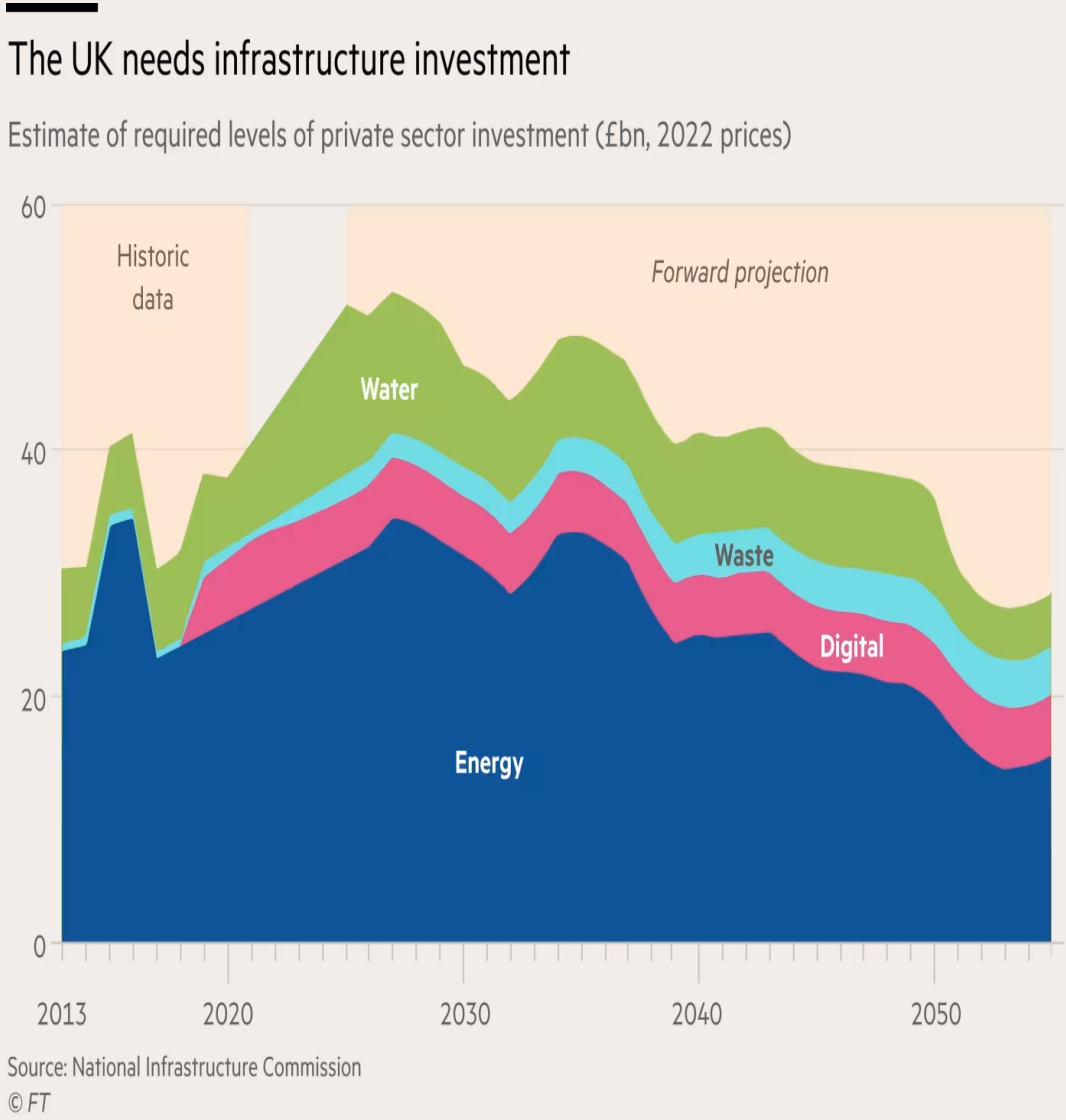
When cost of physical assets is in the range of USD 1 bn (1 000 million).

Infrastructure costs:

- Construction/Building costs
- Operating and maintenance
- Financing costs = cost of capital

1. UK example: FT 21 Nov, the infrastructure problem

- "Investable infrastructure projects are in short supply, fund managers say privately.
- A risk of private investments for pension funds . . . is in committing to projects which end up not being deployed, or achieving sub-market returns for the risk being assumed
- …This supply problem is not down to an absence of needs
- Short-termism is often to blame — both at a central and local government levels. All too often, decision-making about vital infrastructure has been piecemeal. Rarely has a long-term plan been drawn up to assess the country's needs — and stuck to."

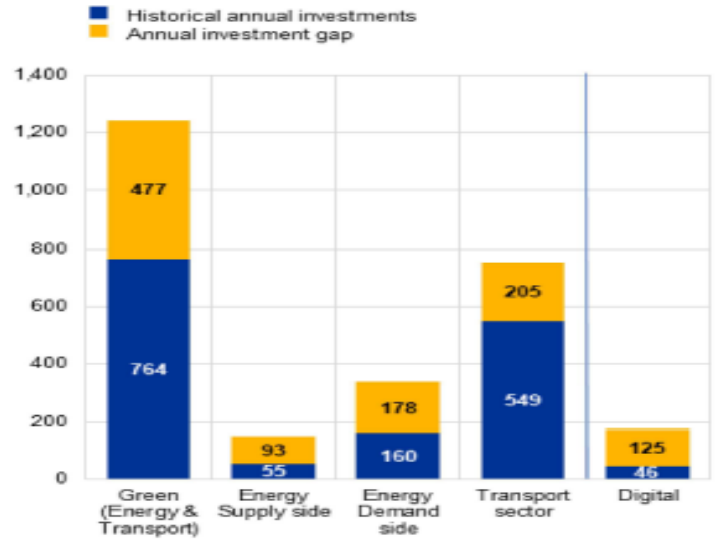


1. A gap for investment in future decarbonation and digital – EU

Chart A
EU green and digital investments

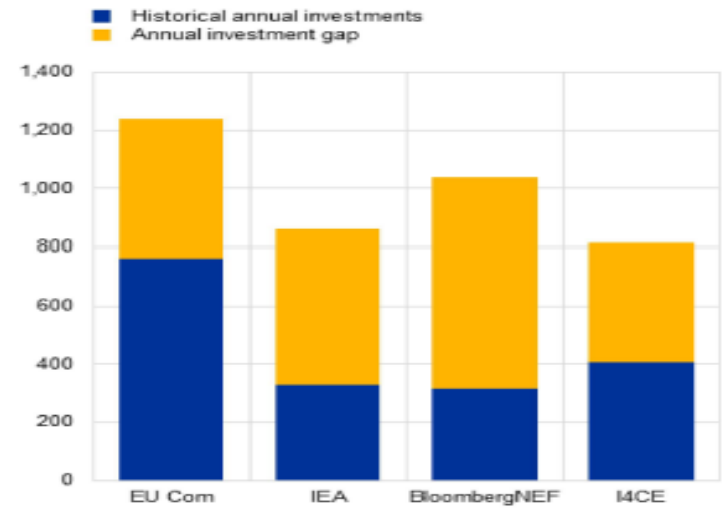
a) EU annual green and digital investment needs by category

(EUR billions)



b) Comparison of EU annual green investment needs estimates by institution

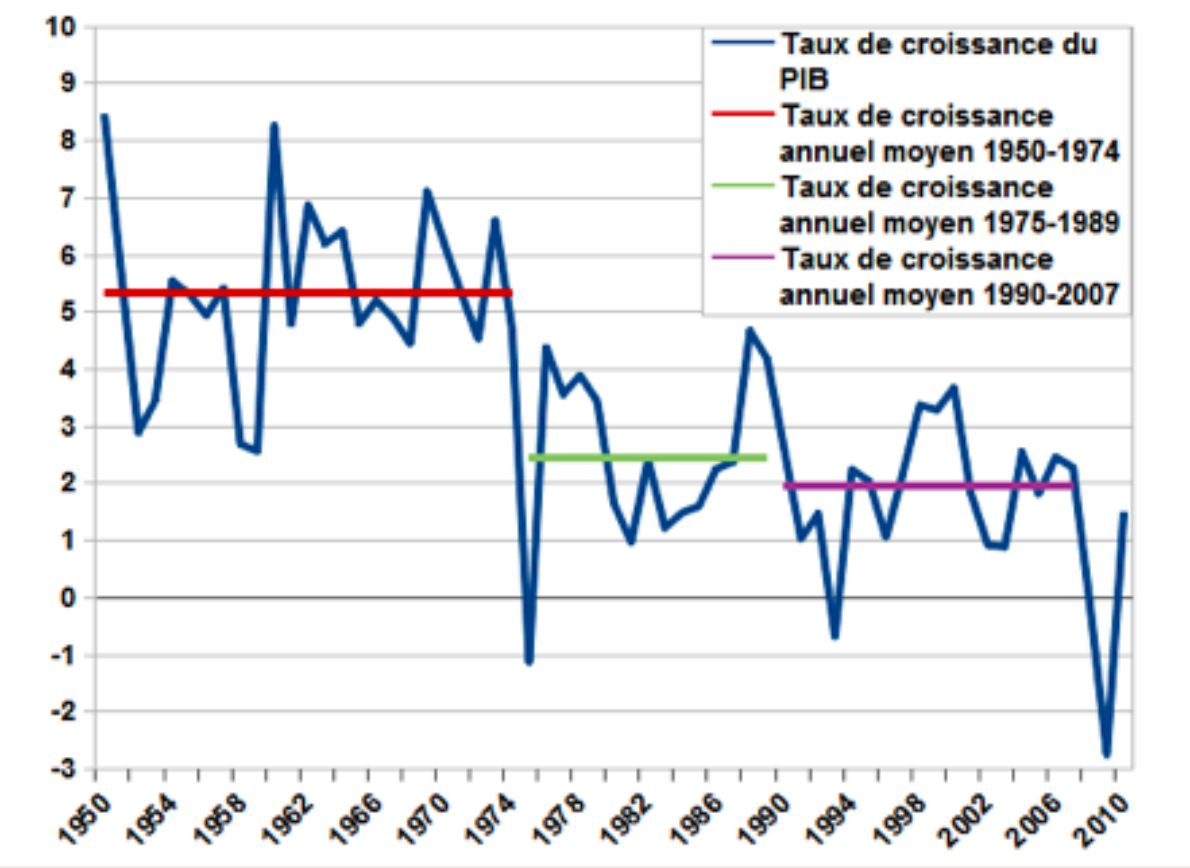
(EUR billions)



Sources: European Commission (EU Com), International Energy Agency (IEA), BloombergNEF, Institute for Climate Economics (I4CE) and ECB own calculations.
Notes: Panel a) shows green and digital investment needs. Historical annual green investments (including the sub-categories energy and transport) refer to the period 2011-2020 and for digital to the period 2014-2020. The annual investment gap is the additional annual investment needs until 2030 on the basis of the Fit for 55 policy package and the Digital Compass, respectively. The sum of the historical and additional investment gives the total annual

https://www.ecb.europa.eu/press/fie/box/html/ecb.fiebox202406_01.en.html

2. By contrast, an infrastructure boom during the Golden Age (1948-1973)



2. By contrast, an infrastructure boom during the Golden Age (1948-1973)

Croissance du PIB, de l'emploi et de la productivité du travail (taux annuels moyens) : 1950-1975 (Source : Beaud, 2010 : 290)

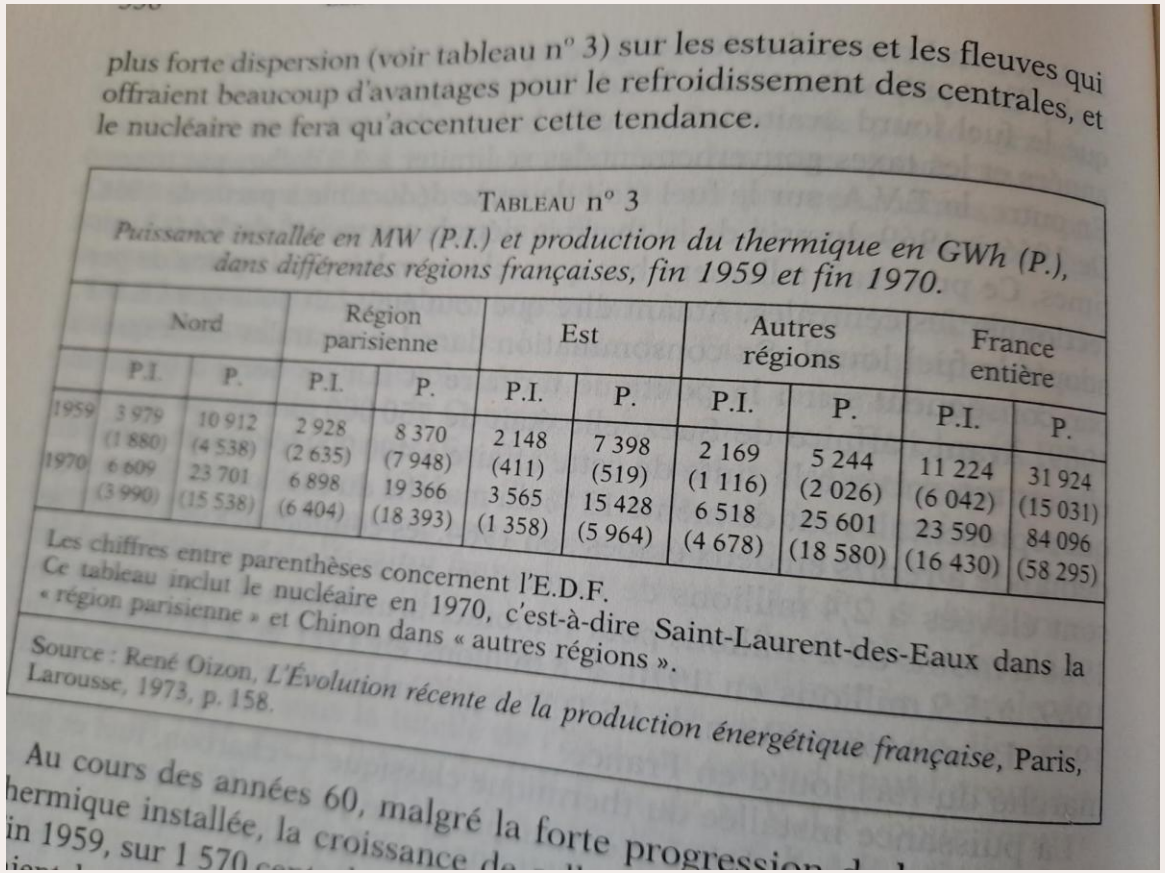
	Etats-Unis	Grande-Bretagne	France	Allemagne (RFA)	Japon
PIB (volume)	3,3	2,5	4,9	5,5	8,6
Effectifs employés	0,9	0,3	0,9	0,7	1,2
Productivité du travail	1,5	2,3	4,6	4,7	8,6
Capital par tête	2,7	3,1	4,5	5,2	9,0

2. The 1948-1973 period was a Golden Age for infrastructure building in France

Power generation

1959- 1970 : 31 to 84 GWh

In Histoire de l'électricité en France, Henri Morsel, Fayard



plus forte dispersion (voir tableau n° 3) sur les estuaires et les fleuves qui offraient beaucoup d'avantages pour le refroidissement des centrales, et le nucléaire ne fera qu'accentuer cette tendance.

TABLEAU n° 3

Puissance installée en MW (P.I.) et production du thermique en GWh (P.), dans différentes régions françaises, fin 1959 et fin 1970.

	Nord		Région parisienne		Est		Autres régions		France entière	
	P.I.	P.	P.I.	P.	P.I.	P.	P.I.	P.	P.I.	P.
1959	3 979 (1 880)	10 912 (4 538)	2 928 (2 635)	8 370 (7 948)	2 148 (411)	7 398 (519)	2 169 (1 116)	5 244 (2 026)	11 224 (6 042)	31 924 (15 031)
1970	6 609 (3 990)	23 701 (15 538)	6 898 (6 404)	19 366 (18 393)	3 565 (1 358)	15 428 (5 964)	6 518 (4 678)	25 601 (18 580)	23 590 (16 430)	84 096 (58 295)

Les chiffres entre parenthèses concernent l'E.D.F.
Ce tableau inclut le nucléaire en 1970, c'est-à-dire Saint-Laurent-des-Eaux dans la « région parisienne » et Chinon dans « autres régions ».

Source : René Oizon, *L'Évolution récente de la production énergétique française*, Paris, Larousse, 1973, p. 158.

Au cours des années 60, malgré la forte progression
hermique installée, la croissance
in 1959, sur 1 570

3. What is the Cost of Capital: in practice

Balance sheet	
Equity 20	Cost of equity 15%
Debt 80	Cost of debt 5%
	WACC = 7%.
	(15%*0,2)+(5%*0,8)

- WACC = Weighted Average Cost of Capital
- Cost of equity (dividends + capital gains) (variable), plus Cost of debt (fixed)
- Used in international accounting (IFRS norm) to value “affiliated companies” (“goodwill”): hence, we can find the WACC in annual consolidated accounting reports.
- The WACC must be lower than the expected profit
- There may be non monetized profits that the state/public investor may consider.

François Ecalle, L’évaluation socio économique des investissements publics;
France Stratégie, La valeur de l’action climat.

3. The theory around the Cost of Capital: Capital Asset Pricing Model

- Underlying financial theory Capital Asset Pricing Model CAPM (Sharpe, Markowitz, Miller). The CAPM is a foundational theory to determine the cost of equity.

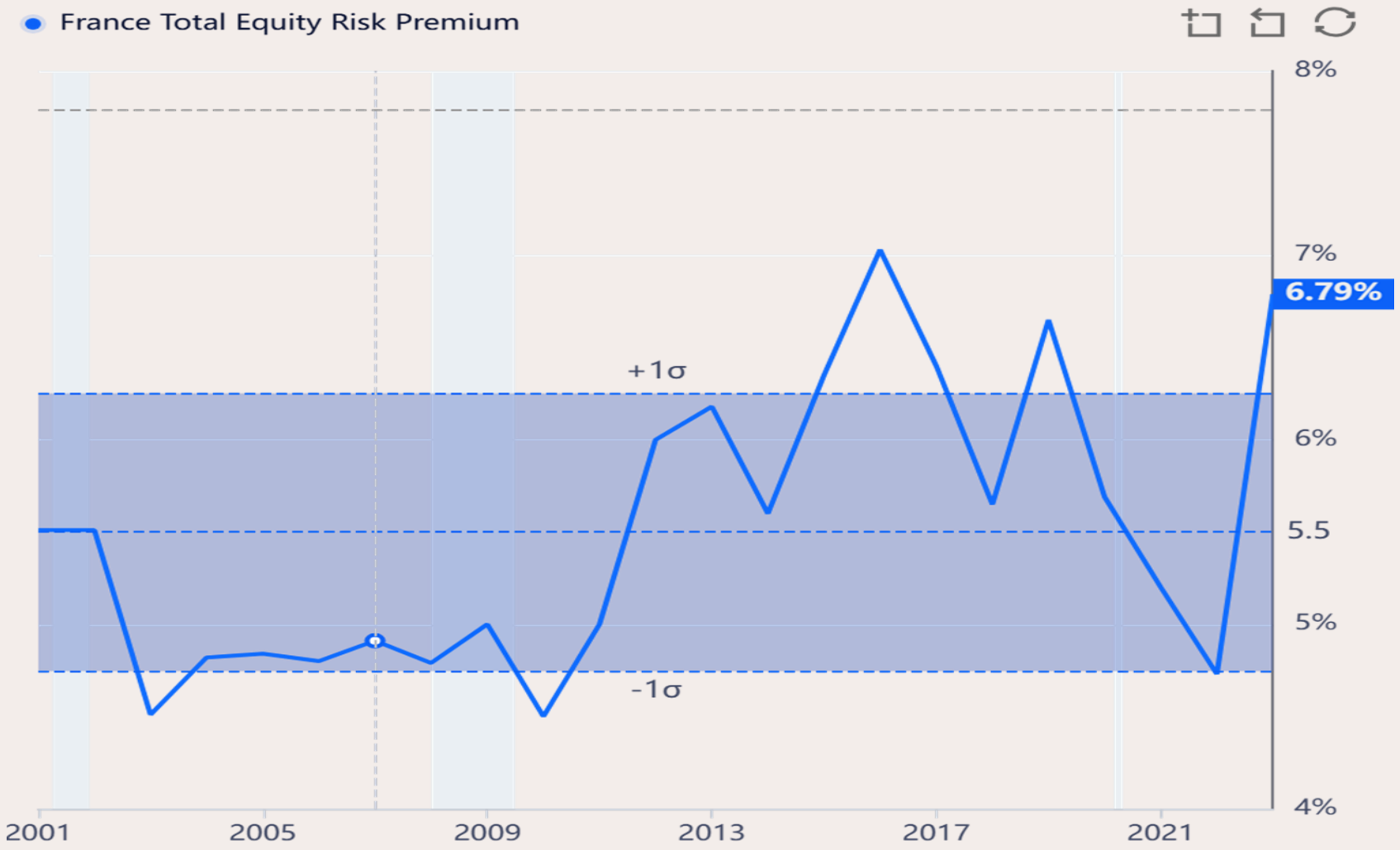
- **Cost of Equity = Expected return = Risk-Free Rate of Return + Risk Premium**

  The "Risk Free Rate of Return" is the cost of borrowing for the State. State debt (in own currency) is risk free because States can always print money to repay their debt.

  The "Risk Premium" is the additional risk on financial markets; the more volatile markets, the more expensive the cost of equity, hence the cost of capital.

- The theory therefore validates the fact that volatile financial markets mean expensive cost of capital: risk is expected return.

3. France (listed) equity risk premium



See Damodaran

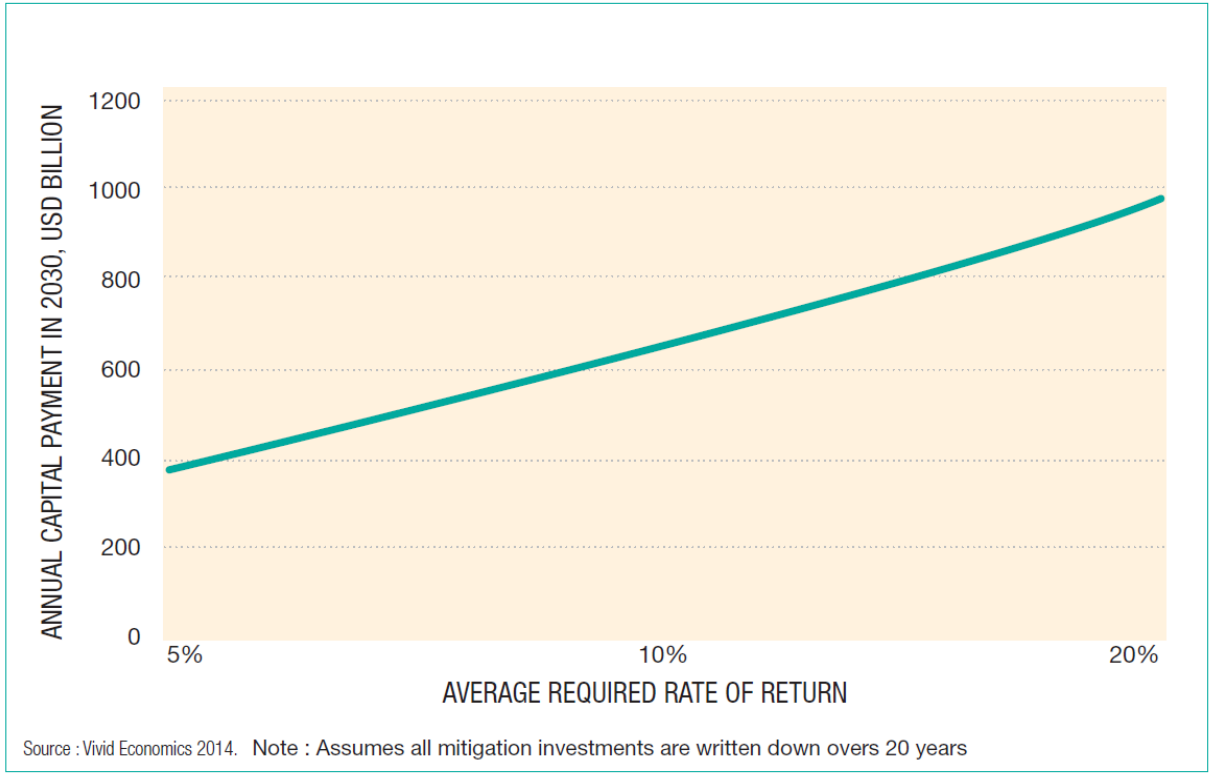
3. Why does the cost of capital for infrastructure matter?

- Infrastructure provides not a consumer good, but a public/collective service which often conditions other developments (such as the RER to Palaiseau)
- The cost of infrastructure therefore impacts not only users, but also indirectly budgets and other developments
- Infrastructure may also not happen in the first place, because it cannot be financed – a tender submission needs to be fully financed. When sponsors cannot finance, they do not tender projects.
- Multiplier effect of infrastructure investment: one dollar of [public] investment in infrastructure increases GDP by [1,6 dollar].
- There is some evidence that public service infrastructure is reducing inequality/ and that decaying public service infrastructure has political consequences.

3. Infrastructure is financed over long periods of time

- Large infrastructure is depreciated over 20, 30, 60 years in order to reduce yearly operating costs.
- The cost of financing accrues over time. A high IcoK will result in a significant share of total project costs being financing costs.
- Nb: accrued interest: at 7,18% interest money doubles in 10 years time.

3. The higher the Cost of Capital, the higher the cost of the green transition (or any other infra investment plan)

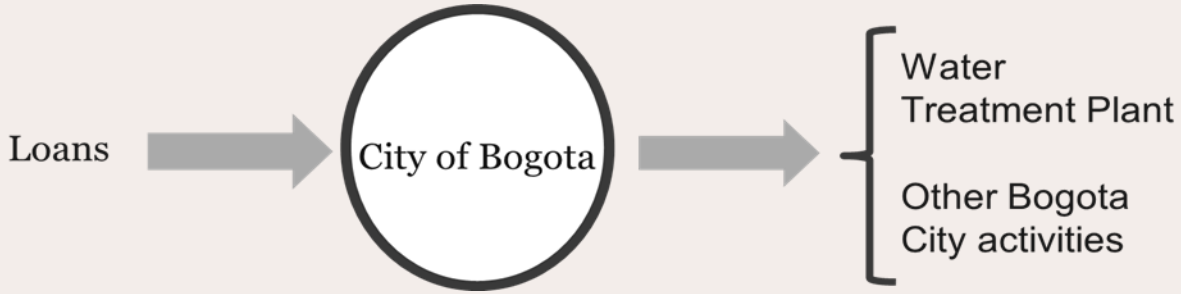


[Mobilizing Climate Finance: A Roadmap to Finance a Low-Carbon Economy]

3. How high is the Cost of Capital for infrastructure? Option One: state/sub state finance.

Situation: Veolia and the City of Bogota (fiction) are considering a new water treatment plant.

Option one: the City borrows and finances the plant with this loan

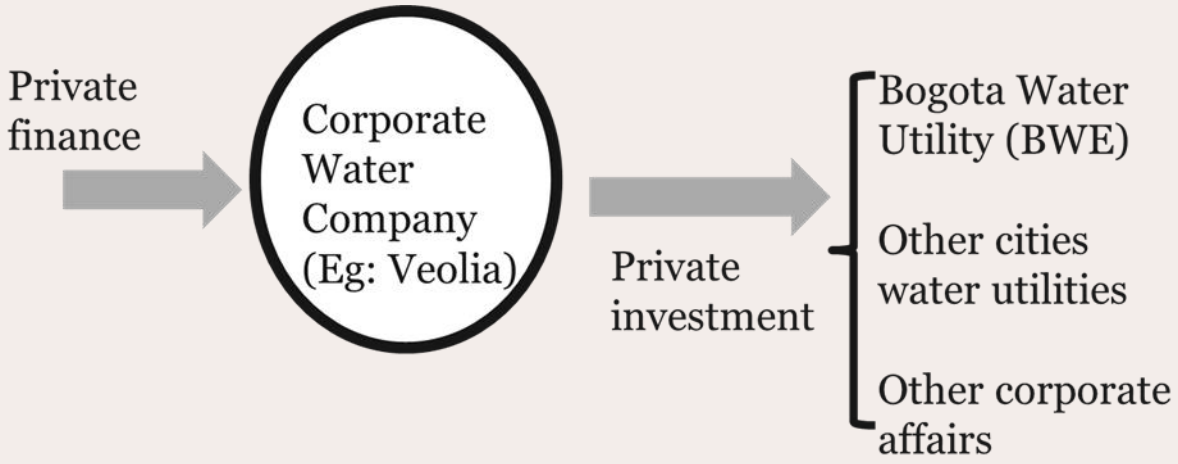


City of Paris cost of debt Dec 31, 2023 (new borrowings) **3,8%**

Fitch ratings: Fitch affirms City of Paris rating, Dec 15 2023
M.Martini, The Ecology of the Financial System, Elsevier (paywall)

3. Option Two: corporate finance.

Veolia will own the plant i.e. finance it from its own balance sheet. It will contract the water use to the City of Bogota.

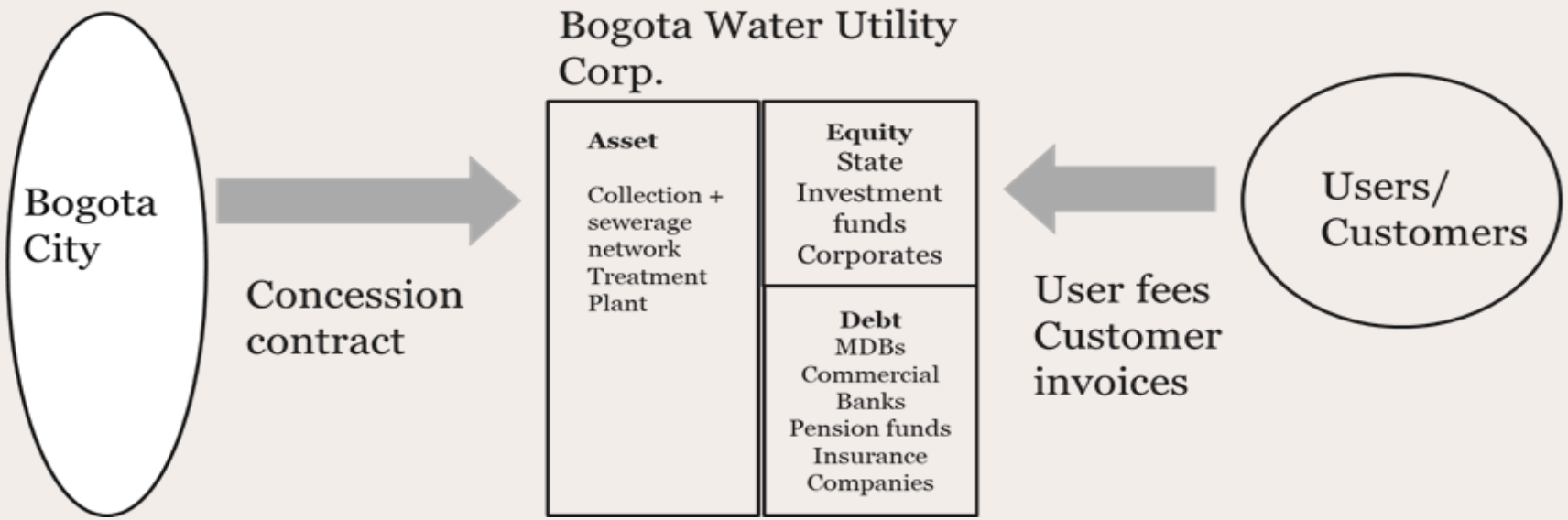


Total Energies WACC 31.12.2023: **8% average after tax** – 7 to 14% before tax.

Total Energies, Universal Registration Document page 430

3. Option Three: Project Finance.

Project finance: ring-fencing of the infrastructure asset in a Special Purpose Vehicle company.



Project finance companies do not share public financial information. WACC is in the range of **15%** in advanced economies.

3. Cost of capital estimated at 7% for energy infrastructure… above return expectations

Article by Pr Graham Weale, Can an Energy-Only Market Fully Remunerate Investment? Empirical Evidence Since 2005

"This paper presents the results of a detailed investigation into the cost recovery for thermal, nuclear, and renewable plants in France and Germany between 2005 and 2019.

The internal rate of return (IRR) was estimated.

It was negative for CCGTs and wind plants; coal plants recorded a level of 2-3%, nuclear plants 7- 8% and PV plants 0-2%, and compares with a typical utility cost of capital of 7%. "

Nb: this means that the energy sector is not investable without subsidies, see article.

Article's argument is on the market price of electricity. Our argument: is Cost of Capital too high? Could it be lower? Were there more infrastructure investment when it was lower? Etc…

3. Financing costs represent a significant share of total plant costs (2005 – 2019)

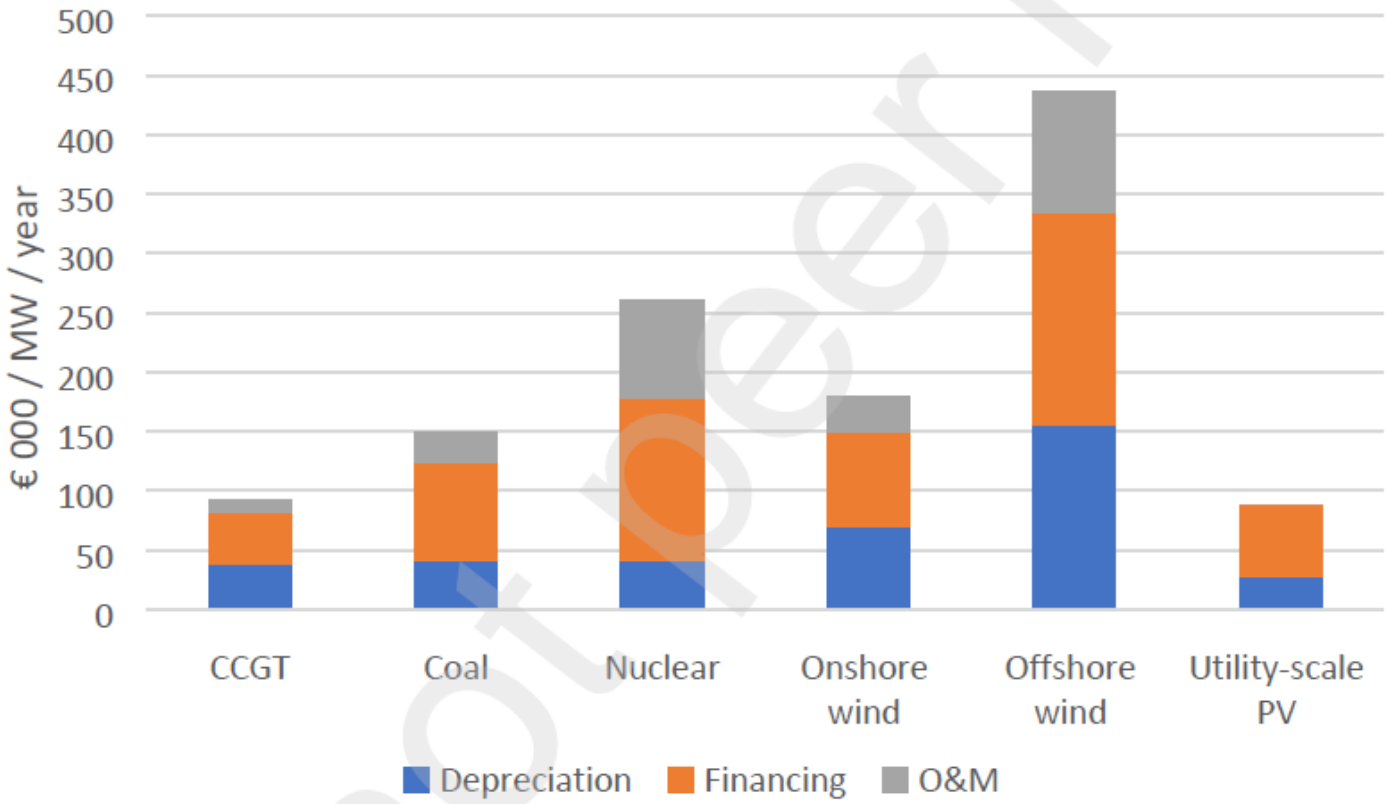


Figure 2 Depreciation, financing costs and O&M costs for selected plants

3. Flamanville EPR, French Court of Auditors

- Total extra costs € 6,7 bn of which more than 50% (€ 4,2 bn) are additional **interest** costs;
- Total project cost at termination € 19,1 bn of which 65% (€ 12,4) bn are construction costs
- Financing costs are at least 25% of total project costs (but, Cour des Comptes does not have the exact information).

Cour des Comptes, Rapport sur la filière EPR.

3. To summarize:

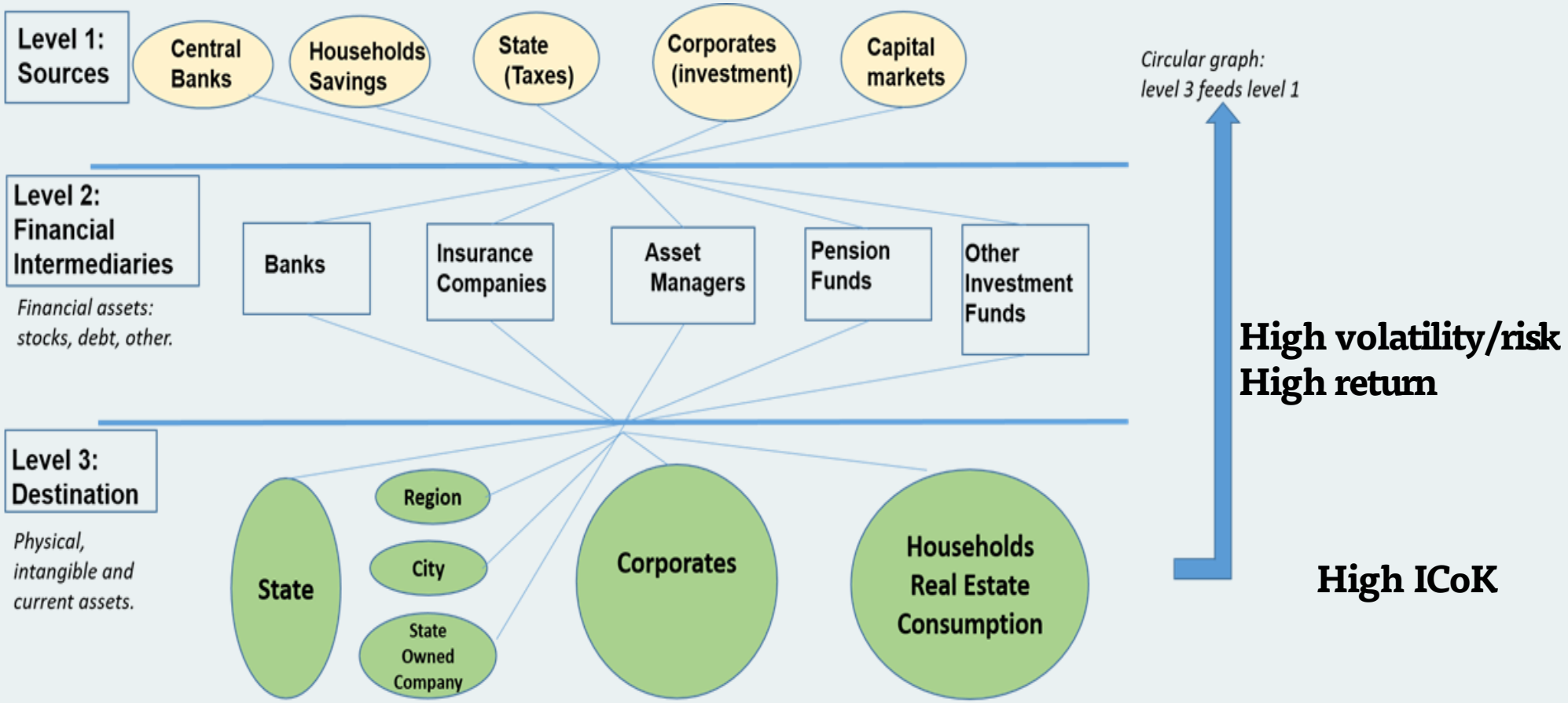
- The ICoK is ranging from 4% if the infrastructure is State owned to 15% if it is project financed.
- The above are estimates – data is scarce, notably because of the confidentiality around private financial contracts.

- The ICoK accrues over time. Infrastructure is financed over long periods of time. At current ICoK levels, financing costs represent a significant share of total infra costs.
- At current cost levels, there are estimates that energy projects in France and Germany are not profitable without subsidies.

- The Capital Asset Pricing Model, the foundational financial theory, links the level of ICoK to the level of risk on financial markets.

- We’ll now have a look at the level of risk on financial markets and some possible explaining factors.

4. A financial system that produces a (too) high ICoK

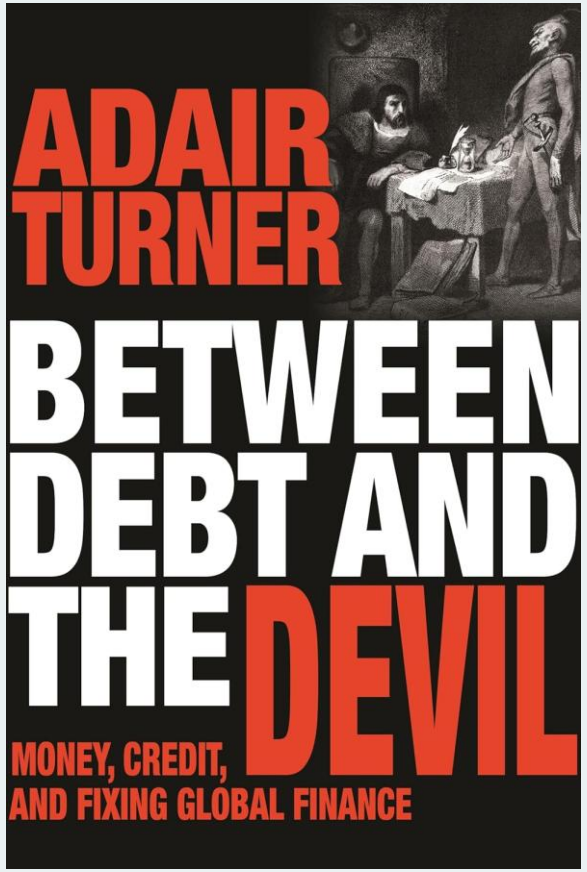


https://lafinanceauxcitoyens.org/files/pdfs/Financeaucitoyens-GB-261118-VF.pdf p18

4. Reference critical book on today's financial system

Adair Turner is a British businessman and academic who was Chairman of the Financial Services Authority during the 2007–2008 financial crisis, a former chairman of the Pensions Commission and the Committee on Climate Change, as well as a former Mc Kinsey and Merrill Lynch staff.

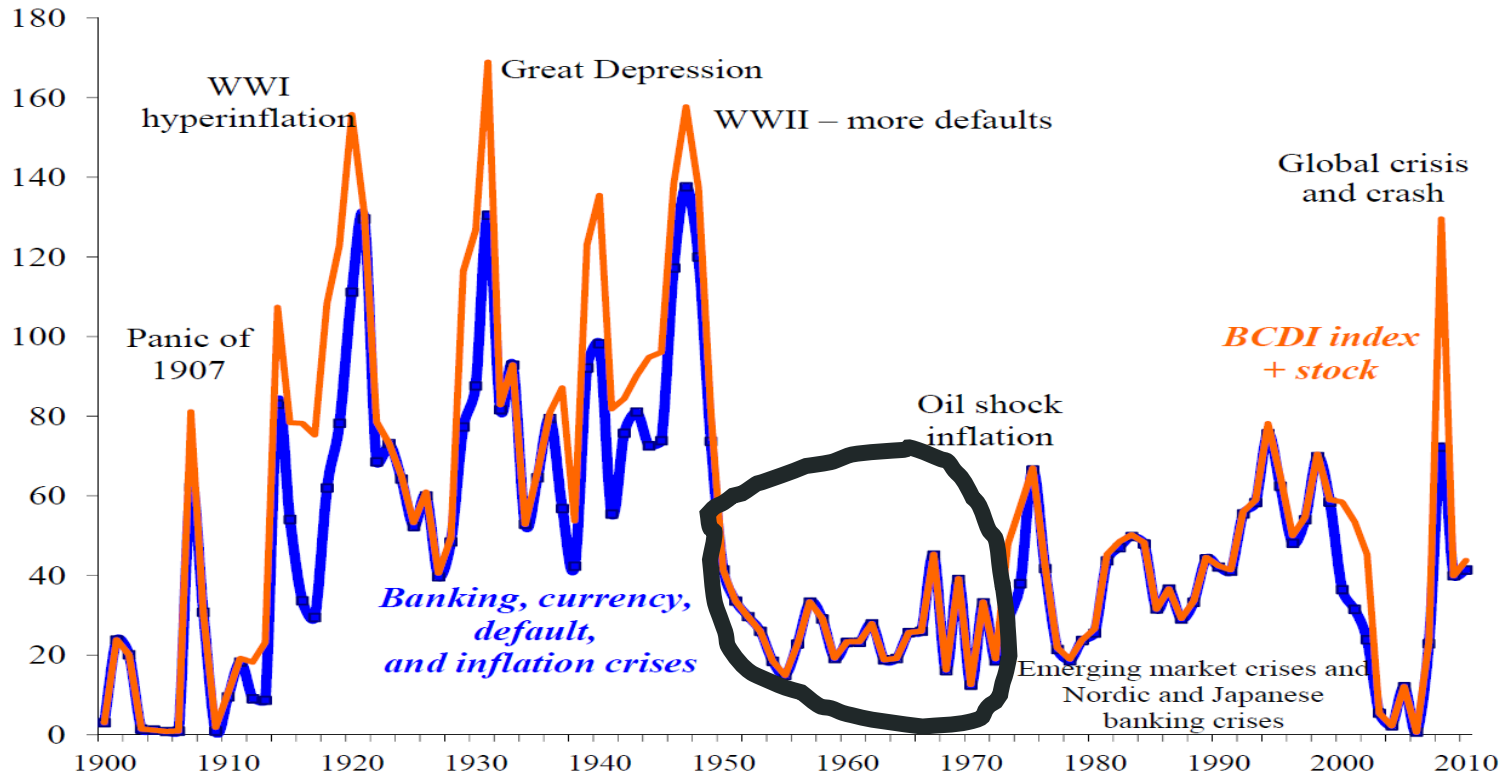
- Dramatic growth of the financial system after the gold standard disappeared in 1971.
- Excessive credit creation is the core driver of financial instability.
- We cannot leave the quantity of credit created or its allocation to users entirely to market forces.
- Without radical policies we could face secular stagnation and populist Trump like regimes.
- Similar "radical financial policies" were in place in France during the Golden Age (1948 – 1973 or "Trente Glorieuses")



4. High volatility/risks in the financial sector – relative stability between 1948 and 1973

Figure 1. Varieties of Crises: World Aggregate, 1900–2010

A composite index of banking, currency, sovereign default, and inflation crises, and stock market crashes (weighted by their share of world income)



https://www.imf.org/en/Publications/WP/Issues/2016/12/31/Financial-and-Sovereign-Debt-Crises-Some-Lessons-Learned-and-Those-Forgotten-41173

4. Global banks are huge and trade more than they lend

- BNP Paribas 2022 Balance Sheet Total € 2 423 bn //France GDP € 2 351 bn
- 70% of the balance sheet is shorter than one year (mostly trading)
- 17% is between 1 and 5 years
- 13% is above 5 years (mostly mortgages)

TABLEAU N° 103 : ÉCHÉANCIER CONTRACTUEL DU BILAN PRUDENTIEL (EU CR1-A) [Audité]

En millions d'euros	31 décembre 2022							
	Non déterminé	JJ et à vue	De JJ (exclu) à 1 mois	De 1 à 3 mois	De 3 mois à 1 an	De 1 an à 5 ans	Plus de 5 ans	TOTAL
ACTIF								
Caisse, banques centrales		318 569						318 569
Instruments financiers en valeur de marché par résultat								
Portefeuille de titres	166 946							166 946
Prêts et opérations de pension		64 994	57 714	29 441	24 085	9 961	5 828	192 024
Instruments financiers dérivés	328 358							328 358
Instruments financiers dérivés de couverture	25 681							25 681
Actifs financiers en valeur de marché par capitaux propres								
Titres de dette	59		3 890	797	3 787	12 120	17 916	38 570
Instruments de capitaux propres	2 188							2 188
Actifs financiers au coût amorti								
Prêts et créances sur les établissements de crédit		9 987	13 023	5 055	2 463	649	1 297	32 474
Prêts et créances sur la clientèle		13 851	56 802	78 893	134 620	345 125	258 376	887 667
Titres de dette	154	92	3 503	4 100	14 908	47 213	43 741	113 711
Écart de réévaluation des portefeuilles couverts en taux	(7 477)							(7 477)
Actifs financiers	**515 910**	**407 494**	**134 931**	**118 287**	**179 864**	**415 067**	**327 158**	**2 098 711**
Autres actifs	187 930	21 181	6 832	9 241	1 835	1 977	8 727	237 722
Actifs destinés à être cédés				86 839				86 839
TOTAL ACTIF	**703 839**	**428 674**	**141 764**	**214 366**	**181 699**	**417 045**	**335 885**	**2 423 272**

Bnpparibas, reference document 2022 p 512

4. If not the banks, can investment funds finance infrastructure?

- Banks lend via credit – a bank contract is a long- term relationship, not subject to market movements.
- Investment funds lend via bonds – not a contract, but a title to debt that is traded on financial markets and subject to changes in value ie short term pressures.
- Investment funds are mostly insurance, pension and savings funds that operate under a “fiduciary duty” limiting their risk appetite
- Specialized infrastructure fund require a high ICoK to remunerate the risk (15% + per year)

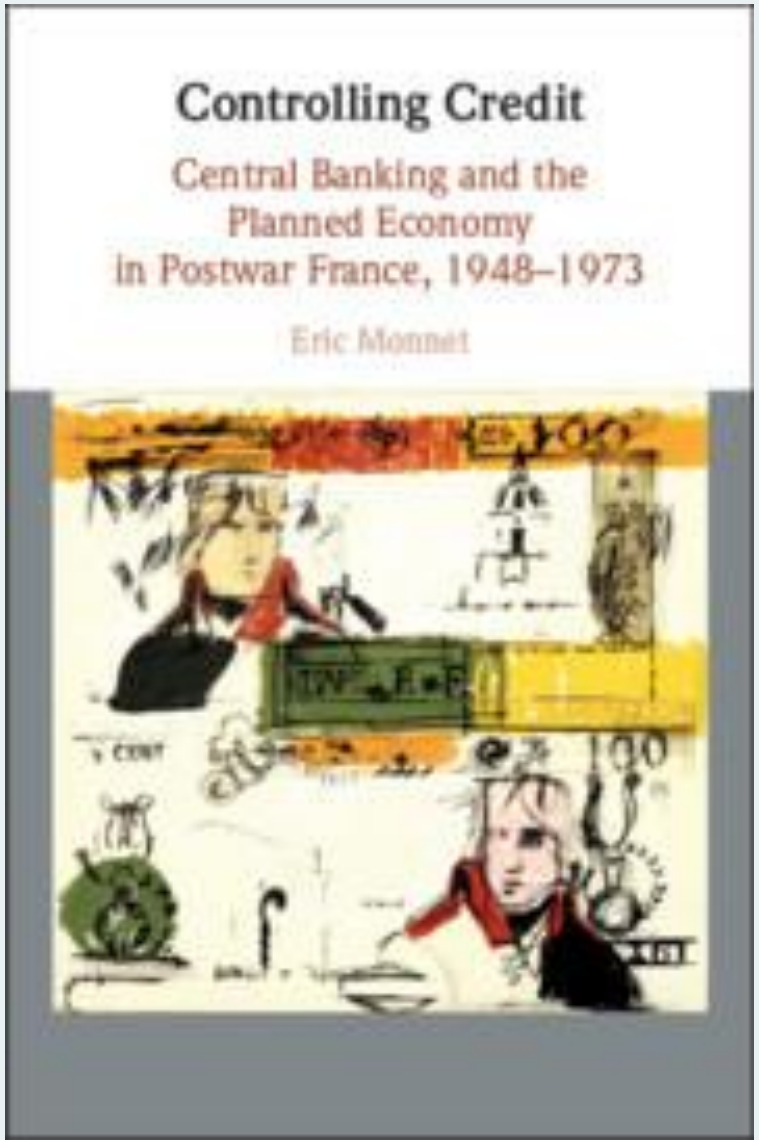
4. If not the banks and not investment funds, can the State(and sub state entities) finance infrastructure?

- As we have seen, the financing cost of the State is relatively cheap, because at least in theory its risk is low.
- But the window of cheap State financing closed down gradually after 1973.
- In 1973, the French government passed a banking law which prohibited monetary financing in France. The Maastricht Treaty in 1992 reiterated this prohibition at the eurozone level.
- Monetary financing is the fact that the Central Bank can print money and give/lend cheaply to the State (“Circuit du Trésor”).
- Central Banks started printing money in huge amounts after the 2008 crisis but monetary financing was still prohibited. This money could only be lent to banks, for the banks to on lend to governments, at their conditions.

4. Before 1973, the financial system was organized very differently

Eric Monnet is a Full Professor at EHESS and Paris School of Economics. “I am an economic historian and macroeconomist seeking to better understand how the evolution of finance, state intervention in credit markets, central banking and the international monetary system has shaped European economies since the 19th century.

Understanding where we come from should be an essential contribution to current policy debates. “



4. Sources of finance for investment in France, 1945 - 1973

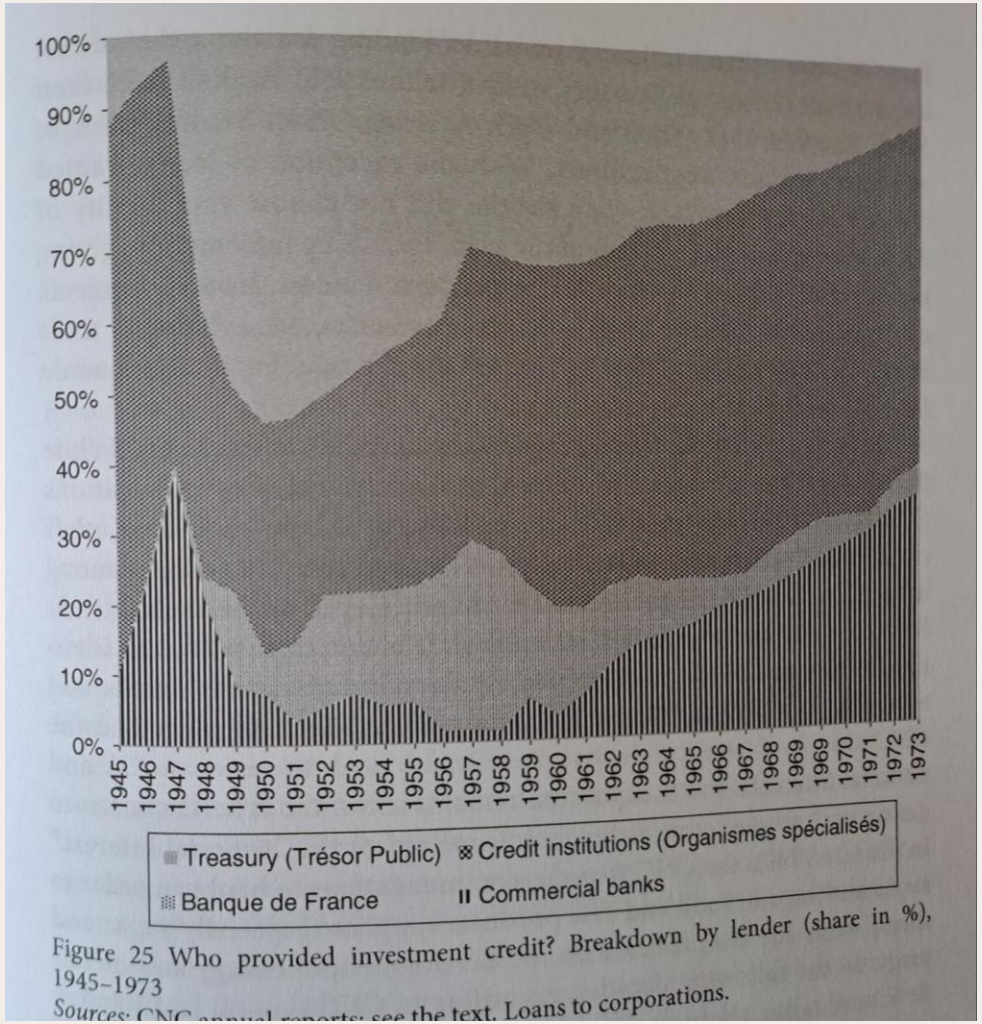


Figure 25 Who provided investment credit? Breakdown by lender (share in %), 1945–1973

Sources: CNC annual reports; see the text. Loans to corporations.

Op cit, Eric Monnet, p 221, "Financing the Post War Golden age"

Commercial banks finance up to 30%

Banque de France up to 20% (no longer available after 1973)

Specialized lending institutions up to 50% (dismantled after 1973)

Treasury up to 50%.

4 . The French Loi Bancaire in 1973 marks a drastic change in the banking system

Before 1973:

- Divide commercial/investment banks
- Specialized banks (eg real estate, municipal lending..)
- No trading (fixed currencies)
- Currency and capital controls: banks are domestic

After 1973:

- Commercial/investment/insurance mergers - moral hazard- Great Financial Crisis resolved by massive money printing, still on going (deregulation)
- Global banks lend mostly to real estate – municipalities and corporates borrow on financial markets (financialization)
- Trading has become a major activity of banks: commoditization including energy and food (commoditization)
- Banks are global (globalization)

See Richard Werner (Oxford Professor) for the same story in the UK: https://www.economicsnetwork.ac.uk/archive/starkey_banking2

4. Before and after the 1973 Loi Bancaire: change in the way the State is financed

Before 1973:

- "Tutelle": The government (Treasury) controls the Central Bank.
- Credit and savings direction: where and how banks lend and where they direct savings is controlled by the Treasury
- Monetary financing is allowed: the State can borrow from the Central Bank which can print money as and when needed
- Please note: banks remain private and the financial system is not nationalized, the government is not a communist government.

After 1973:

- "Inversion des tutelles": Central Bank becomes independent from government. But perhaps not independent, in practice, from banks.
- Deregulation of credit and savings: banks are free to lend as they like (given a basis interest rate) and savings can go where they want.
- Monetary financing is prohibited. The State must borrow on financial markets, which set their price and conditions.
- However, after 2008, money printing by the Central Banks is massively used to bail out ailing banks and uplift financial markets. ("Quantitative Easing").

4. Share of marketable public debt in total public debt, 1945 - 1993

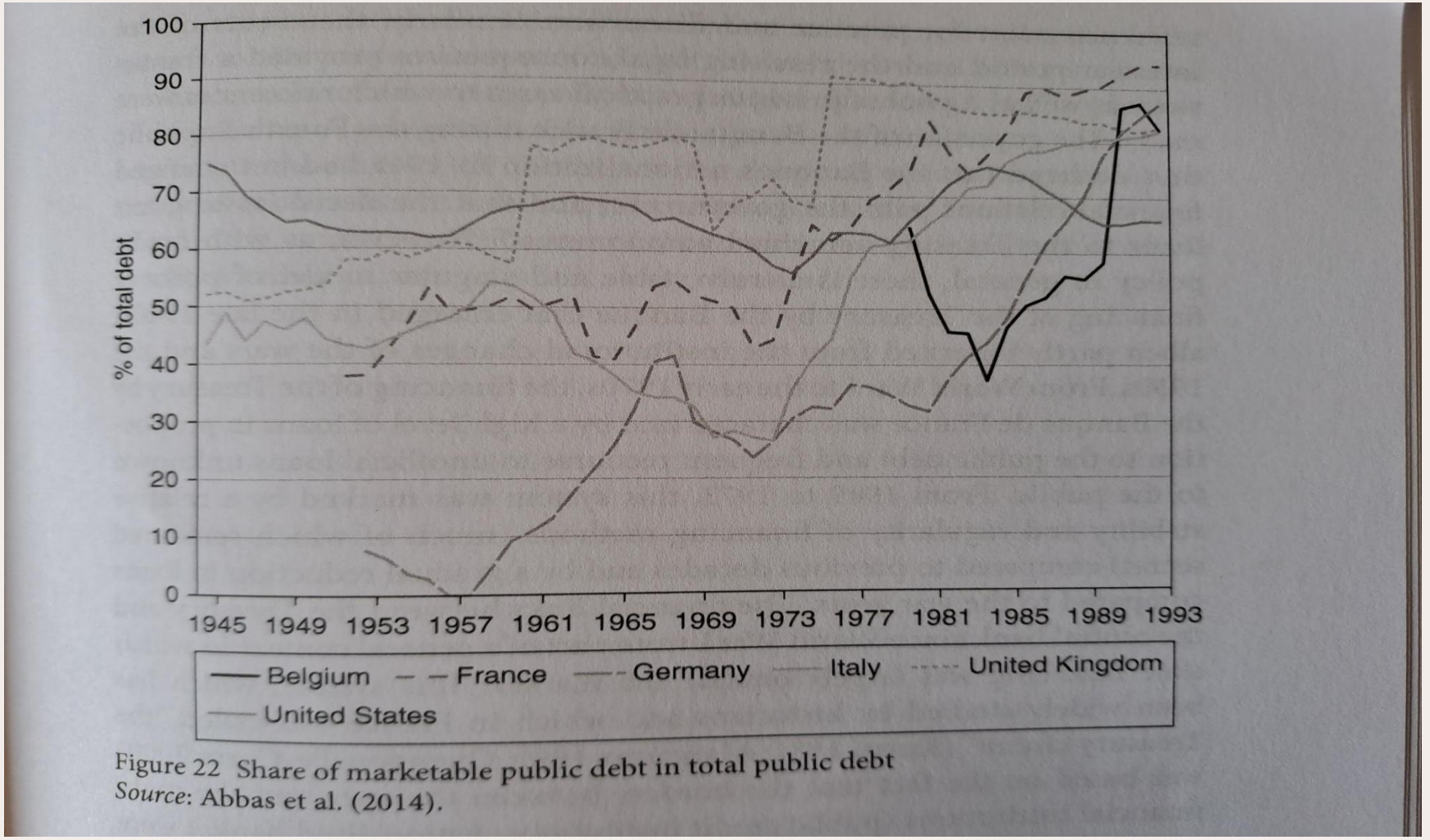


Figure 22 Share of marketable public debt in total public debt
Source: Abbas et al. (2014).

Op cit, Eric Monnet, p 207, “Financing the Post War Golden age” . “After 1973, a political priority in order to reintroduce market forces in the allocation of credit”.

Conclusion

While more research is needed to establish the facts and the possible causal links between them, there is consistent empirical evidence that:

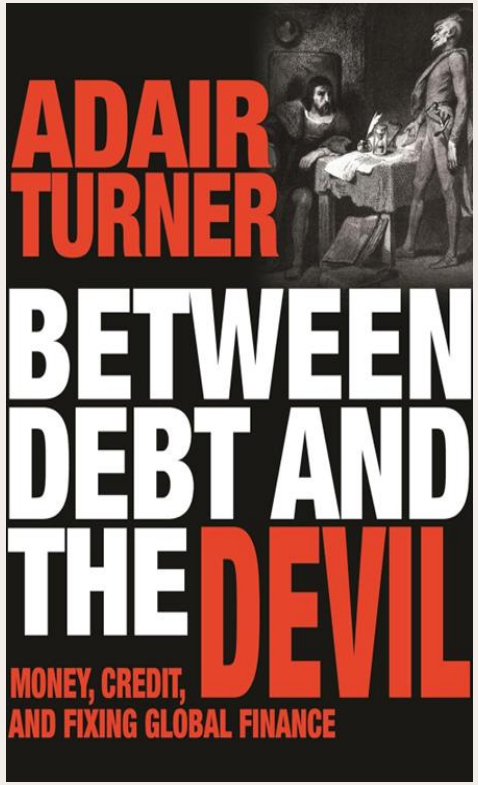
1) There has been and will be a lack of [desirable] infrastructure investment in France.
2) The current financial system provides a high cost of capital for infrastructure
3) In the past, a different financial system provided a lower cost of capital for infrastructure.
4) And during that time, infrastructure investment was booming.

Two possible next steps:

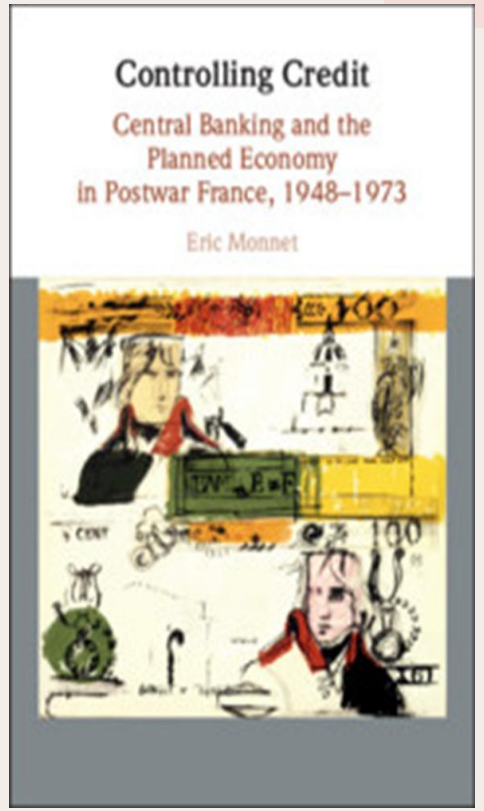
Individually: read Turner and Monnet (academic)

Collectively: more scientific research needed (in economics and finance in general and those topics in particular)

Bibliography



- Alain Grandjean “Comparaison des modèles économiques et climatiques “(et le blog “Chroniques de l’Anthropocène”)
- Richard Werner, Princes of the Yen Documentary on the role of the Japanese Central Bank
- Rawi Abdelal, Capital rules (History of the globalization of finance)
- Benjamin Lemoine, L’ordre de la dette (History of the “inversion des tutelles” in France)
- Jean-François Bouchard, Le banquier du diable (How Central Banker Schacht overcame the Weimar Republic financial crash).
- Brett Christophers, Our Lives in their Portfolio, Why Asset Managers Own the World (How asset managers require high returns for more and more daily services in health, housing, education).
- Nicolas Bouleau, Le Mensonge de la Finance (How financial trading masks commodity scarcity by masking price signal trends).



Thank you

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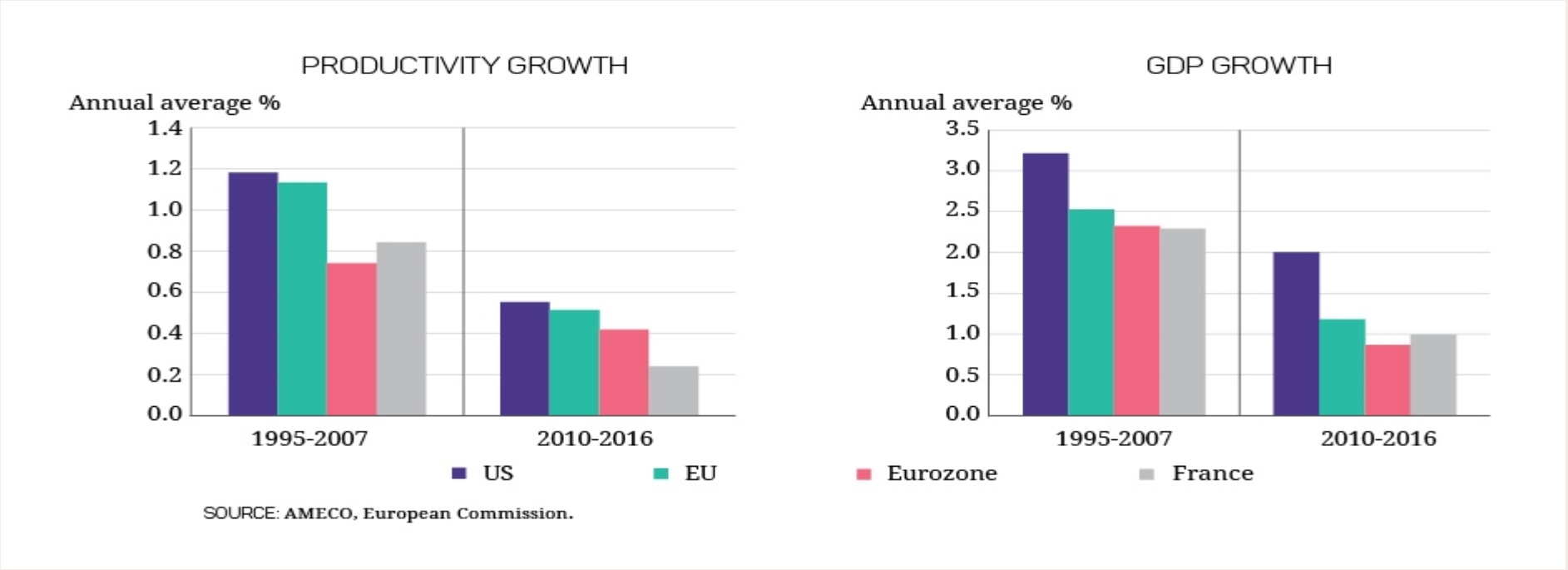
Annexes. An infrastructure gap in France for the past 2/3 decades: overview

Eight years after the end of the global financial crisis, the French economy continues to grow at a noticeably slower pace than the 2.3% average annual growth it recorded from 1995 to 2007. Today, many economists and international organizations fear hysteresis effects due to long-term unemployment and decreasing labour force participation and **the decline of the stock of capital resulting from insufficient investment**. (France Stratégie)



1. An infrastructure gap in France for the past 2/3 decades: specifics

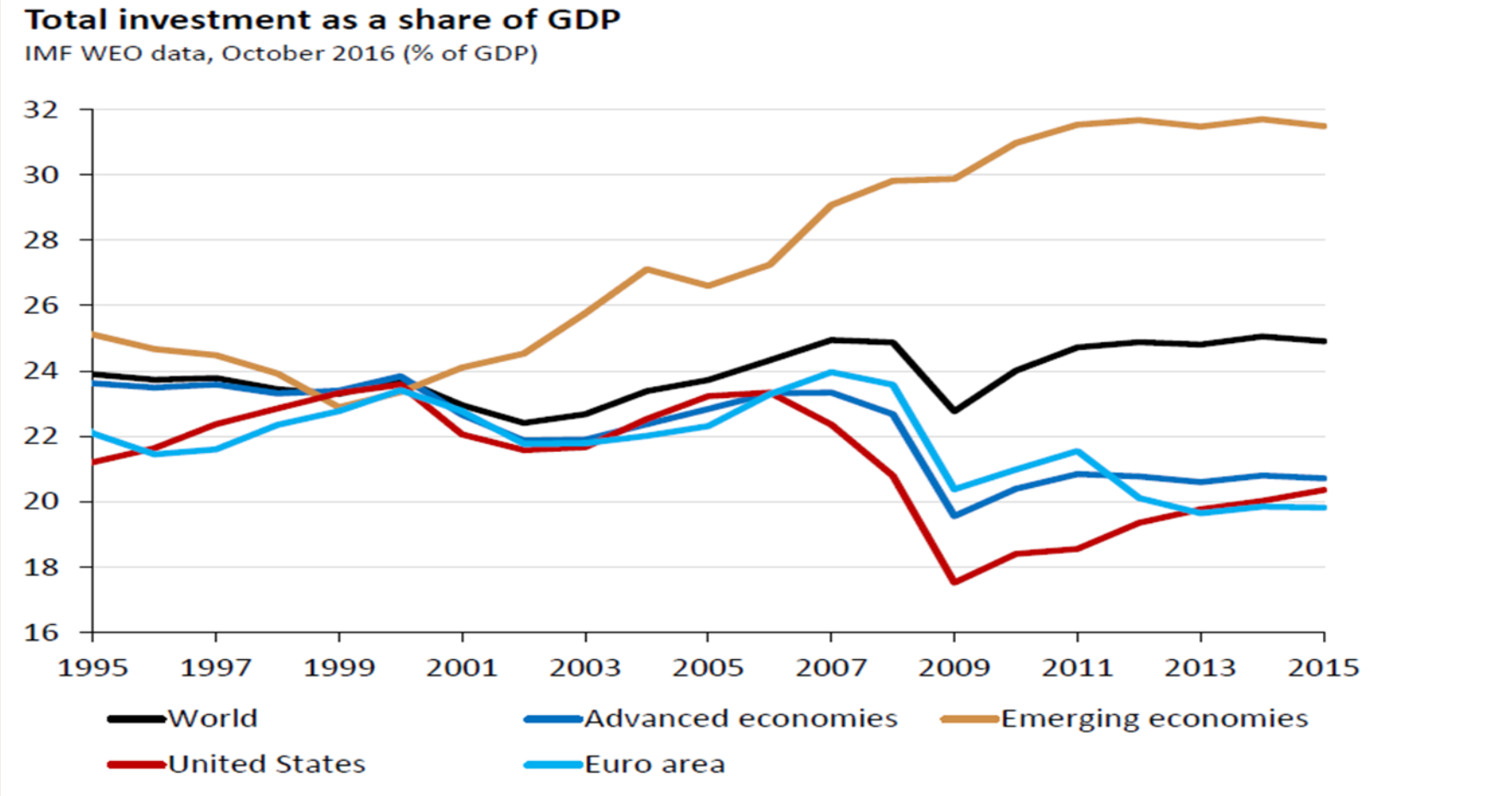
- French Senate: the financing model is not adapted to maintenance and expansion of the French railway network. Already diagnosed in Rapport Rivier 2005 – Ageing and decaying railway network strongly affecting performance.

- Occupancy rate of prisons: 155% , indictments by the European Court of Human Rights.

- Drinking water and sanitation : only most urgent maintenance needs have been covered since 2008.

- ….

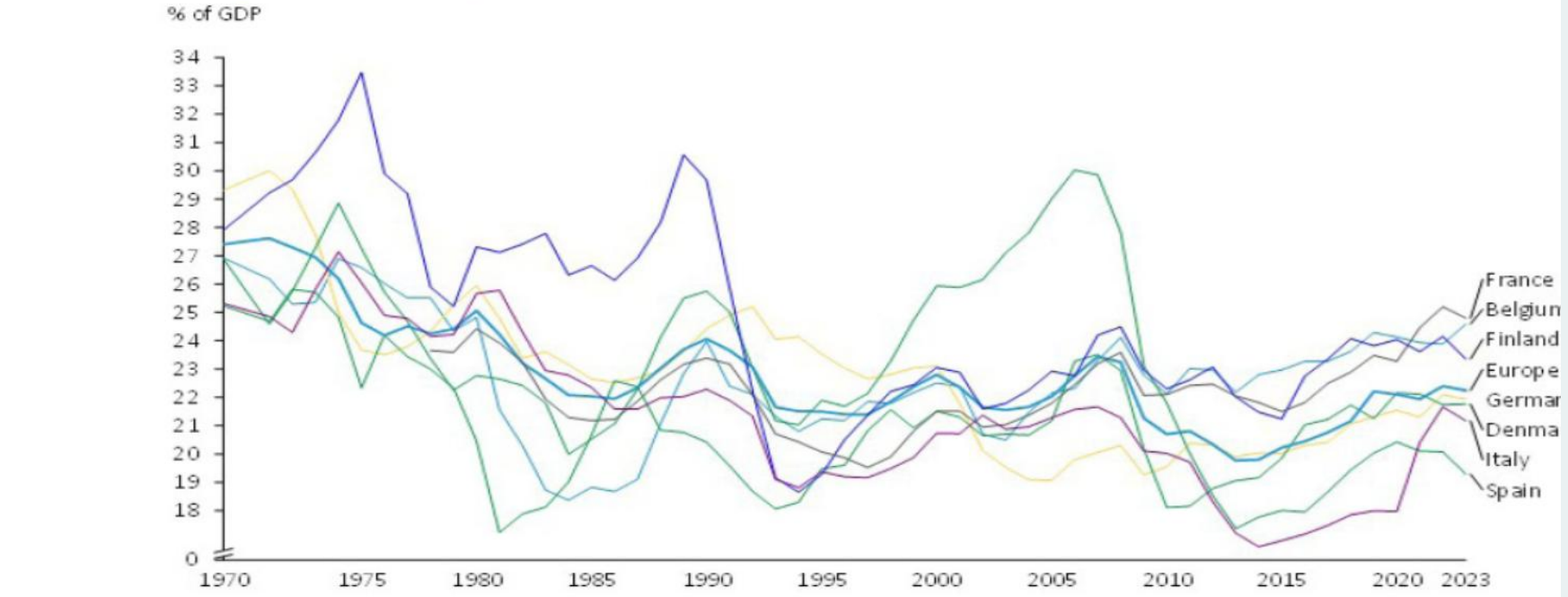
1. An infrastructure gap at EU level for the past 2/3 decades



1 At EU and French levels, decline in investment after the 1970s

FIGURE 3

Evolution of gross fixed capital formation



Source: World Bank national accounts data

1. A gap for investment in future decarbonation–France

Table 1: Sectoral breakdown of the additional low-carbon investment requirement in 2030 compared to the 2021 figure

Sector	Additional low-carbon investment requirement (€bn$_{2022}$/year)	Type
Construction	+39	Gross
	−6	Cost of carbon-emitting alternatives
	−12	Drop in newbuilds
Transportation	+43	Gross
	−29	Cost of carbon-emitting alternatives
Energy	+17	Gross
Industry	+5*	Gross (investment), including operational cost increases
Agriculture and forestry	+5	Additional costs and reforestation
Waste	+1	Additional costs
Total	**Environ +110**	**Gross**
	+63	**Net**
For information	*+13*	*Electric vehicles without demand reduction measures*
	−10	*Energy savings (residential)*
	−9	*Energy savings (road vehicles)*

* Including operating expenses.

Source: L. Gourmand (2024), op. cit.

2. Financing EDF : the Golden Age, and subsequent periods

- In 1958 (max), EDF gets the maximum public investment allocation: 5,7% of the whole GFCF. In 1973 the public budget allocation is the lowest with 2,3%.
- There will be another peak at 5,5% between 1983 and 1985 declining afterwards to finance the nuclear expansion.
- However, the first wave is financed by State investment in EDF, while the second wave is financed by EDF from its own resources.
- In 1967, the Nora reports suggests to lower State investment (“autonomous” “business like management of EDF).
- In 1974, the Treasury advises EDF to directly borrow on financial markets.

In Histoire de l’electricité en France, Henri Morsel, Fayard