Macroeconomics I

Dirk Niepelt

September 11, 2023

Contents

Preface

These slides serve as lecture notes for an intermediate macroeconomics course that closely follows Kurlat (2020). Relative to the material covered in the book it adds a few topics, mostly in chapters A, B and C.

Teaching material prepared by Martín Gonzalez-Eiras (University of Bologna) inspired parts of chapters A and C. See Niepelt (2019) for an advanced treatment of macroeconomic models at the MA/first year PhD level and www.niepelt.ch for related material. See Ljungqvist and Sargent (2018) for an even more advanced treatment.

DN, September 2023

1 GDP

1.1 GDP Accounting

Gross domestic product (GDP) records value of production

Measurement: Three approaches

- Production
- Income
- Expenditure

Table 1.1: US GDP in 2017 according to the three methods. Figures in billions of dollars. Source: BEA.

Production		Income		Expenditure	
Agriculture	169	Employee Comp.	10,421	Consumption	13,321
Mining	269	Corporate Profits	1,807	Investment	3,368
Utilities	308	Proprietor's income	1,501	Govt. spending	3,374
Construction	781	Rental income	730	Exports	2,350
Manufacturing	2,180	Depreciation	3,116	Imports	-2,929
Wholesale + Retail	2,261	Interest Income	768		
Transport	609	Taxes	1,286		
Media	1,051	Statistical discrep.	-143		
Finance + Insurance	1,466				
Real Estate	2,591				
Professional services	2,426				
Educ. + Health	1,700				
Arts + Entertainment	805				
Other services	416				
Government	2,454				
Total	**19,485**	**Total**	**19,485**	**Total**	**19,485**

Kurlat (2020)

Expenditure approach

- $Y = C + I + G + X - M$
- GDP, consumption, investment, public goods/services, exports, imports

Production approach

- Value added rather than sales, to avoid double counting

Depreciation

- "Gross" = before depreciation
- Depreciation recorded as income component

GDP neglects nonmarket activities, important in economies with large informal sectors

Useful examples in book

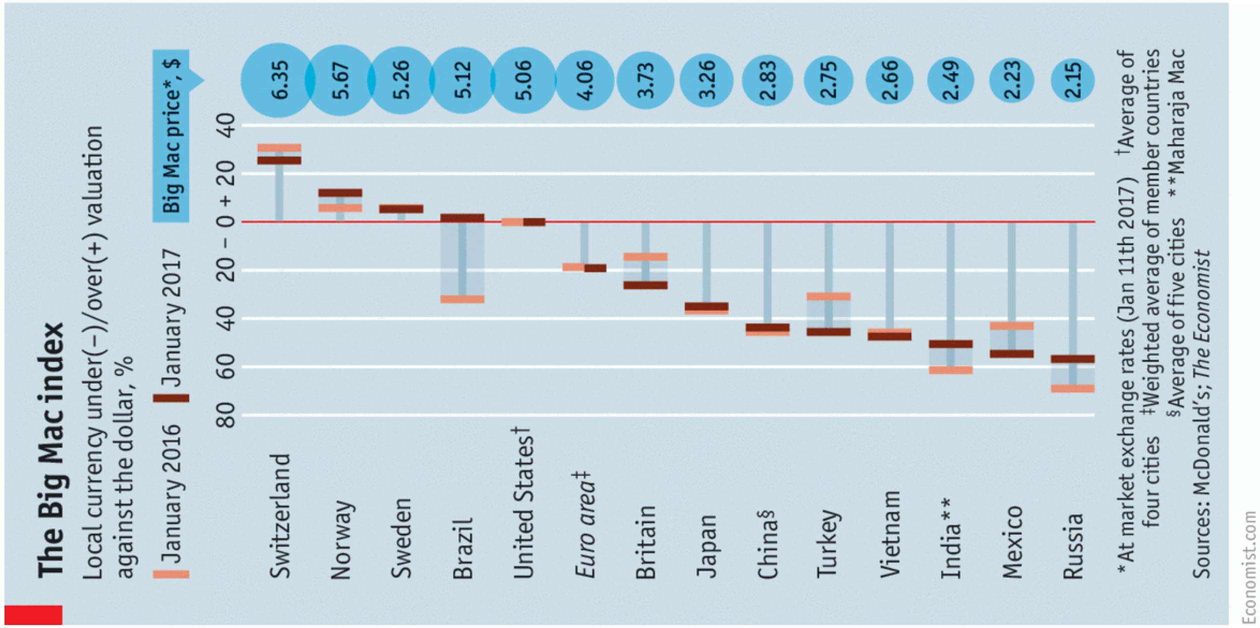
1.2 Making Comparisons

Inter temporally, need to account for price changes

- Real GDP growth reflects nominal growth (valued at current prices) corrected for inflation
- Complicated when prices change asymmetrically

Across borders, need to account for different currencies

- Exchange-rate based adjustments do not fully reflect purchasing power differences
- Valuation of foreign goods, services at domestic prices works
- Side product: Purchasing Power Parity (PPP) exchange rate



The Economist, 2017

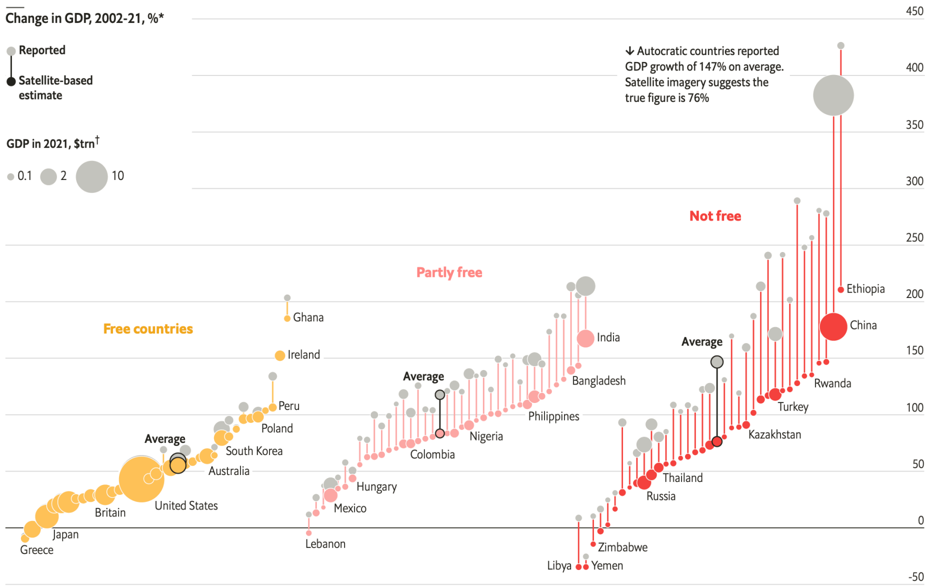
Double checking GDP growth statistics

A study of lights at night suggests dictators lie about economic growth

Satellite data hints at the scale of their deception

Sep 29th 2022

Share



*Countries with over 5m people, freedom status in 2021 †In 2021 $ at market exchange rates, assuming reported 1992 GDP figures are accurate

The Economist, 2022

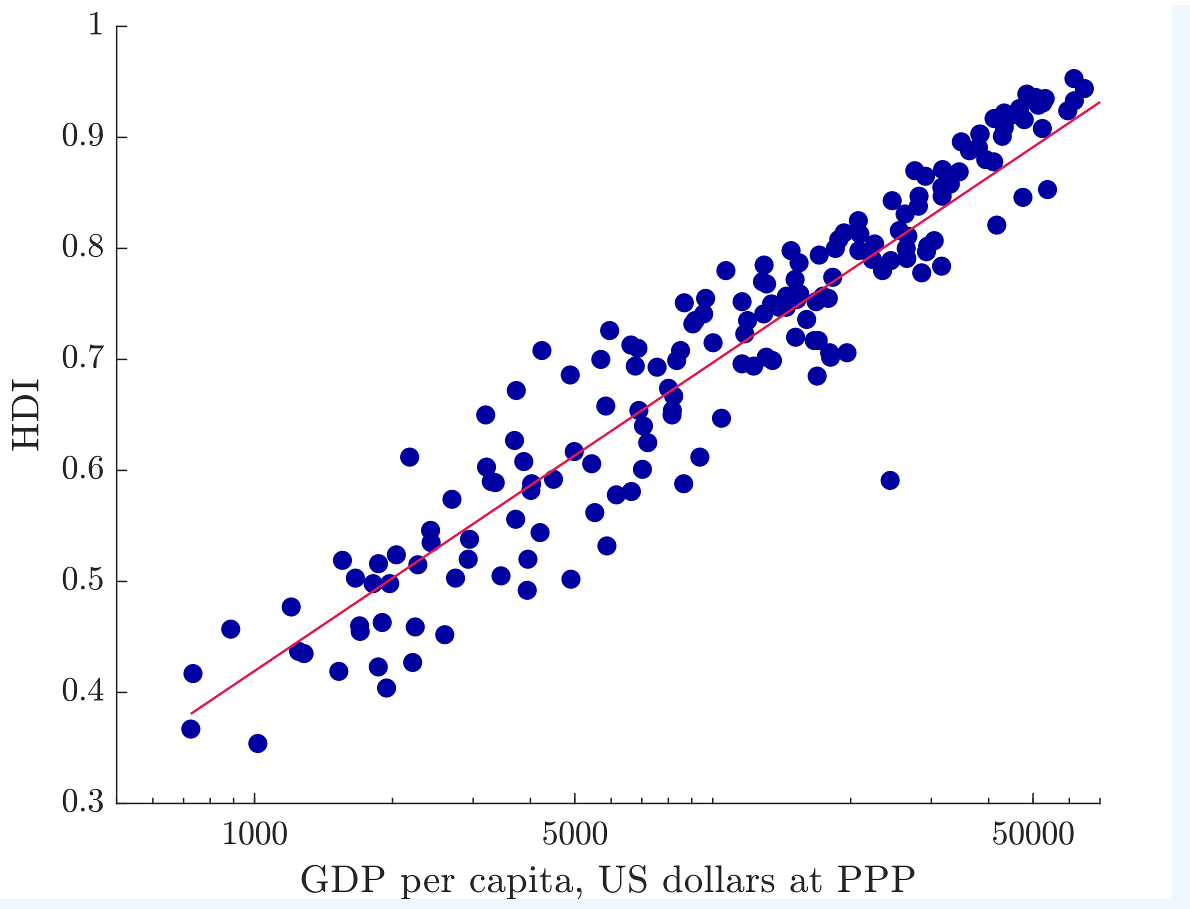
2 Beyond GDP

GDP is incomplete measure of living standards

2.1 The Human Development Index

Average of life expectancy, education, income indices

Highly correlated with GDP per capita



HDI
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
1000
5000
50000
GDP per capita, US dollars at PPP

Kurlat (2020)

2.2 Beyond GDP

Jones and Klenow (2016) propose measure more firmly grounded in economic theory, accounting for

- Consumption (public, private, not production)
- Leisure, consumption of nonmarket production
- Life expectancy
- Inequality

Stipulate utility function

$$u(c,l,a) \equiv \mathbb{E}\left[\left(\bar{u} + \frac{c^{1-\sigma}}{1-\sigma} - \theta(1-l)^2\right) a\right], \sigma > 0$$

Consumption, leisure/nonmarket activity time share, being alive

Compare country X, US based on equivalent variation λ^X

$$u(\lambda^X c^X, l^X, a^X) = u(c^{US}, l^{US}, a^{US})$$

Expectation reflects veil of ignorance, accounts for cross-household consumption variability

Concavity of u with respect to c (governed by σ) reflects aversion to risk, inequality

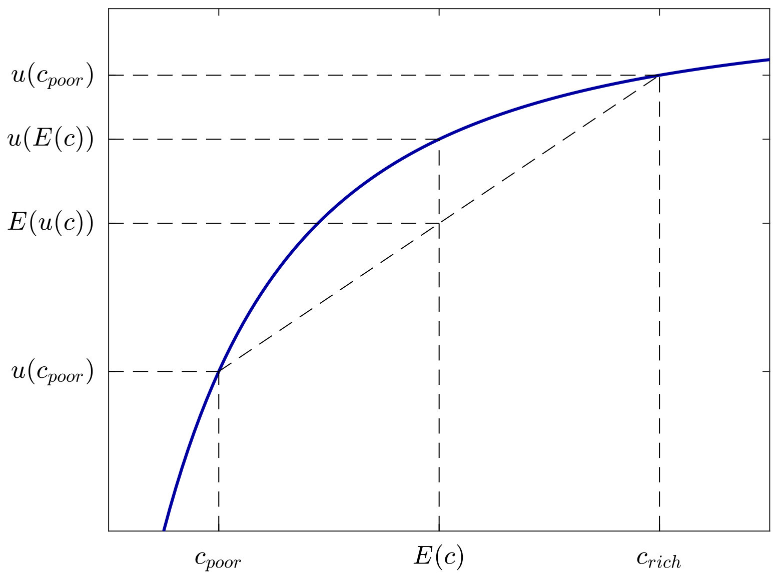


Fig. 2.2.1: *Concavity of the utility function and risk aversion.*

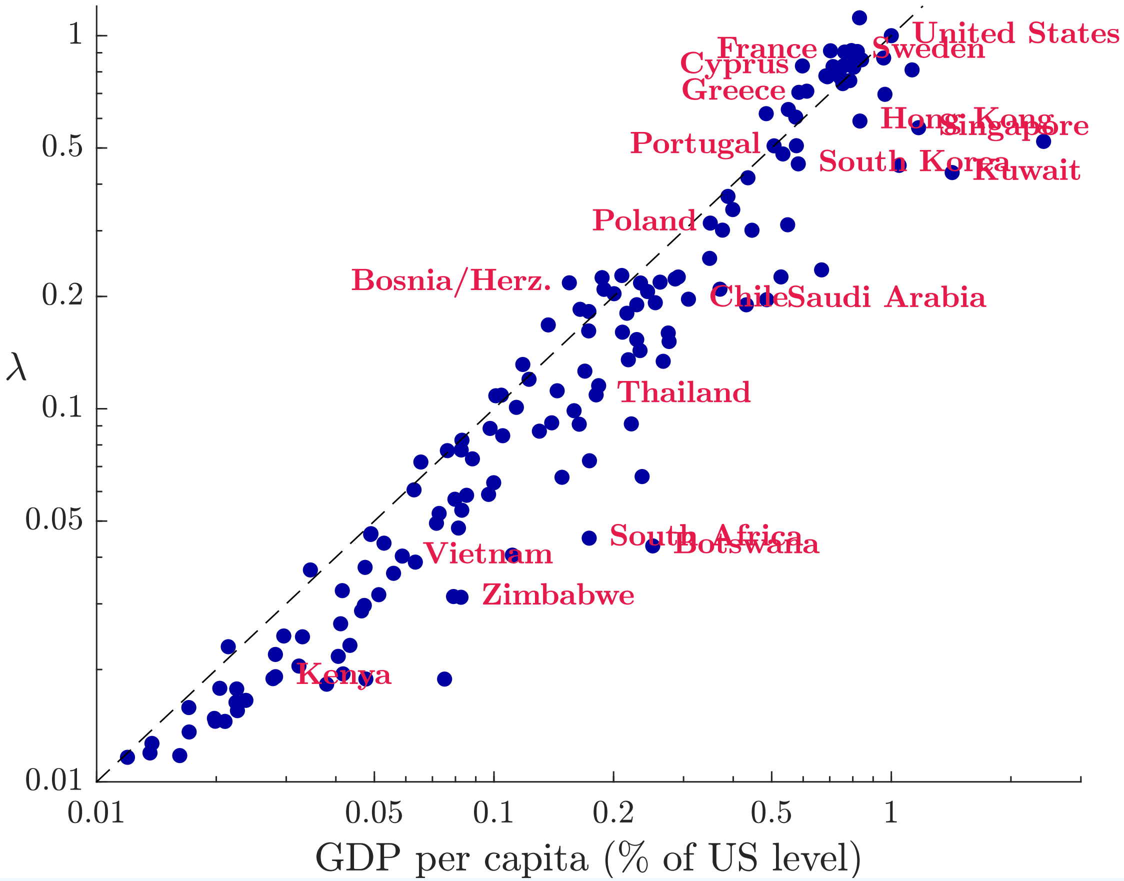
Kurlat (2020)

Jones and Klenow (2016) back out $\bar{u}$, σ, θ from observed choices

Feed data on c distribution, l, a for X, US

Solve for λ^X

$$u(\lambda^X c^X, l^X, a^X) = u(c^{US}, l^{US}, a^{US})$$



United States
France
Sweden
Cyprus
Greece
Hong Kong
Singapore
Portugal
South Korea
Kuwait
Poland
Bosnia/Herz.
Chile
Saudi Arabia
Thailand
South Africa
Botswana
Vietnam
Zimbabwe
Kenya
λ
1
0.5
0.2
0.1
0.05
0.01
0.01
0.05
0.1
0.2
0.5
1
GDP per capita (% of US level)

Kurlat (2020)

Findings

- GDP per capita highly correlated with λ
- Western Europe does better than what GDP suggests, due to life expectancy, leisure, low inequality
- Rich East Asia, Kuwait do worse than what GDP suggests, due to low consumption relative to GDP
- Sub-Saharan Africa does worse than what GDP suggests, due to life expectancy, inequality

3 Basic Facts about Economic Growth

3.1 The Very Long Run

Low GDP per capita for centuries, barely above subsistence

Industrial revolution in 19th century, shift from agriculture to industry

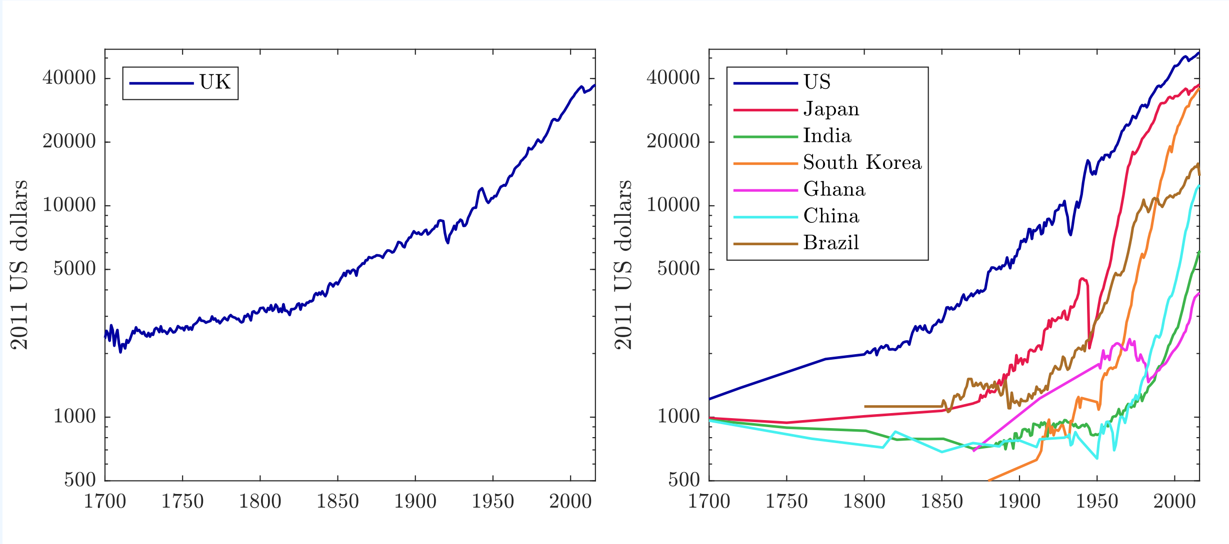


Fig. 3.1.1: *GDP per capita in the UK and selected countries. Source: Bolt et al. (2018).*

Kurlat (2020)

3.2 The Kaldor Facts

Kaldor (1957) observes "stylized facts"

- Constant GDP-per-capita growth, 1.5% annually in US
- Constant capital-to-GDP ratio, 3.2 on annual basis in US
- Constant capital, labor shares, 1/3 vs. 2/3 in US
- Constant return on capital (follows from #2, #3)

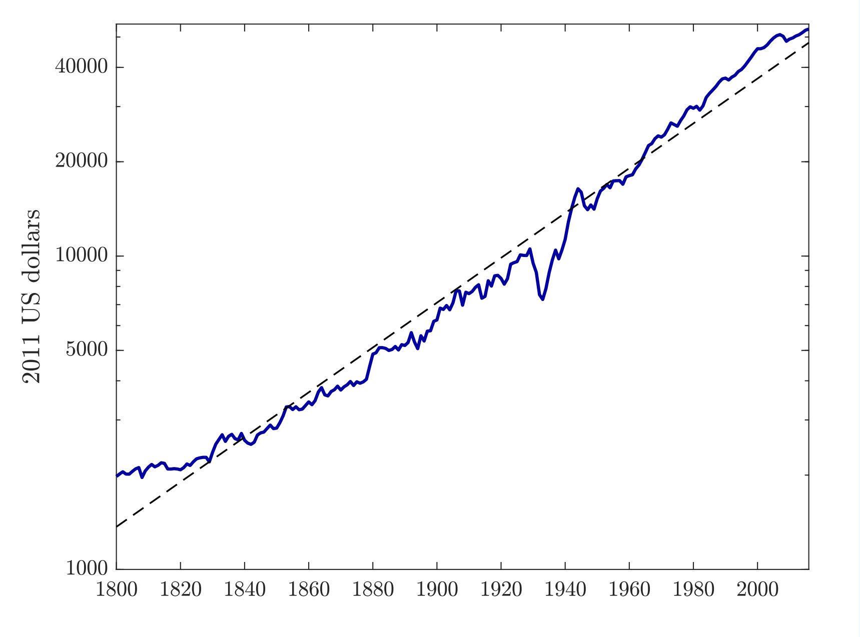


Fig. 3.2.1: *GDP per capita in the US. Source: Bolt et al. (2018).*

Kurlat (2020)

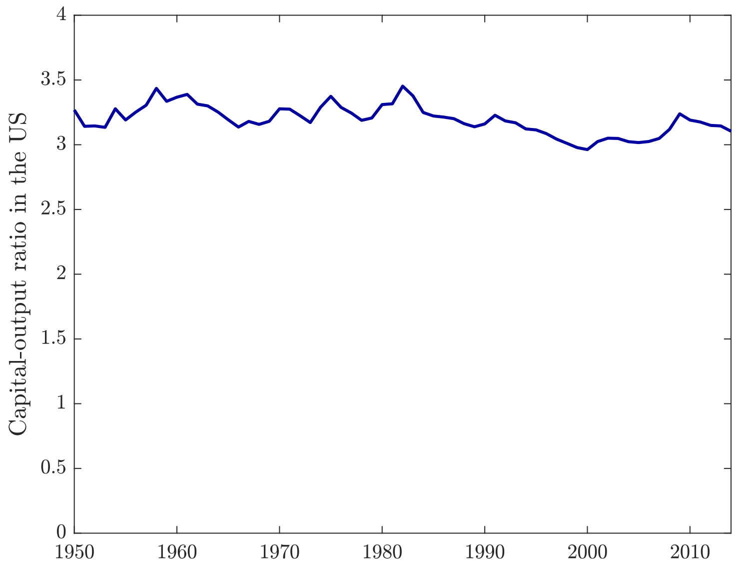


Fig. 3.2.2: *Capital-to-output ratio in the US. Source: Feenstra et al. (2015).*

Kurlat (2020)

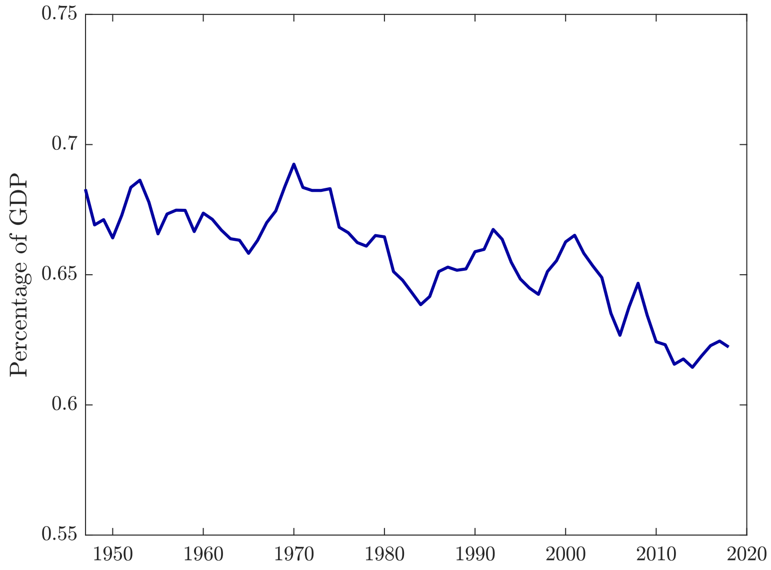


Fig. 3.2.3: *The labor share of GDP in the US. Labor income is Compensation of Employees. Capital income is Corporate Profits + Rental Income + Interest Income + Depreciation. Source: NIPA.*

Kurlat (2020)

3.3 Growth Across Countries

Conditional on GDP per capita in 1960

- Rich countries subsequently exhibited similar growth rates
- Poor countries did not; some caught up, others stagnated

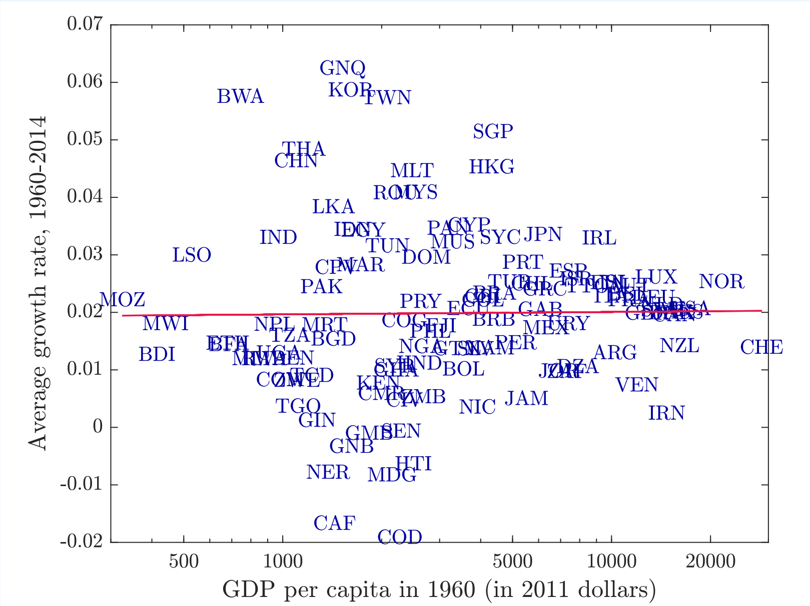


Fig. 3.3.1: *Growth across countries since 1960. Source: Feenstra et al. (2015).*

Kurlat (2020)

4 The Solow Growth Model

Simple model to think about growth, due to Solow (1956)

4.1 Ingredients of the Model

Production function, $Y = F(K, L)$

- Constant returns to scale, $F(\lambda K, \lambda L) = \lambda F(K, L) \;\; \forall \, \lambda > 0$
- Positive marginal products, $F_K(K, L), F_L(K, L) > 0$
- Diminishing marginal products, $F_{KK}(K, L), F_{LL}(K, L) < 0$
- Inada conditions, $\lim_{K \to 0} F_K(K, L) = \infty$, $\lim_{K \to \infty} F_K(K, L) = 0$, etc.

Example: Cobb-Douglas production function, $Y = K^{\alpha} L^{1-\alpha}$

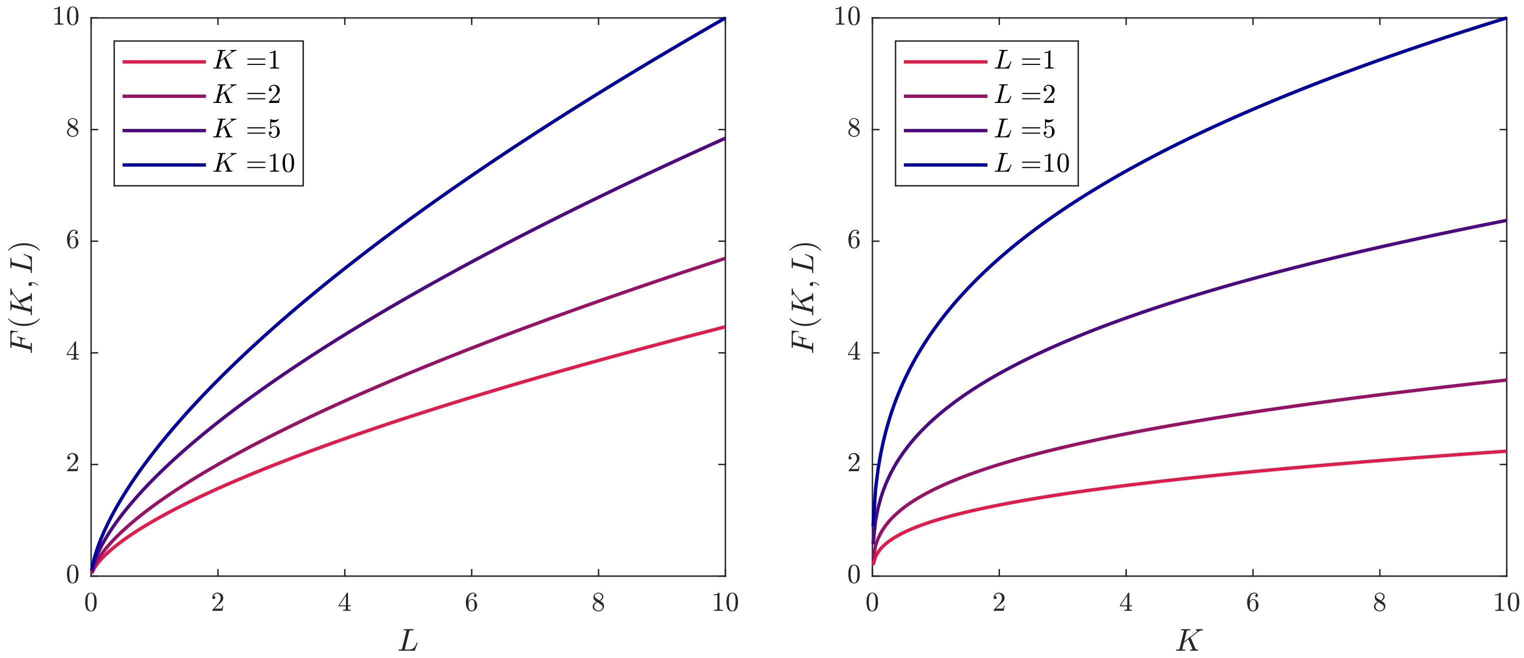


Fig. 4.1.1: *The Cobb Douglas production function for $\alpha = 0.35$.*

Kurlat (2020)

Population and labor supply, $L_{t+1} = (1+n)L_t$

- Constant population growth rate, n
- Labor force = population

Consumption and investment, $Y = C + I$

- Closed economy ($X = M = 0 \Rightarrow S = I$)
- No government ($G = 0$)
- Exogenous savings rate, $S/Y \equiv (Y - C)/Y = s \Rightarrow I = sY$

Depreciation and capital accumulation, $K_{t+1} = (1-\delta)K_t + I_t$

- Constant depreciation rate, δ

4.2 Mechanics of the Model

Normalize output, using constant returns to scale

$$y \equiv \frac{Y}{L} = \frac{F(K,L)}{L} = F\left(\frac{K}{L},1\right) \equiv f\left(\frac{K}{L}\right)$$

Normalize capital accumulation, letting $k_t \equiv K_t/L_t$

$$k_{t+1} - k_t = \frac{sf(k_t) - (\delta + n)k_t}{1+n}, \;\; \Delta k_t \uparrow \text{in } s, \downarrow \text{in } \delta, n$$

Convergence to (stable) steady state, k_{ss}, $f(k_{ss})$

$$\Delta k_t \lesseqgtr 0 \;\Leftrightarrow\; sf(k_t) \lesseqgtr (\delta + n)k_t$$

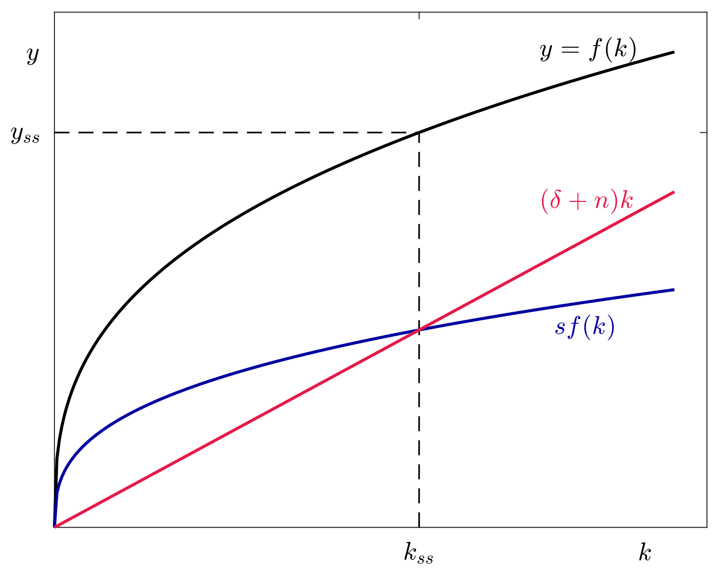


Fig. 4.2.1: *The forces that govern the evolution of the level of capital per worker in the Solow model.*

Kurlat (2020)

Increase in s (left), n (right): Level, not growth effects (p.c.)

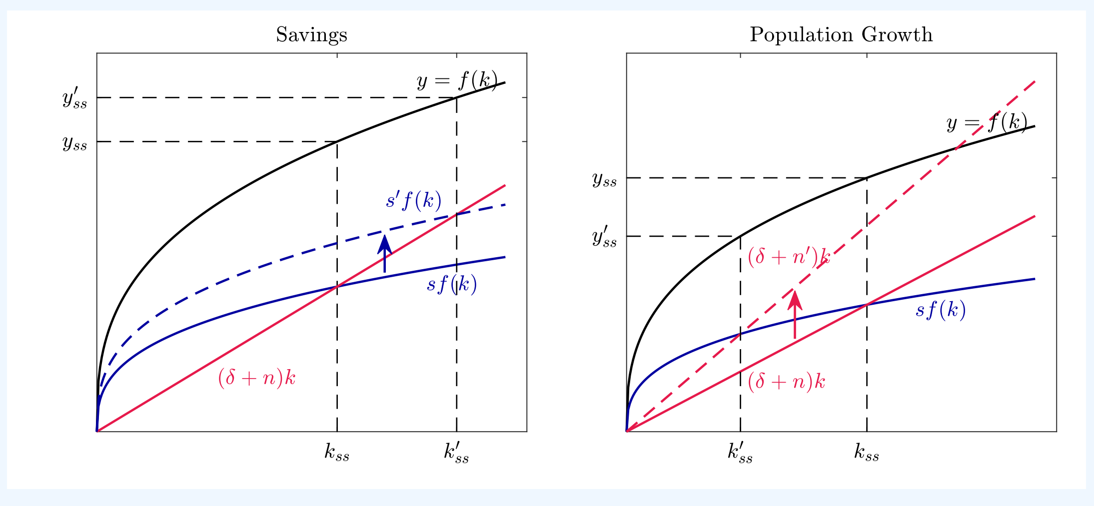


Fig. 4.2.2: *Increases in the savings rate and the rate of population growth.*

Kurlat (2020)

Increase in productivity: Level, not growth effect (p.c.)

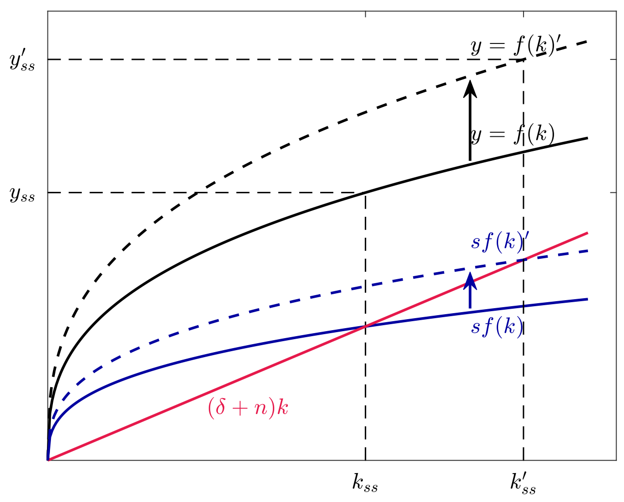


Fig. 4.2.3: *An upward shift in the production function.*

Kurlat (2020)

4.3 The Golden Rule

Which savings rate maximizes steady-state consumption?

$$c_{ss} = (1-s)f(k_{ss})$$

positive and negative effect of s

Or, which steady-state capital stock maximizes c_{ss}?

$$c_{ss} = f(k_{ss}) - (\delta + n)k_{ss}$$

Golden rule capital stock, k_{gr}, solves

$$f'(k_{gr}) = \delta + n$$

(k_{gr} implies maximizing s)

4.4 Markets

What are equilibrium factor prices if firms produce output?

Competitive (price taking), profit maximizing firms rent K, L from households, produce output

$$\max_{K_i,L_i} F(K_i, L_i) - wL_i - r^K K_i$$

Market clearing, $\sum_i K_i = K, \sum_i L_i = L$

Optimality, market clearing, constant returns to scale imply

$$\begin{aligned} r^K &= F_K(K_i, L_i) = F_K(K, L) = f'(k) \\ w &= F_L(K_i, L_i) = F_L(K, L) = f(k) - kf'(k) \end{aligned}$$

Pure firm profits equal zero in competitive equilibrium, due to constant returns to scale

$$\begin{aligned} \text{profit}_i &= F(K_i, L_i) - wL_i - r^K K_i \\ &= F(K_i, L_i) - F_L(K_i, L_i)L_i - F_K(K_i, L_i)K_i \equiv 0 \end{aligned}$$

Return on investment determines interest rate, r_{t+1}

$$\begin{aligned} & \text{unit of investment at } t \text{ yields } 1 - \delta + r^K_{t+1} \text{ at } t+1 \\ \Rightarrow \quad & r_{t+1} = r^K_{t+1} - \delta = f'(k_{t+1}) - \delta \end{aligned}$$

4.5 Technological Progress

For long-term per-capita growth, introduce technological progress

$$Y_t = F(K_t, A_t L_t)$$
$$A_{t+1} = (1+g)A_t$$

Normalizing by labor in efficiency units, AL, rather than L yields

$$\bar{k}_{t+1} - \bar{k}_t = \frac{sf(\bar{k}_t) - (\delta + n + g)\bar{k}_t}{1+n+g} \quad \text{(letting } ng \approx 0\text{)}$$

Previous characterization of steady state directly extends

$$sf(\bar{k}_{ss}) = (\delta + n + g)\bar{k}_{ss}$$

In steady state, constant $\bar{k}_{ss}, \bar{y}_{ss}$ but growing (at rate g) per-capita output, consumption, capital

5 Confronting Theory and Evidence

Comparing Solow (1956) model with data

5.1 The Kaldor Facts Again

Kaldor (1957)	Solow (1956)
• Constant GDP-per-capita growth	success, exogenous
• Constant capital-to-GDP ratio	success
• Constant capital, labor shares	success
• Constant return on capital (follows from #2, #3)	

5.2 Putting Numbers on the Model

Assume Cobb-Douglas production function, $Y = K^{\alpha}(AL)^{1-\alpha}$, implying labor share $L \cdot (\partial Y/\partial L)/Y = 1 - \alpha$

Calibration for US

- $\alpha = 0.35$ (labor share ≈ 0.65)
- $g = 0.015$ (per-capita growth post 1800)
- $n = 0.01$ (population growth post 1950)
- $\delta = 0.04$ (average across types of capital)
- $s = 0.20$ (investment rate, assuming closed economy)

Implies realistic capital-output ratio

$$\frac{K_{ss}}{Y_{ss}} = \frac{\bar{k}_{ss}}{f(\bar{k}_{ss})} = \frac{s}{\delta + n + g} \approx 3.08$$

But very high interest rate, close to real-world equity return (risky)

$$r = f'(\bar{k}_{ss}) - \delta = \alpha \frac{f(\bar{k}_{ss})}{\bar{k}_{ss}} - \delta \approx 7.38\%$$

Increase in s from 0.20 to 0.25: Slow transition

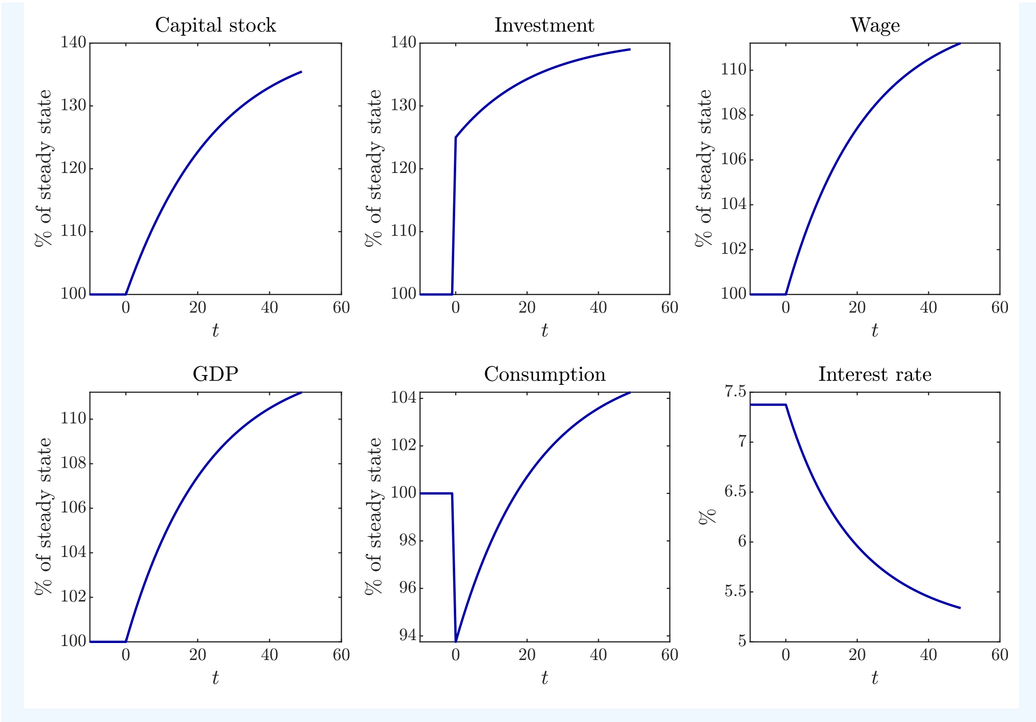


Fig. 5.2.3: The economy's response to a higher saving rate. The capital stock, GDP, consumption, and investment are scaled by efficiency units of labor.

Kurlat (2020)

5.3 The Capital Accumulation Hypothesis

Why cross-country y variation? Conjecture: Same F, A, not k

Implies convergence (for simplicity, let $n = g = 0$)

$$\frac{y_{t+1} - y_t}{y_t} \approx \frac{f'(k_t)(k_{t+1} - k_t)}{f(k_t)} = \frac{f'(k_t)(sf(k_t) - \delta k_t)}{f(k_t)} = sf'(k_t) - \delta\alpha$$

Previously (ch. 3), found no empirical support (stronger support with population weighting (China, India effect), within US, EU)

Also, y differences implied by k differences do not match data

Also, r^K differences implied by y differences do not match data

$\Rightarrow$ Conjecture of same F, A appears not to hold up

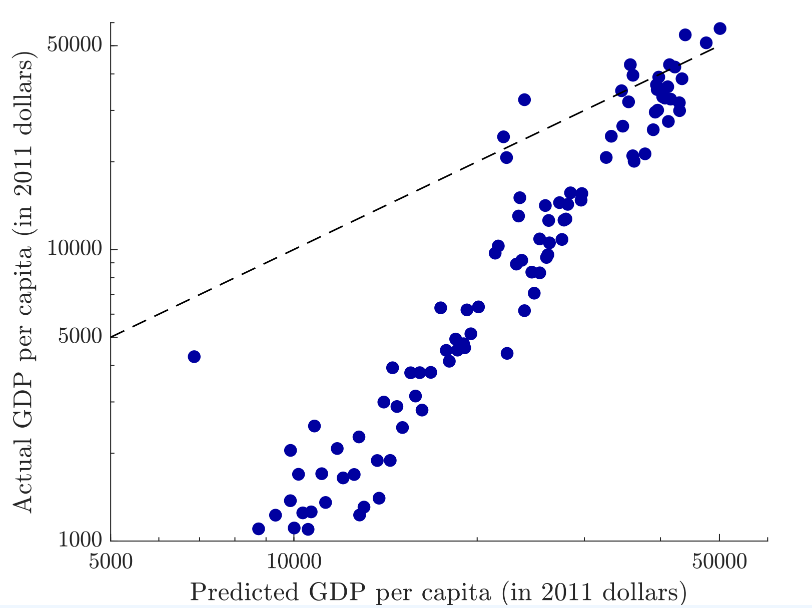


***Fig. 5.3.3:** Predicted GDP per capita on the basis of capital stock compared to actual GDP per capita. Source: Feenstra et al. (2015)*

Kurlat (2020)

5.4 Growth Accounting

Decompose GDP growth, assuming $Y_t = F(K_t, L_t, A_t)$

$$g_{Yt} \approx \underbrace{\frac{F_K(\cdot)K_t}{F(\cdot)}}_{\text{capital share}} g_{Kt} + \underbrace{\frac{F_L(\cdot)L_t}{F(\cdot)}}_{\text{labor share}} g_{Lt} + \underbrace{\frac{F_A(\cdot)A_t}{F(\cdot)} g_{At}}_{\text{Solow residual, TFP growth}}$$

Implications

- Fast growth in USSR in 1960s reflected investment, not TFP
- Ditto for some East Asian "tigers" in 1990s
- China?

5.5 Where Do TFP Differences Come From?

Human capital (identification problem!)

- Years of schooling (wage valued) improve model fit

Geography

- Moderate climate benefits agriculture, health

Institutions (identification problem!)

- Democracy, rule of law, . . . (settler mortality instrument)

Efficient resource allocation (identification problem!)

- Barriers to entry, credit constraints, management style

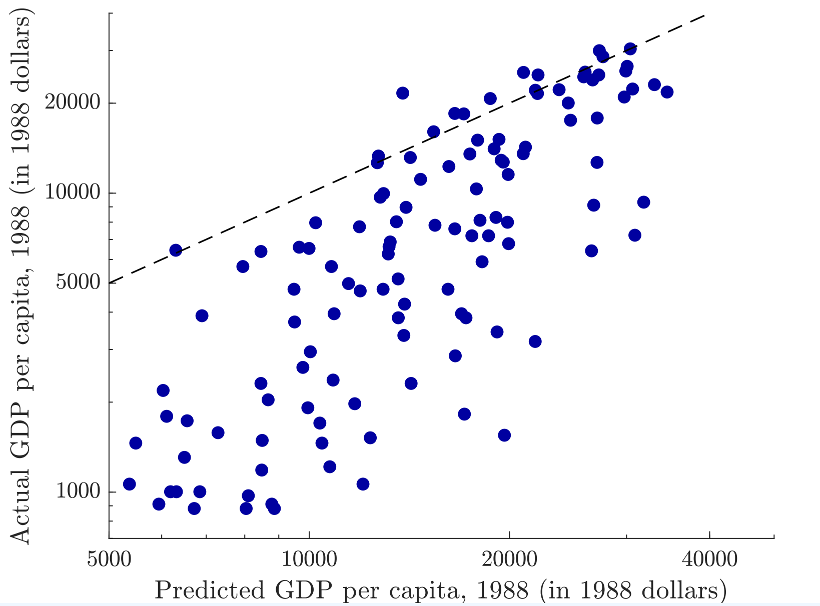


Fig. 5.5.1: *Predicted GDP per capita on the basis of capital stock human capital compared to actual GDP per capita. Source: Hall and Jones (1999).*

Kurlat (2020)

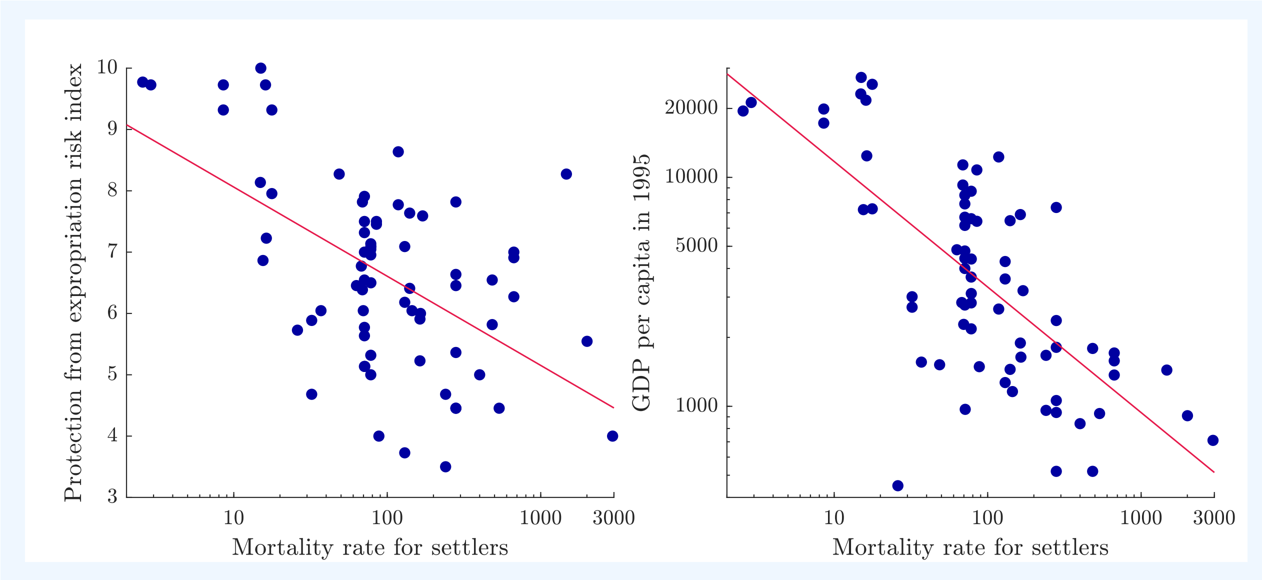


Fig. 5.5.3: Mortality of colonial settlers, present-day institutions and present-day GDP per capita. Source: Acemoglu et al. (2001).

Kurlat (2020)

A Endogenous Growth, Inequality, Global Warming

A.1 Endogenous Growth

Endogenous long-term per-capita growth due to bounded marginal product of capital

Example: Ak model

$$\begin{aligned} & Y = F(K, L) = AK \ \text{(letting } L = 1, n = 0, g = 0) \\ \Rightarrow \ & F_K(K, L) > 0,\ F_{KK}(K, L) = 0 \end{aligned}$$

Permanent (positive or negative) capital accumulation

$$k_{t+1} - k_t = sAk_t - \delta k_t \lesseqgtr 0 \ \Leftrightarrow \ sA - \delta \lesseqgtr 0$$

Example: Externalities (Romer, 1986)

$$Y_i = F(K_i, 1) = AK_i^{\alpha} \qquad (F_{KK} < 0 \text{ at firm level for given } A)$$

$$A = \bar{A} \cdot (\mathbb{M}\text{ean}[K_j])^{1-\alpha} \qquad \text{(externality across firms)}$$

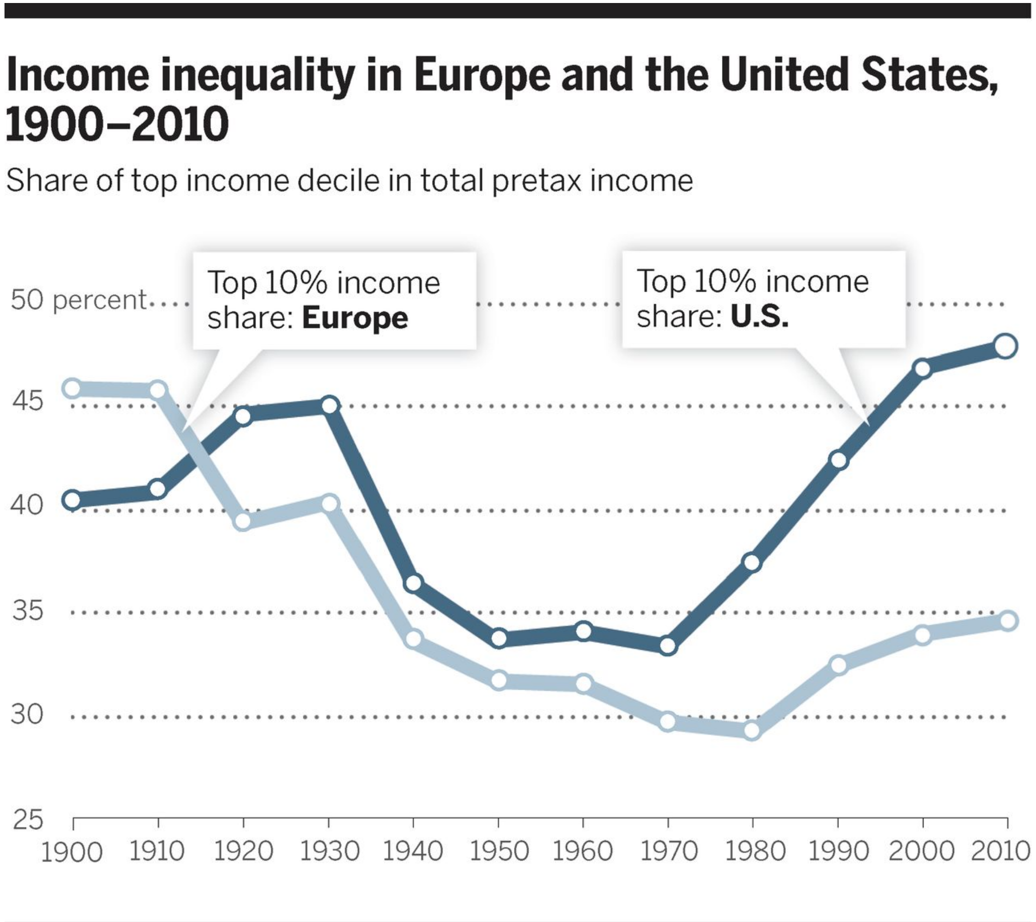
$$\Rightarrow \quad F(K_i, 1)|_{K_i = K_j} = \bar{A}K_i \qquad (\text{in equilibrium } Ak \text{ structure})$$

A.2 Inequality

US income tax data (Piketty and Saez, 2003)

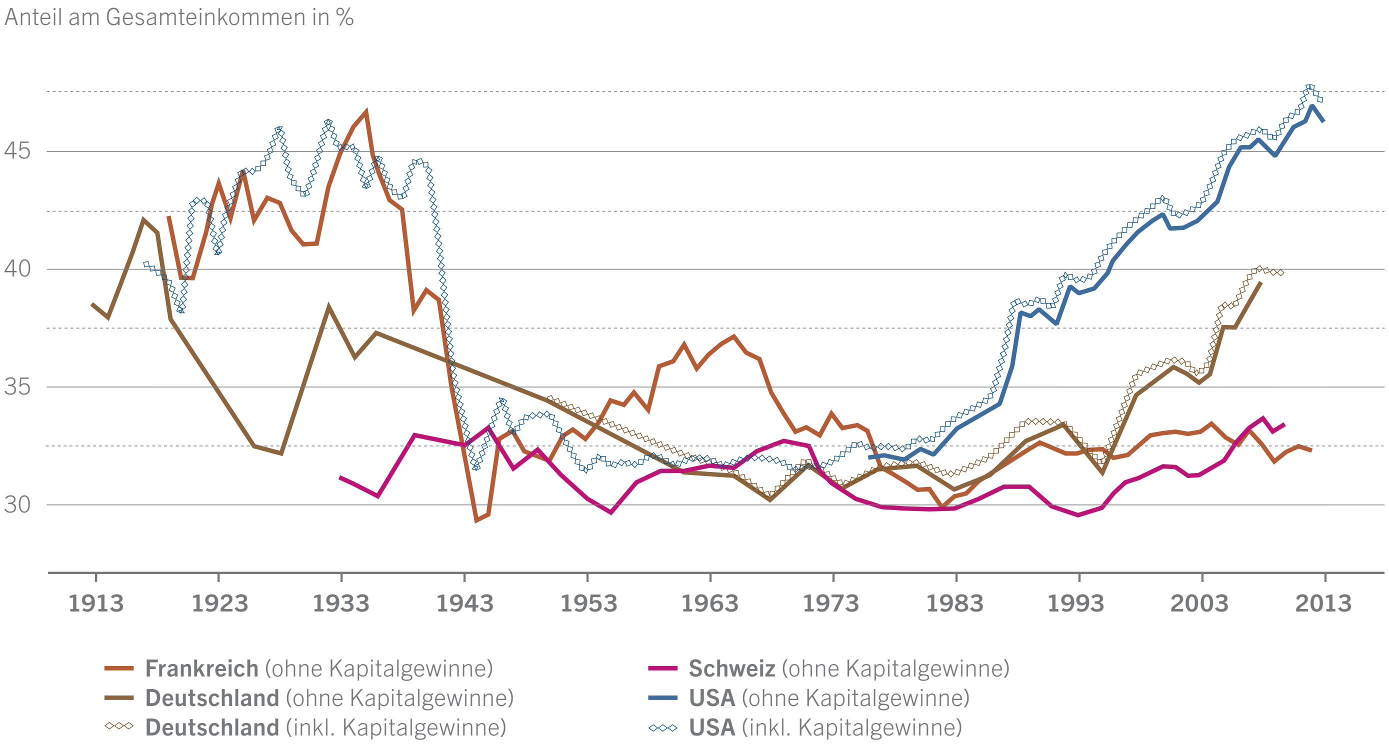
- Income share of top 10%, top 1% declined after WWII
- Reverted around 1980

Similar results for other but not all countries



Piketty and Saez (2014)

Abb. 2 **Anteile der einkommensstärksten 10% im internationalen Vergleich, 1913–2013**



Quelle: WID (World Wealth and Income Database).

Föllmi and Martínez (2017)

Abb. 13 **Mobilitätsmatrix Kanton Zürich**

Einkommensversteilung in Dezilen

2001 \ 2010	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
D1	43	19	10	6	5	4	4	3	3	3
D2	19	29	19	11	7	5	4	3	2	1
D3	10	17	23	18	12	8	5	4	2	1
D4	7	11	16	20	17	11	8	5	3	2
D5	5	8	11	15	19	17	12	8	5	2
D6	4	6	8	11	15	19	16	11	7	3
D7	4	4	6	8	11	16	19	17	10	5
D8	3	3	4	5	7	11	17	22	18	8
D9	3	2	3	3	5	7	11	19	29	18
D10	3	2	1	2	2	3	4	8	20	56

Dezile der Einkommensverteilung, 25- bis 64-Jährige (2001, d.h. Jahrgänge 1937–1976), 2001 bis 2010 ununterbrochen im Kanton Zürich Steuerpflichtige, Werte in Zeilenprozenten. Die Dezilsabgrenzungen (steuerbares Einkommen in 1000 Franken) sind auf der Basis 2010 kaufkraftbereinigt.

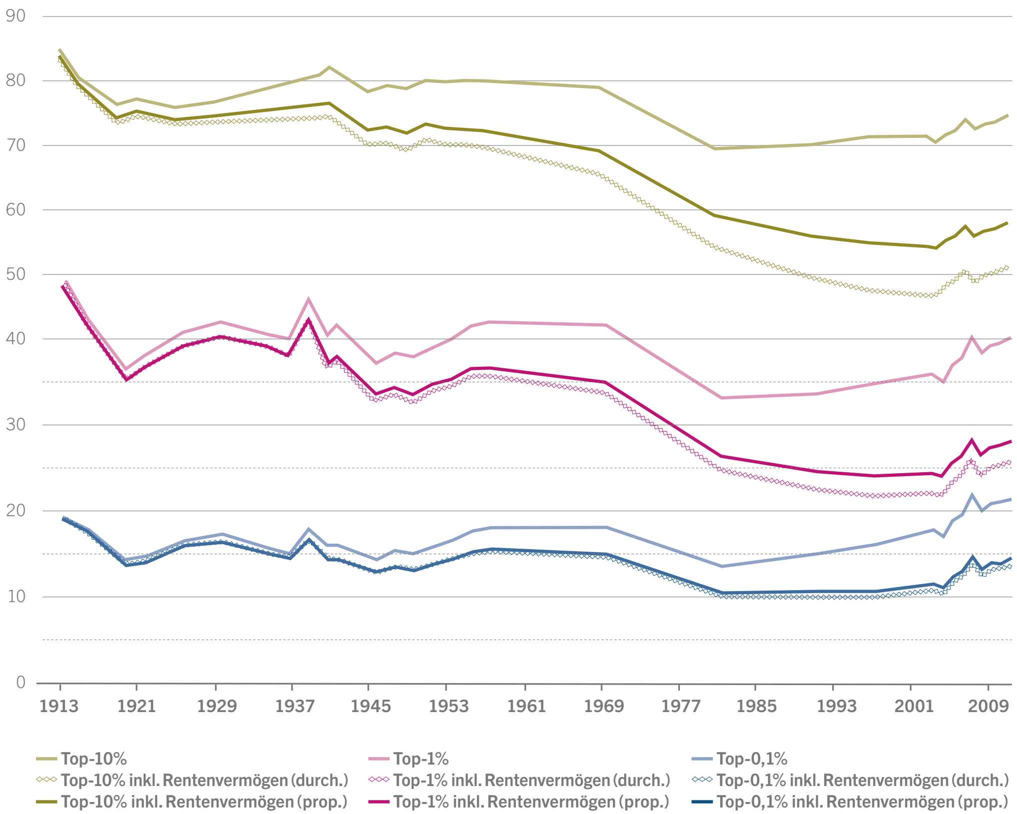
Lesehilfe: 43% der Steuerpflichtigen, welche 2001 zum untersten Zehntel der Einkommensverteilung gehörten (D1), waren auch 2010 auf demselben Rang; 10% sind vom ersten ins dritte Dezil aufgestiegen.

Quelle: Moser (2013), eigene Darstellung.

Föllmi and Martínez (2017)

Abb. 17 **Vermögensanteile der Reichsten 10%, 1% und 0,1%**

Anteil am Gesamtvermögen in %



Quelle: Föllmi und Martínez (2017).

Föllmi and Martínez (2017)

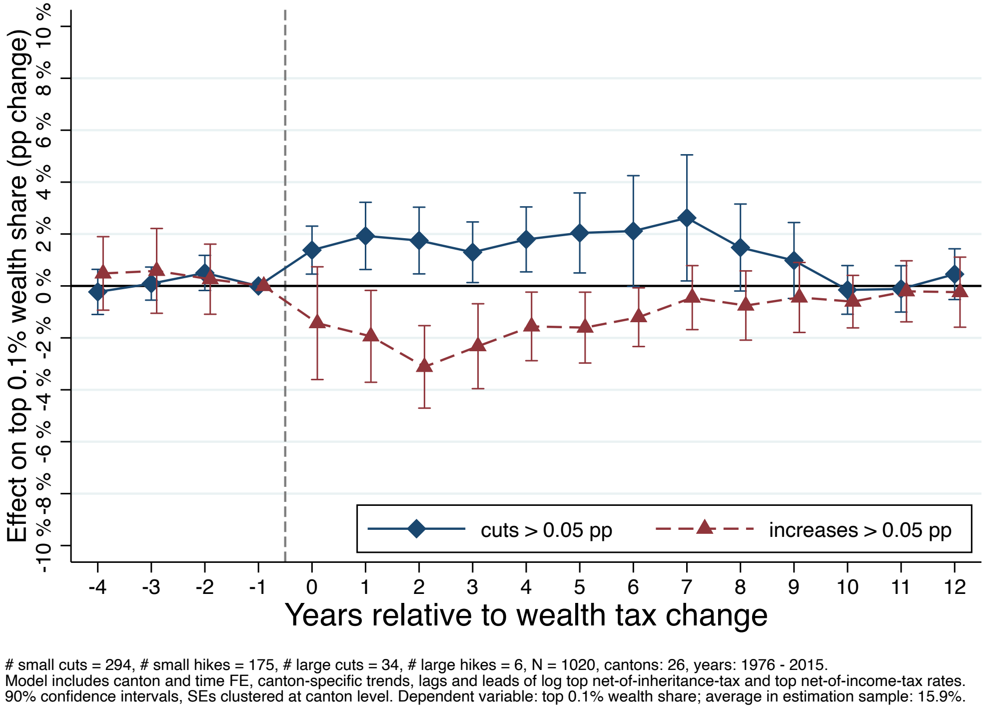


Figure 8: Cross-canton event study, top 0.1% wealth share

Marti et al. (2023)

Inequality and growth

- Inequality coupled with frictions prevents efficient investment, undermines growth

  Example: University admission subject to credit constraints

- Inequality lets insiders buy political influence, helps prevent entry of competitors, undermines growth

- Inequality reduction via taxes, transfers distorts choices, undermines growth

  Example: Labor income tax reduces labor supply, incentive to study

A.3 Global Warming

Carbon emissions raise temperatures over long periods

Long-term effects on growth, quality of life

- Negative for some, positive for others
- SwissRe Institute report predicts 10% output loss by 2050 on current trajectory (failure to meet Paris Agreement targets)
- Dispute about quantitative relevance: Is 10% a lot?

Avoidance vs. adaptation

CO_2 price, climate clubs, innovation (Nordhaus, 2019)

A.4 Further Readings

See, e.g., Acemoglu (2009), Niepelt (2019, ch. 6.1.3, 6.2.2)

6 Consumption and Saving

6.1 The Keynesian View of Consumption

$$C = c(Y),\ \ c'(Y) < 1$$

Or alternatively

$$C = c(Y),\ \ \frac{c'(Y)/c(Y)}{1/Y} = \frac{\partial \ln(c(Y))}{\partial \ln(Y)} < 1$$

Estimated slope, elasticity in cross-household data

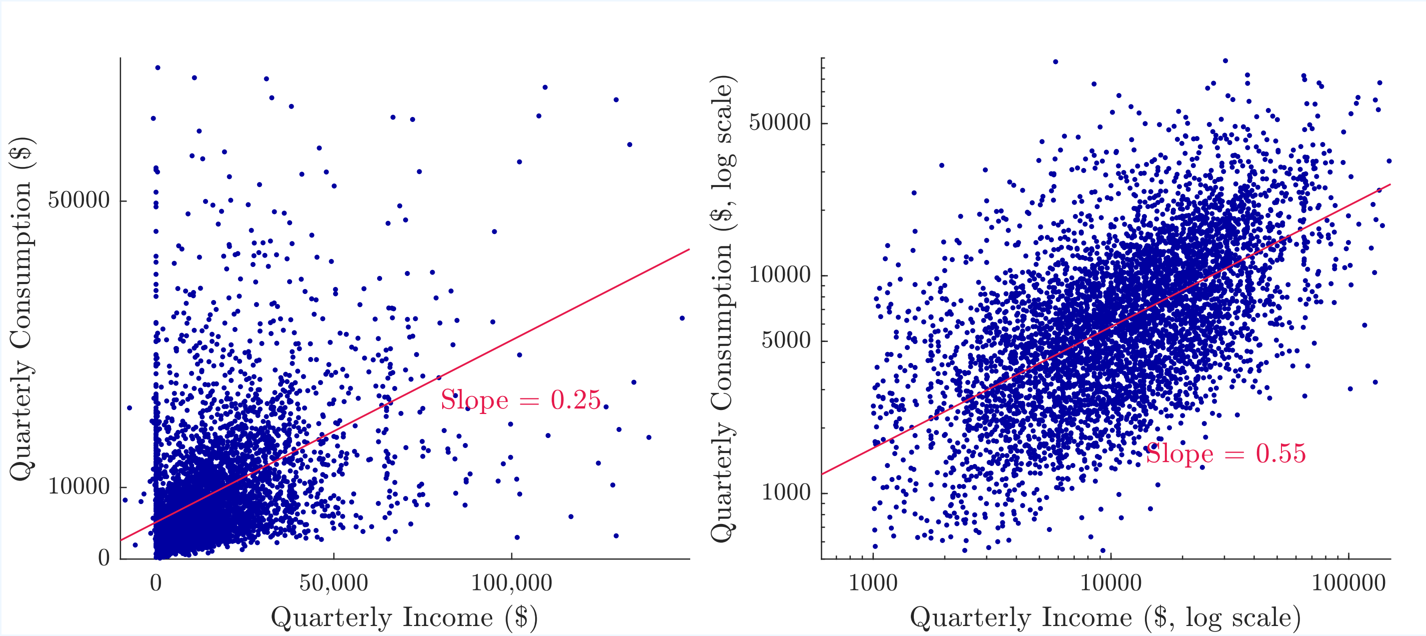


Fig. 6.1.1: *Evidence on the Keynesian consumption function. Each dot represents a household. Source: Consumer Expenditure Survey, 2014.*

Kurlat (2020)

Estimated slope, elasticity in time series, cross-country data

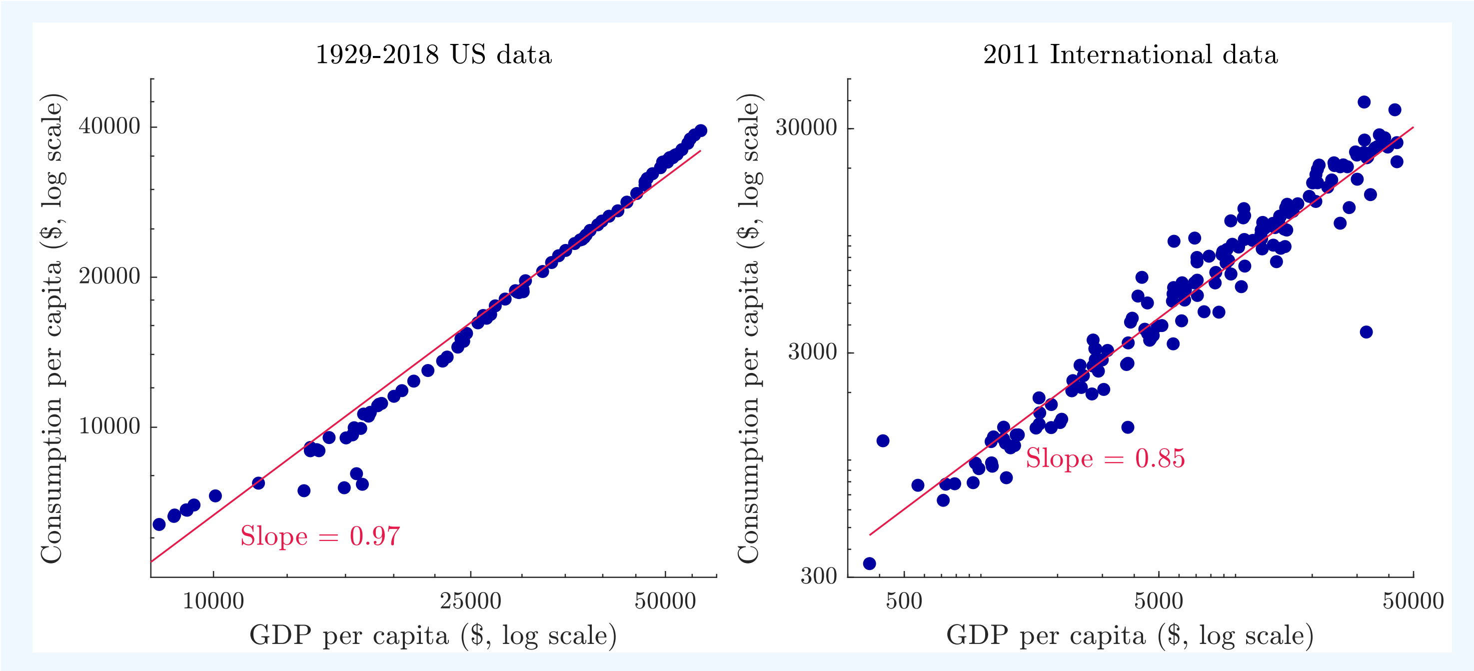


Fig. 6.1.2: *Evidence on the Keynesian consumption function from aggregate data. The left panel is US time-series evidence; the right panel is cross-country evidence. Sources: NIPA and Feenstra et al. (2015)*

Kurlat (2020)

6.2 A Two-Period Model of Consumption

Objectives

- Make sense of data
- Micro economic foundations

Model

- Household lives for two periods, $t = 1, 2$
- Likes consumption, $U(c_1, c_2) = u(c_1) + \beta u(c_2)$
- Exogenous incomes, y_1, y_2
- Saving, borrowing at rate r

Budget constraints

$$\begin{aligned} c_1 &= y_1 - a \\ c_2 &= y_2 + a(1+r) \\ \Rightarrow \; c_1 + \frac{1}{1+r}c_2 &= y_1 + \frac{1}{1+r}y_2 \end{aligned}$$

Income, consumption, savings, wealth, relative price, consumption expenditures

Household's program

$$\max_{c_1,c_2} U(c_1,c_2) \;\text{ s.t. }\; c_1 + \frac{1}{1+r}c_2 = y_1 + \frac{1}{1+r}y_2$$

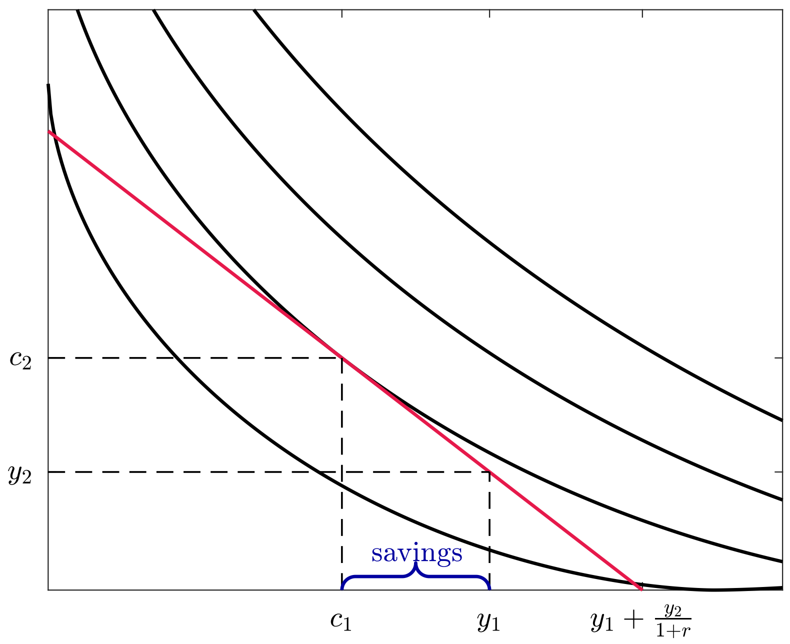


Fig. 6.2.1: *The consumption-savings decision as a two-good consumption problem.*

Kurlat (2020)

Lagrangian

$$\mathcal{L}(c_1, c_2, \lambda) = u(c_1) + \beta u(c_2) - \lambda \left[c_1 + \frac{c_2}{1+r} - y_1 - \frac{y_2}{1+r} \right]$$

First-order conditions

$$\begin{aligned} u'(c_1) &= \lambda \\ \beta u'(c_2) &= \lambda/(1+r) \\ \Rightarrow \quad u'(c_1) &= \beta(1+r)u'(c_2) \end{aligned}$$

Concave u, marginal utility, shadow value of wealth, Euler equation, consumption smoothing

MRS = price

$$\frac{u'(c_1)}{\beta u'(c_2)} = 1 + r$$

Savings when $y_2 = 0$ (left), $y_2 \gg y_1$ (right)

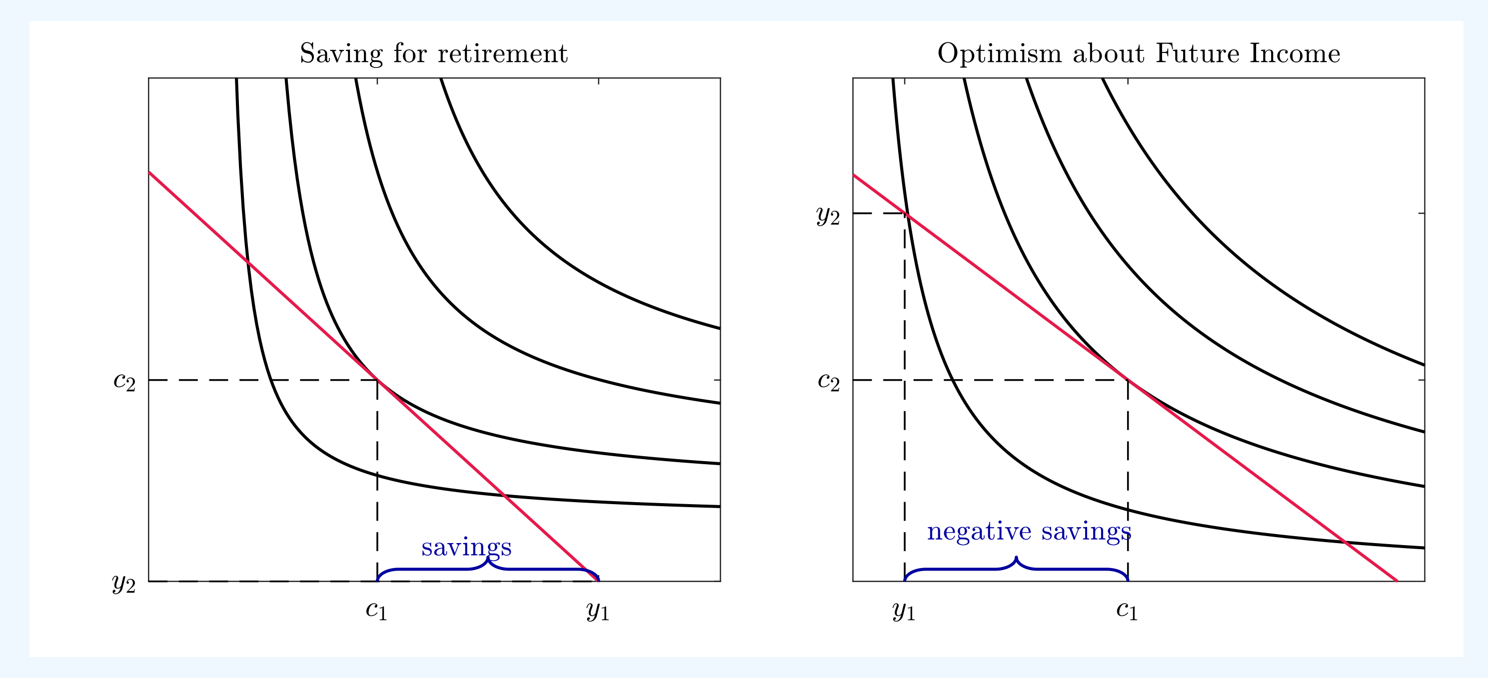


Fig. 6.2.2: *Consumption decisions in two examples.*

Kurlat (2020)

Interest rate increase induces income, substitution effects

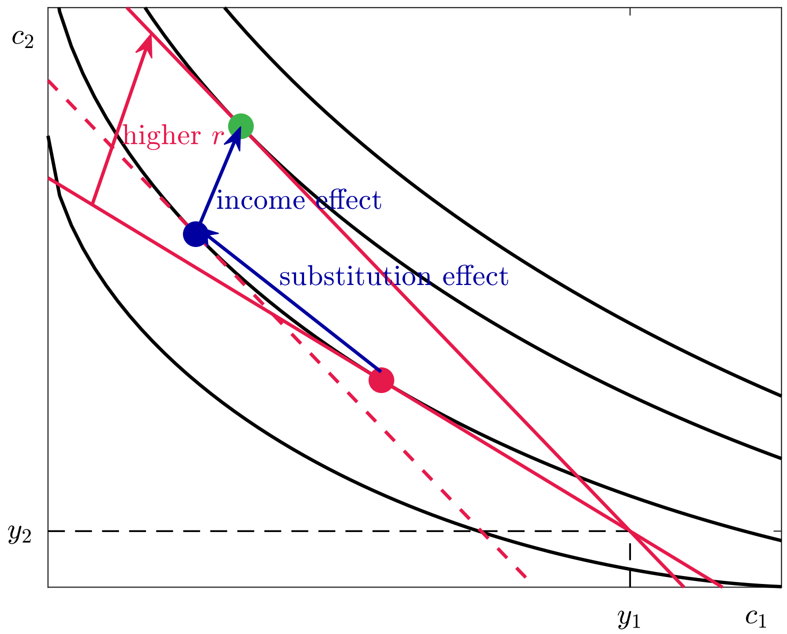


Fig. 6.2.3: *Consumption response to higher interest rates.*

Kurlat (2020)

Income, substitution effects when $y_2 = 0$ (left), $y_2 \gg y_1$ (right)

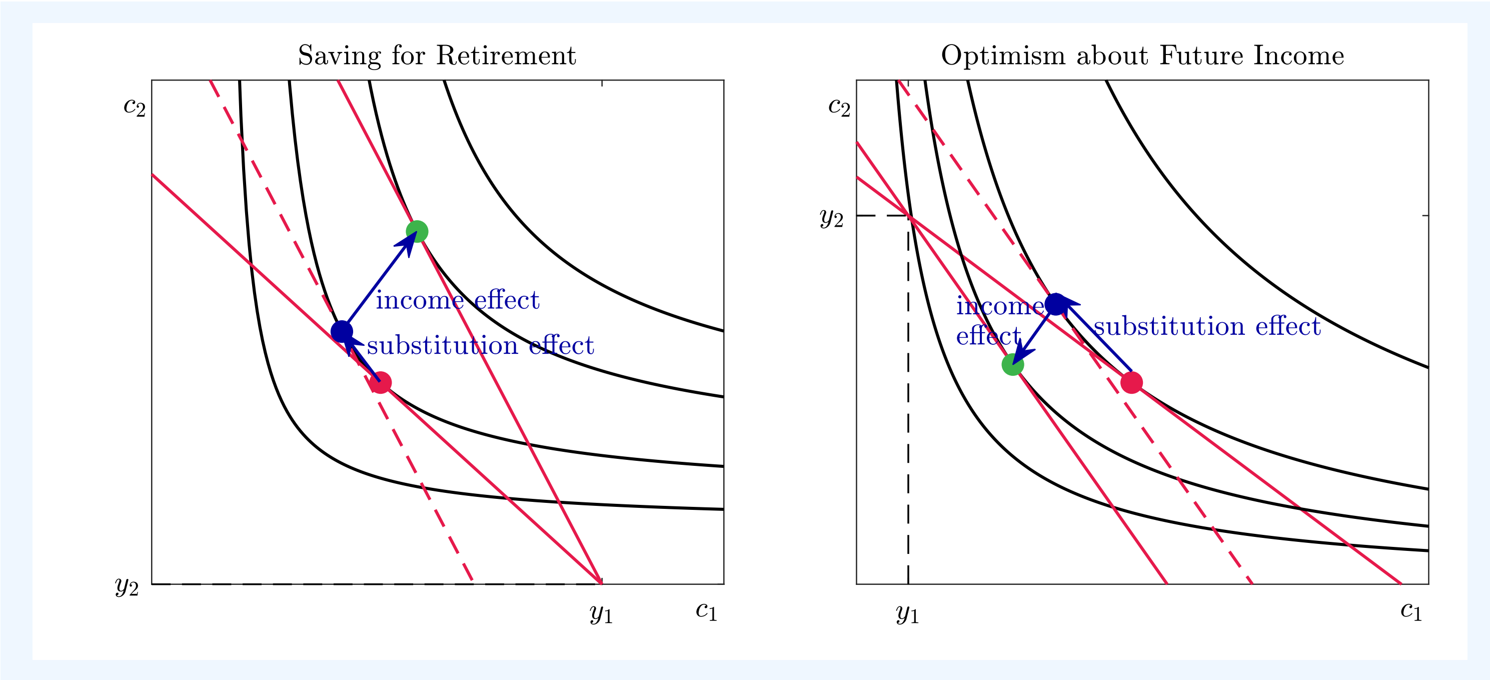


Fig. 6.2.4: *Higher interest rates in two examples.*

Kurlat (2020)

Consumption driven by "permanent income" (Friedman, 1957)

$$\frac{\partial c_1}{\partial \text{ current income}} < \frac{\partial c_1}{\partial \text{ permanent income}}$$

Reflects consumption smoothing motive

Difference to Keynes (1936)

Permanent income hypothesis explains motivating evidence

Extension: "Lump sum" taxes

$$c_1 + \frac{1}{1+r} c_2 = y_1 - \tau_1 + \frac{1}{1+r}(y_2 - \tau_2)$$

Budget constraints of government

$$\begin{aligned} G_1 &= \tau_1 + B \\ G_2 &= \tau_2 - B(1+r) \\ \Rightarrow \; G_1 + \frac{1}{1+r} G_2 &= \tau_1 + \frac{1}{1+r}\tau_2 \end{aligned}$$

Combining budget constraints

$$c_1 + \frac{1}{1+r} c_2 = y_1 + \frac{1}{1+r} y_2 - \left(G_1 + \frac{1}{1+r} G_2 \right)$$

Ricardian equivalence: Timing of taxation irrelevant

- Only total value of taxes matters, not timing

  (In general equilibrium: Timing of taxes irrelevant $\Rightarrow$ government debt irrelevant)

- Requires nondistorting taxes, same r, no redistribution

Extension: Risky second period income

Incomes $y_1, y_2^H = y_2 + \epsilon$ (prob π), $y_2^L = y_2 - \epsilon$ (prob $1 - \pi$)

Budget constraints

$$\begin{aligned} c_1 &= y_1 - a \\ c_2^H &= y_2^H + a(1+r), \;\; c_2^L = y_2^L + a(1+r) \end{aligned}$$

Household's program (expected utility)

$$\max_a u(c_1) + \beta \left\{ \pi u(c_2^H) + (1-\pi) u(c_2^L) \right\} \text{ s.t. budget constr.}$$

Modified Euler equation

$$u'(c_1) = \beta(1+r) \left\{ \pi u'(c_2^H) + (1-\pi) u'(c_2^L) \right\} = \beta(1+r)\mathbb{E}_1[u'(c_2)]$$

Convex marginal utility implies “precautionary” savings motive

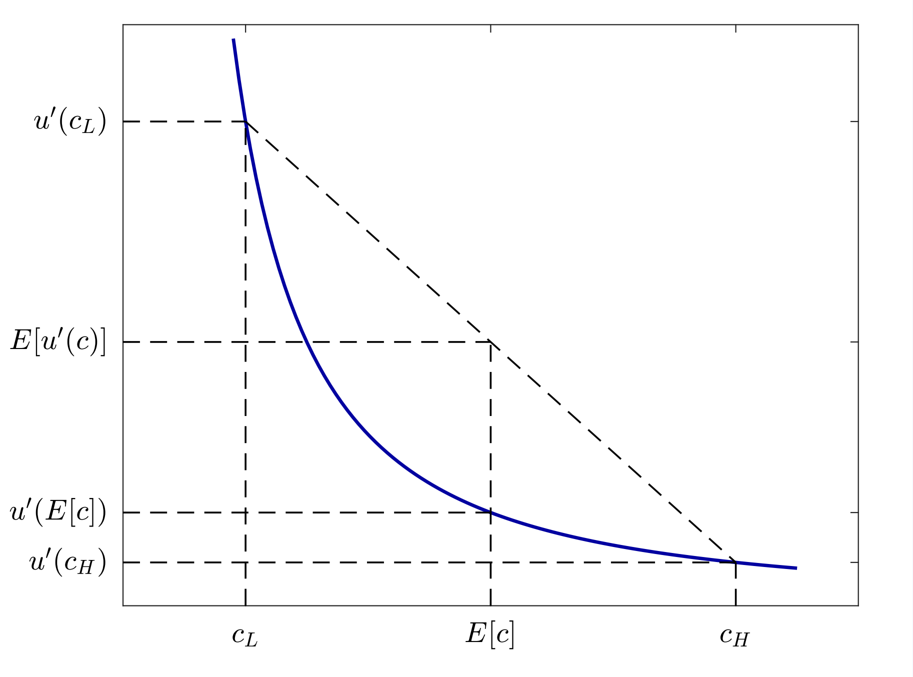


Fig. 6.2.5: *Convex marginal utility and precautionary savings.*

Kurlat (2020)

6.3 Extension to Many Periods

$$U(c_0, \ldots, c_T) = \sum_{t=0}^{T} \beta^t u(c_t) \qquad \text{(so far: } U(c_1, c_2) = u(c_1) + \beta u(c_2)\text{)}$$

$$c_t = y_t + (1+r)a_t - a_{t+1} \qquad (c_1 = y_1 - a_2,\ c_2 = y_2 + (1+r)a_2)$$

$$\sum_{t=0}^{T} \frac{c_t}{(1+r)^t} = \sum_{t=0}^{T} \frac{y_t}{(1+r)^t} \qquad \text{(so far: } c_1 + \frac{c_2}{1+r} = y_1 + \frac{y_2}{1+r}\text{)}$$

Many Euler equations (so far: one Euler equation)

6.4 Behavioral Theories

One rational behavior, many irrational behaviors

- Rule of thumb (study for exam three weeks before exam)
- Limited self control (tomorrow I start learning)

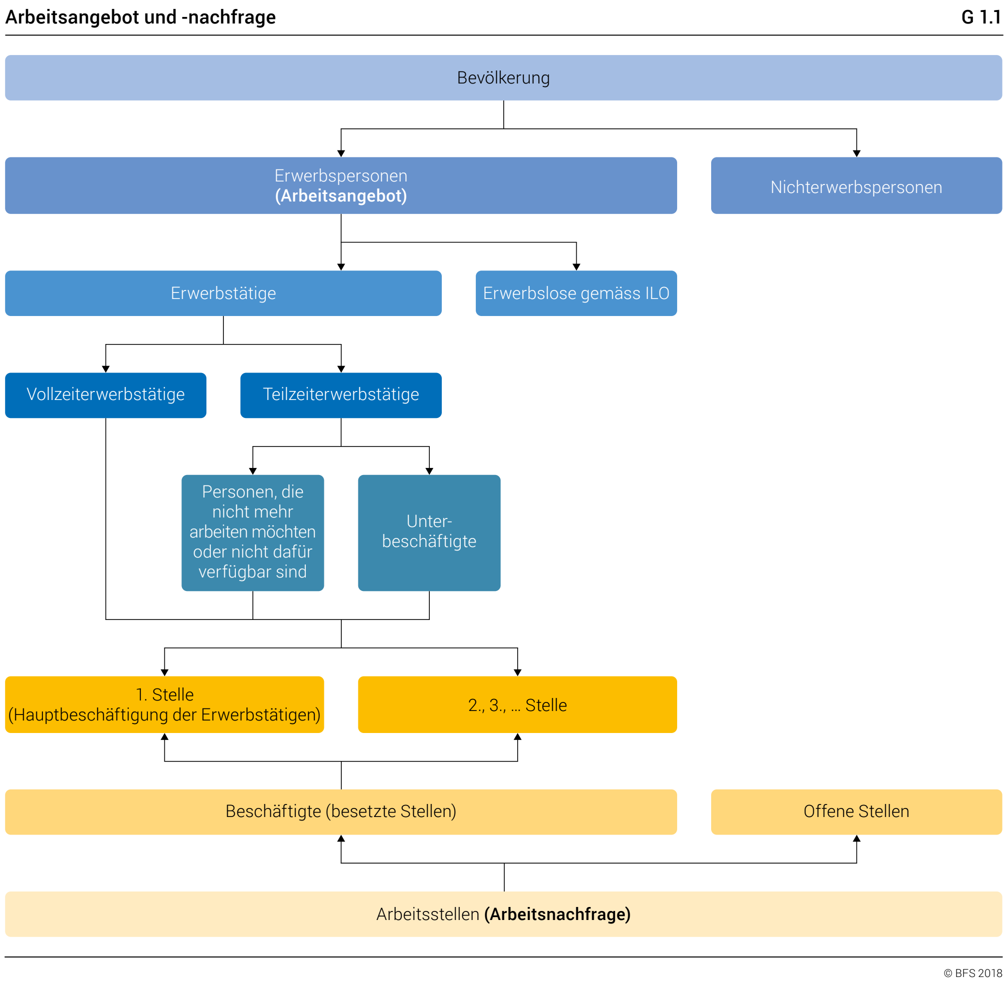
  Commitment device to improve self control (Ulysses)

7 Labor and Leisure

7.1 Measuring the Labor Market

Terminology

- Labor force = Employed + Unemployed
- Participation rate = Labor force / Population
- Employment rate = Employed / Population
- Unemployment rate = Unemployed / Labor force


Arbeitsangebot und -nachfrage
G 1.1
Bevölkerung
Erwerbspersonen
(Arbeitsangebot)
Nichterwerbspersonen
Erwerbstätige
Erwerbslose gemäss ILO
Vollzeiterwerbstätige
Teilzeiterwerbstätige
Personen, die nicht mehr arbeiten möchten oder nicht dafür verfügbar sind
Unter-beschäftigte
1. Stelle
(Hauptbeschäftigung der Erwerbstätigen)
2., 3., ... Stelle
Beschäftigte (besetzte Stellen)
Offene Stellen
Arbeitsstellen (Arbeitsnachfrage)
© BFS 2018

BFS, 2018

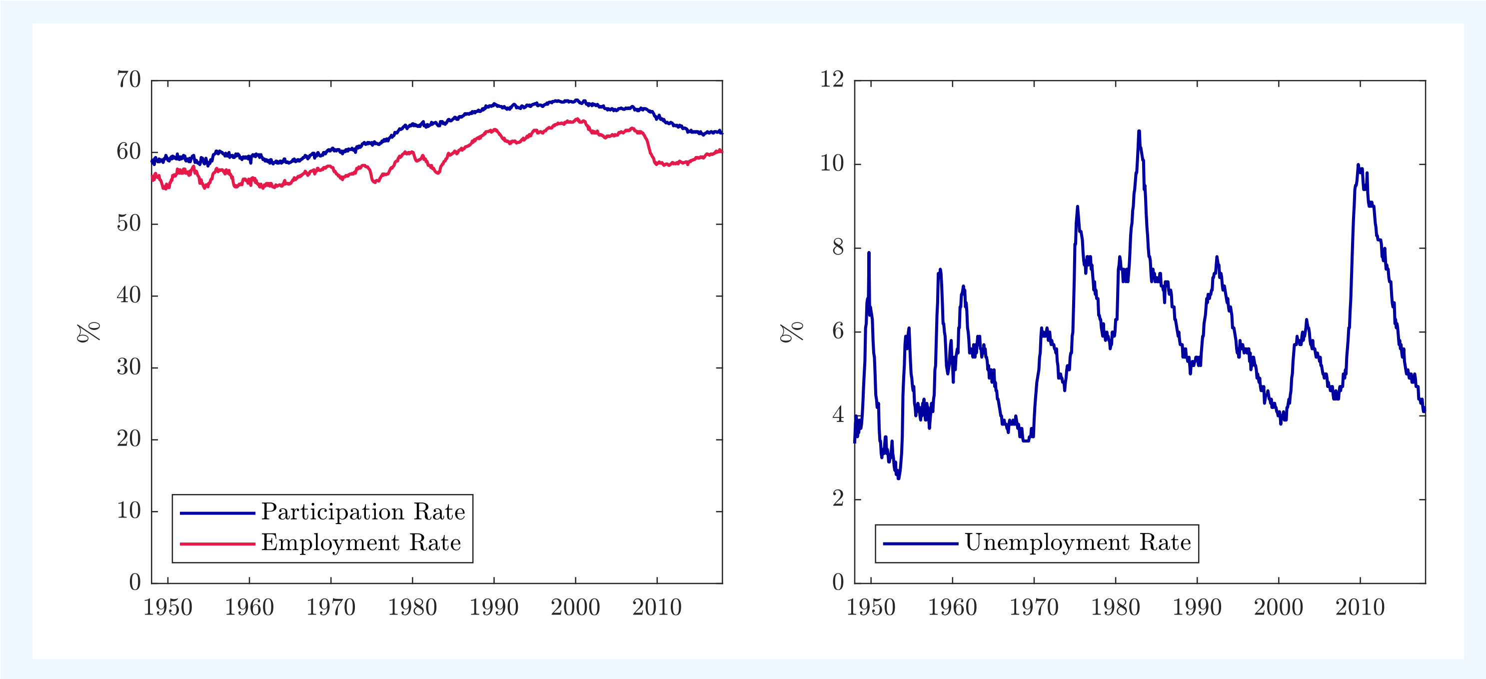


Fig. 7.1.1: *Labor market indicators in the United States. Source: CPS.*

Kurlat (2020)

Stocks and flows

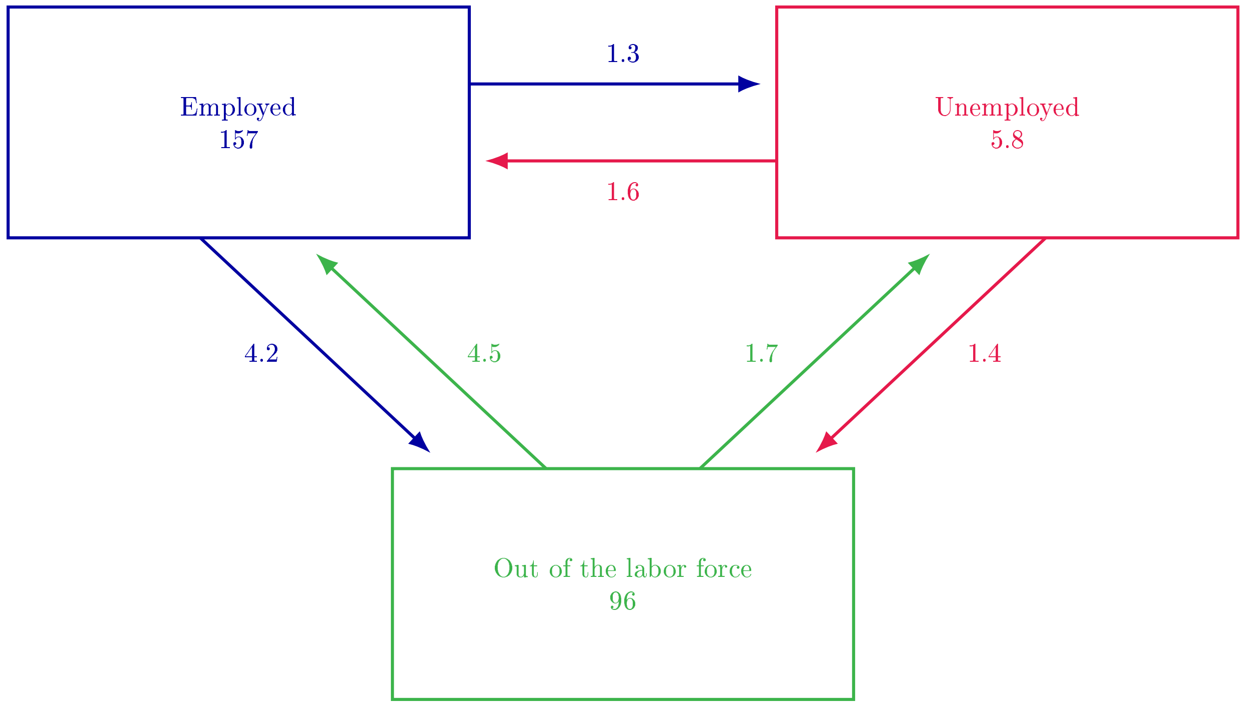


Fig. 7.1.2: *Stocks and flows of workers across labor market status in October, 2018. Figures in millions of workers. Source: CPS.*

Kurlat (2020)

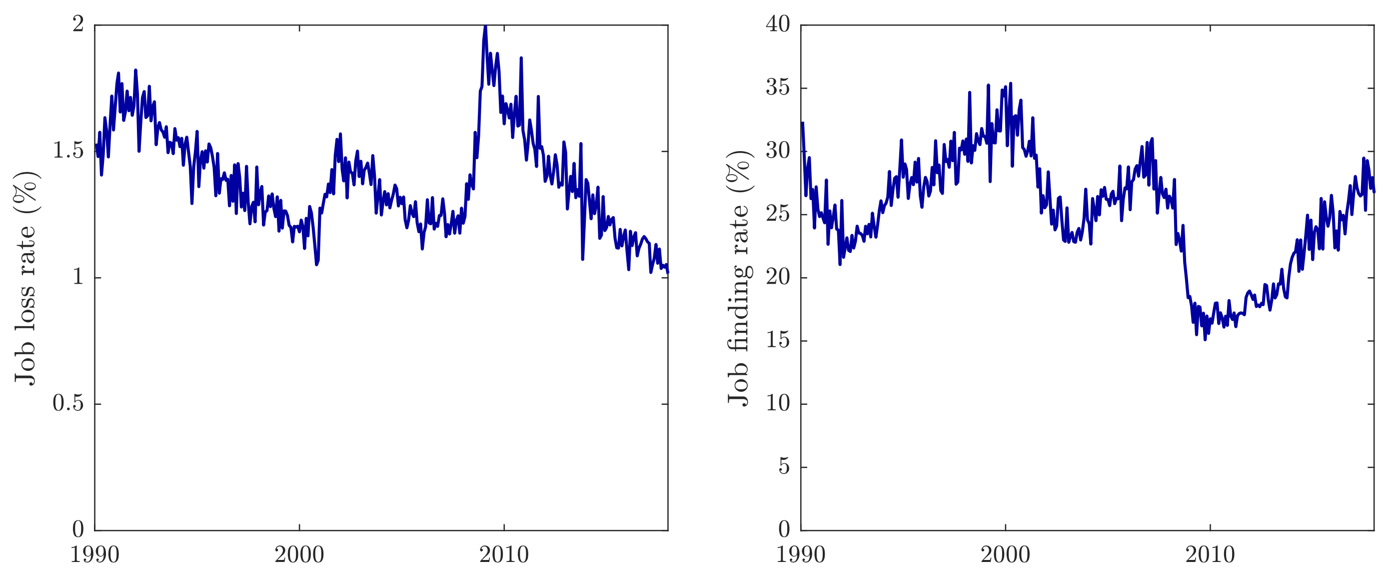


Fig. 7.1.3: *Monthly job loss rate and job finding rate. Source: CPS.*

Kurlat (2020)

Beveridge curve illustrates frictional unemployment

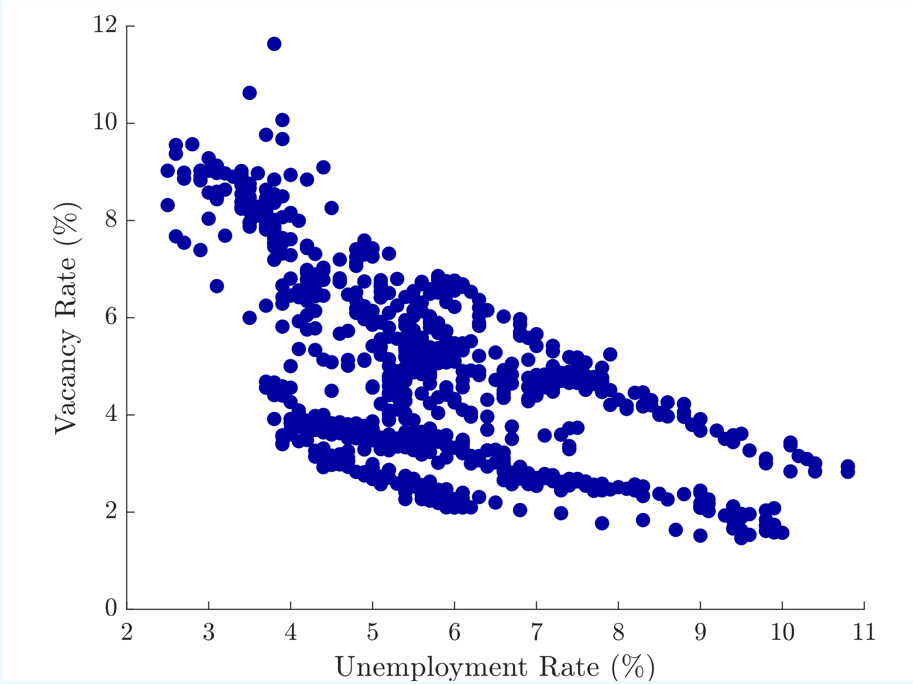


Fig. 7.1.4: *The US Beveridge Curve, 1948-2018. Each dot is one month. Sources: Unemployment from CPS. Vacancies from NBER Macrohistory Database, Barnichon (2010) and JOLTS.*

Kurlat (2020)

7.2 A Static Model of the Labor Market

Model

- Household lives for one period
- Likes consumption, leisure, $U(c, l) = u(c) + v(l)$
- Labor supply, $L = 1 - l$
- Wage, w

Budget constraint

$$c = w(1 - l) \;\text{ or }\; c + wl = w$$

Wealth, relative price, consumption expenditures

Household's program

$$\max_{c,l} U(c, l) \;\text{ s.t. }\; c = w(1 - l)$$

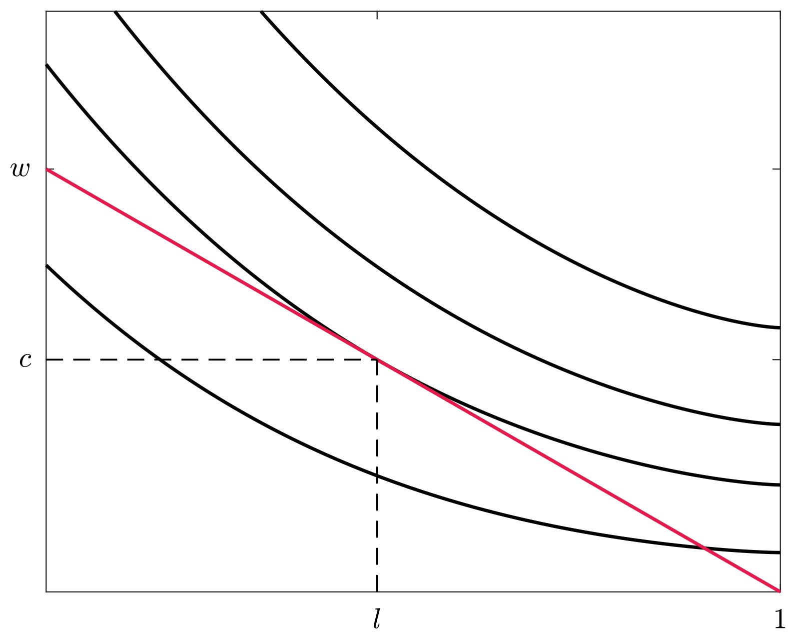


Fig. 7.2.1: *The consumption-leisure decision as a two-good consumption problem.*

Kurlat (2020)

Lagrangian

$$\mathcal{L}(c, l, \lambda) = u(c) + v(l) - \lambda \left[c - w(1 - l)\right]$$

First-order conditions

$$\begin{aligned} u'(c) &= \lambda \\ v'(l) &= \lambda w \\ \Rightarrow \frac{v'(l)}{u'(c)} &= w \end{aligned}$$

Concave u, v, shadow value of wealth, MRS = price

Wage increase induces income, substitution effects

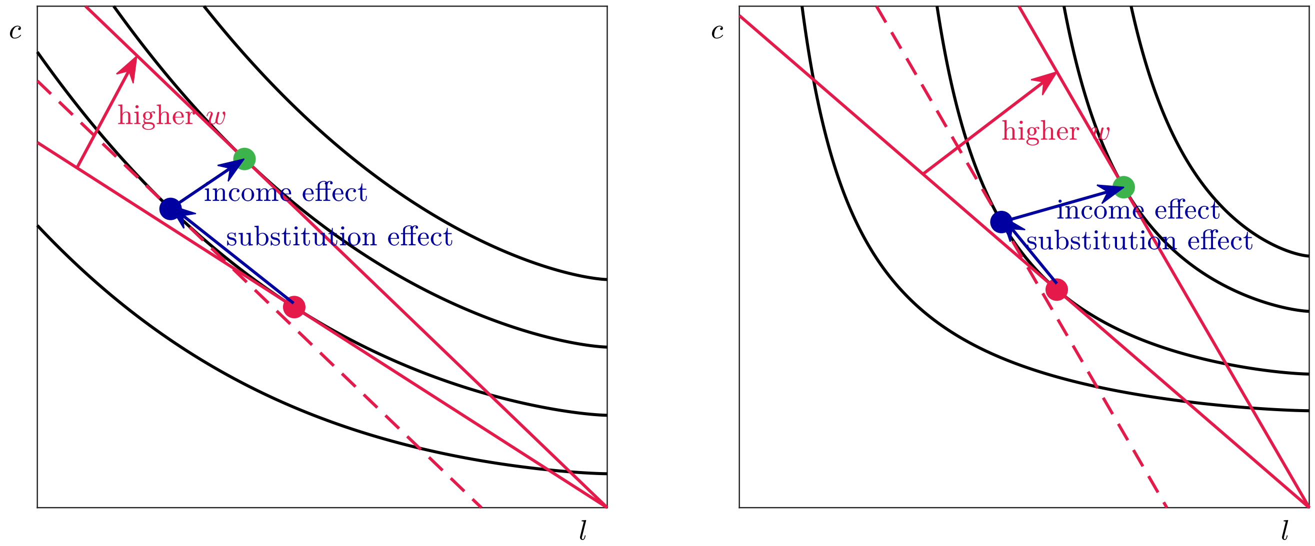


Fig. 7.2.2: *Consumption and leisure response to higher wages. Income and substitution effects.*

Kurlat (2020)

“Lump sum” transfer and distorting labor income tax

$$c = w(1 - l)(1 - \tau) + T$$

Change of transfer induces income effect

Change of tax rate induces income, substitution effects, as with wage change

Effects of T, τ on budget set

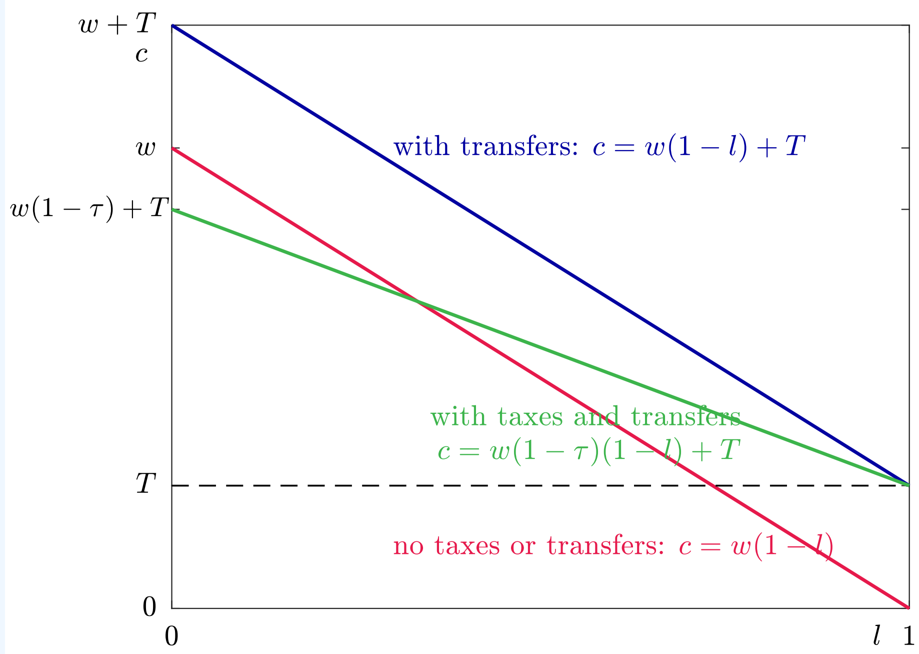


Fig. 7.2.3: *The worker's budget constraint when there are taxes and transfers.*

Kurlat (2020)

Income effect of transfer

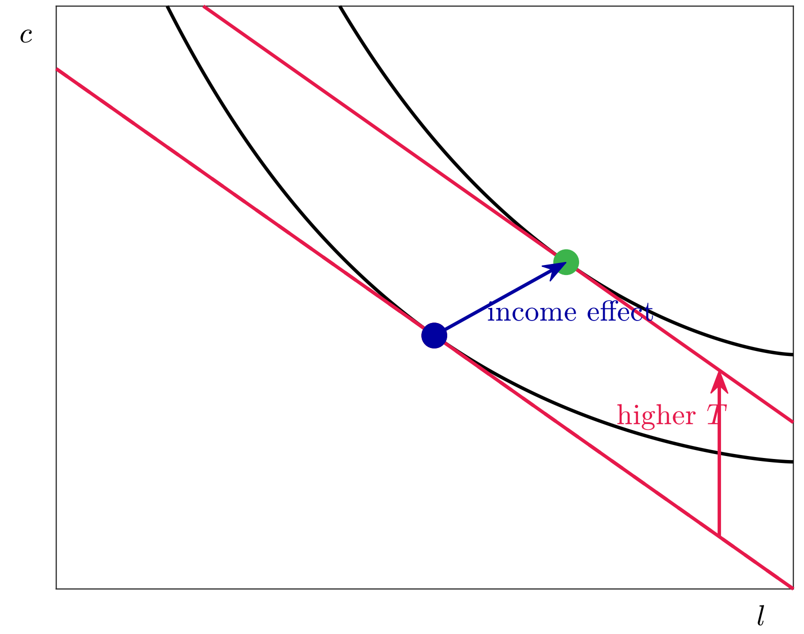


Fig. 7.2.4: *Consumption and leisure response to higher transfers.*

Kurlat (2020)

7.3 Some Evidence on Labor and Leisure Decisions

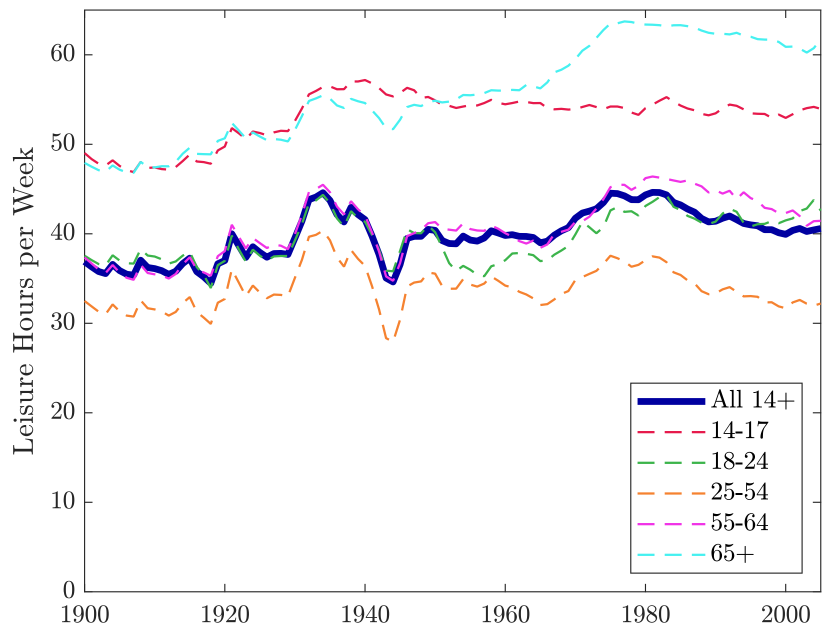


Fig. 7.3.1: *Average hours of leisure per week for everyone ages 14+ in the US. Source: Ramey and Francis (2009).*

Kurlat (2020)

Cross-country evidence suggests income > substitution effect

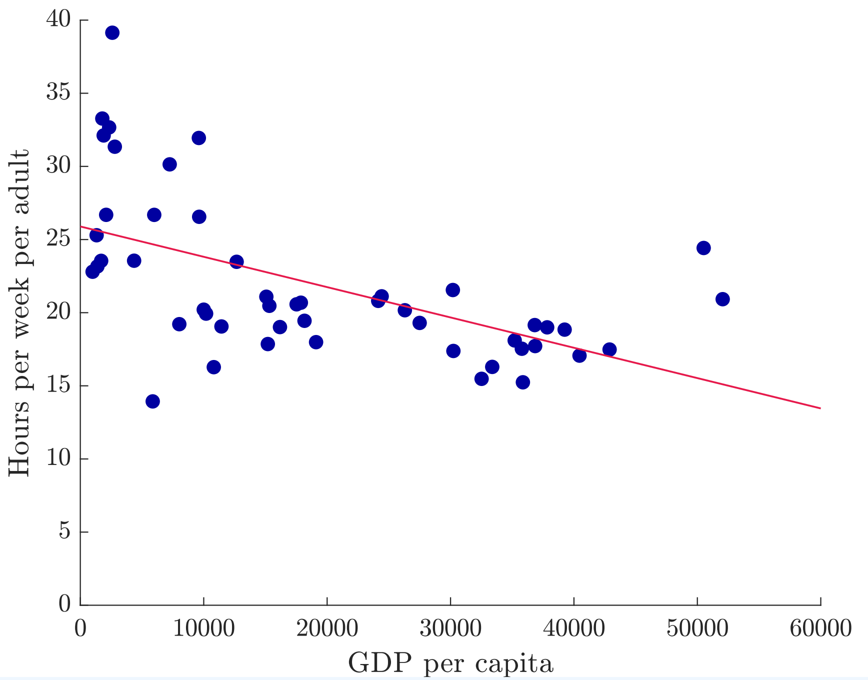


Fig. 7.3.2: Average hours of work per week across countries. Source: Bick et al. (2018).

Kurlat (2020)

U.S. vs. Europe: T, τ, unionization, preferences, "culture"?

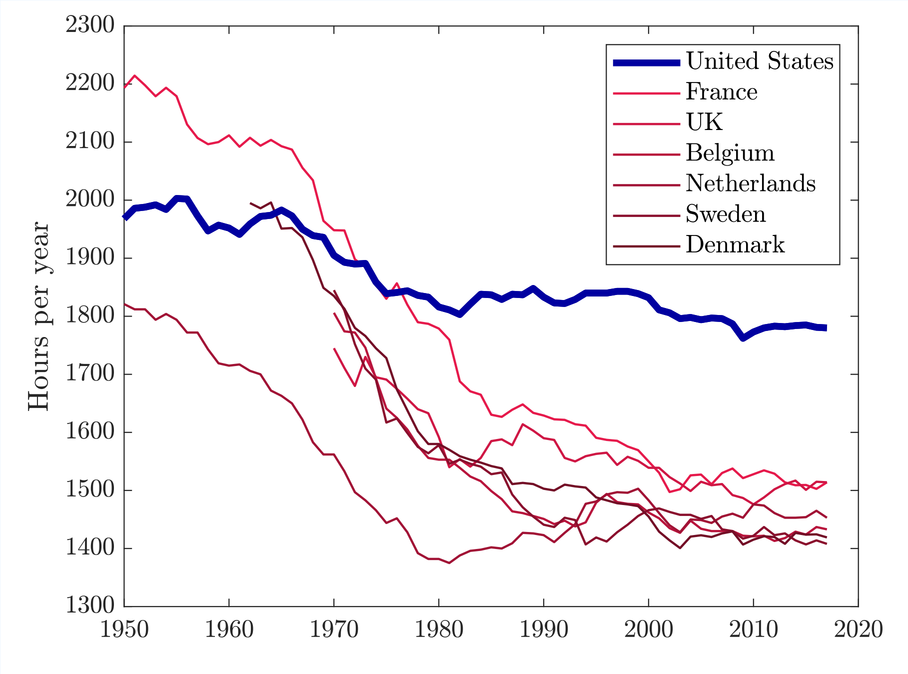


Fig. 7.3.3: *Hours worked per year per employed person in the US and selected European countries. Source: OECD.*

Kurlat (2020)

7.4 A Dynamic Model

Integrate labor supply, consumption-savings choices

Household's program

$$\max_{c_1,l_1,c_2,l_2} U(c_1,l_1)+\beta U(c_2,l_2) \text{ s.t. } c_1+\frac{c_2}{1+r}=w_1(1-l_1)+\frac{w_2(1-l_2)}{1+r}$$

First-order conditions yield

$$\begin{aligned} \frac{v'(l_t)}{u'(c_t)} &= w_t,\ t=1,2 \\ u'(c_1) &= \beta(1+r)u'(c_2) \end{aligned}$$

Effect of wage change on labor supply

$$v'(l_1) = u'(c_1)w_1$$

$$\Rightarrow L_1 = 1 - l_1 = 1 - v'^{-1}(w_1 u'(c_1))$$

decreasing function

Temporary vs. permanent wage increase

- Small vs. large increase of c_1 (income effect)

$\Rightarrow$ Large vs. small increase of $w_1 u'(c_1)$

$\Rightarrow$ Large vs. small increase of L_1

- Reflects small vs. large income effect on leisure

7.5 Equilibrium in the Labor Market

Competitive labor market

- Labor demand reflects marginal product: labor demand(w^-)
- Labor supply reflects household choice: labor supply$(w^?)$, depending on income, substitution effects

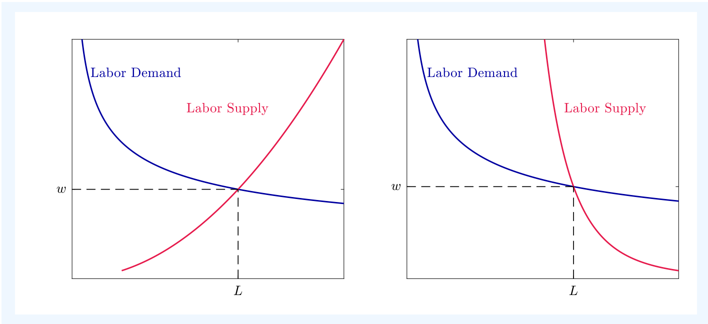


Fig. 7.5.1: Equilibrium in the labor market.

Kurlat (2020)

Response to productivity increase (left), transfer increase (right)

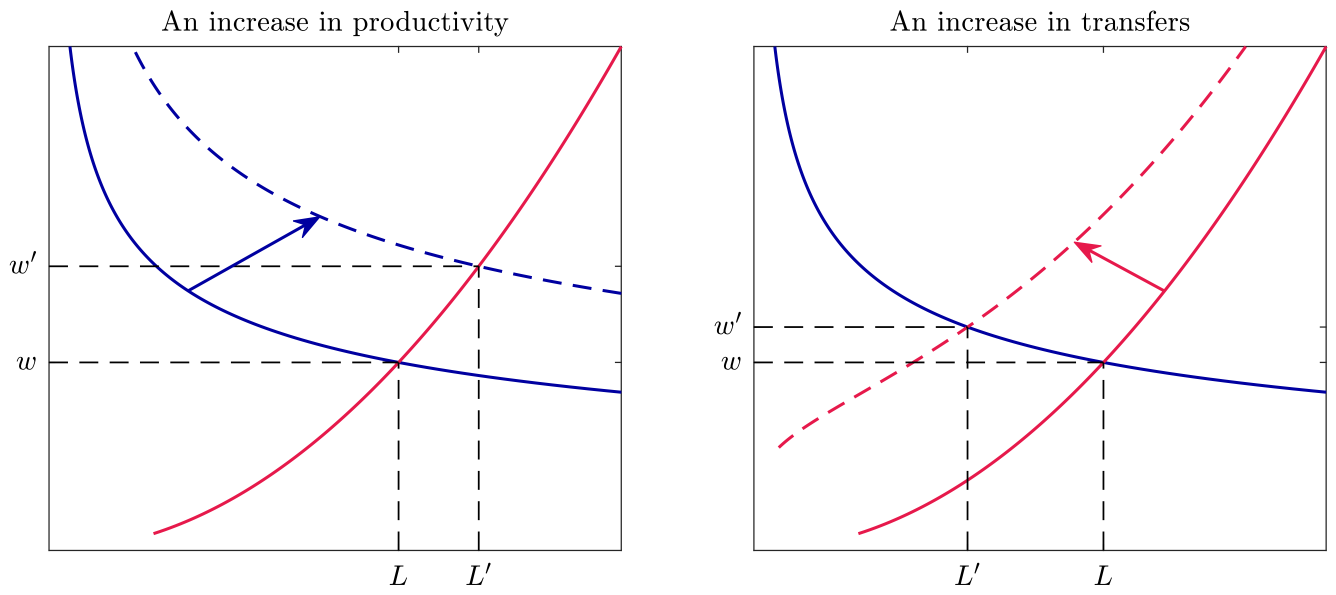


Fig. 7.5.2: *Effects of changes on the labor market.*

Kurlat (2020)

Search equilibrium, to study unemployment, vacancies

- U workers search jobs, V firms advertize vacancies at cost χ
- Matched firm-worker pair produces y; increasing, concave matching probability $m(V, U)$
- Nash wage bargaining: Surplus $y - b$ split according to $w = b + \mu(y - b), y - w = 0 + (1 - \mu)(y - b)$

Equilibrium

- Firms post vacancies until $\chi = (m(V, U)/V)\,(1 - \mu)(y - b)$

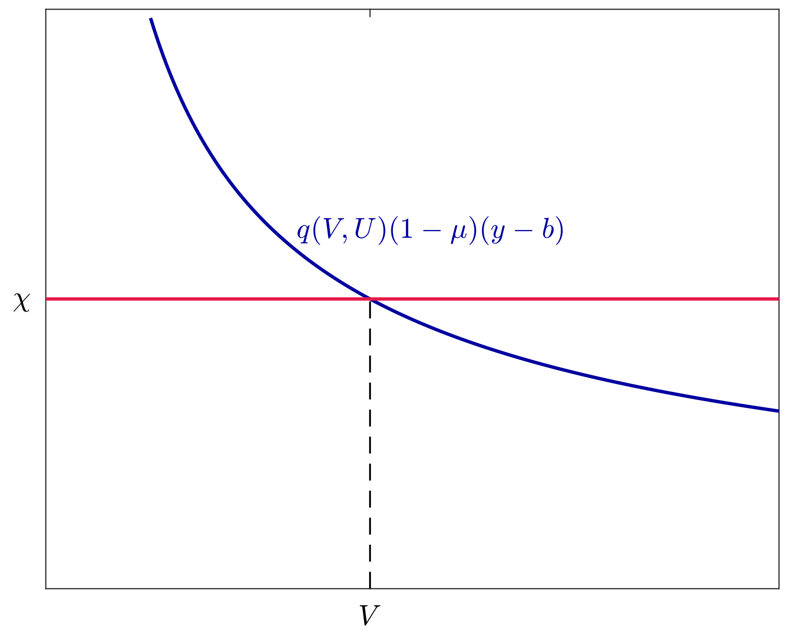


Fig. 7.5.3: *Equilibrium in the Diamond-Mortensen-Pissarides search model.*

Kurlat (2020)

Response to productivity increase (left), unemployment benefit increase (right)

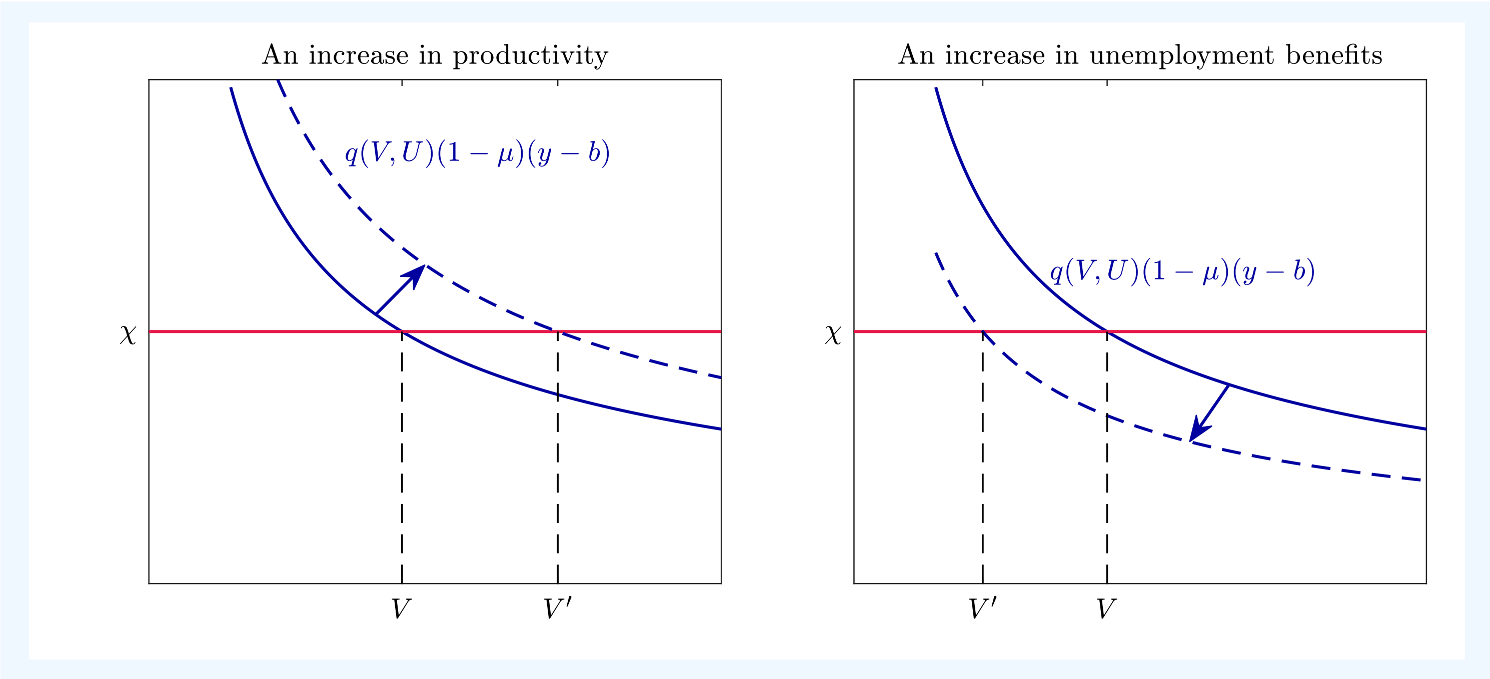


Fig. 7.5.4: *Effects of changes in the Diamond-Mortensen-Pissarides search model.*

Kurlat (2020)

8 Investment

8.1 Present Values

Interest rate = relative price of goods in successive periods

Investment project lucrative $\Leftrightarrow$ NPV positive

$$\text{NPV} = -I + V = -I + \sum_{t=1}^{\infty} \frac{d_t}{(1+r)^t} \text{ (assuming constant } r\text{)}$$

Constant dividend growth: Gordon growth formula

$$V = \sum_{t=1}^{\infty} \frac{d_t}{(1+r)^t} = \sum_{t=1}^{\infty} \frac{d_1(1+g)^{t-1}}{(1+r)^t} = \frac{d_1}{r-g} \text{ (assuming } r > g\text{)}$$

Tobin's Q

- Market value of firm relative to replacement cost (book value)
- Investment lucrative iff $Q > 1$
- Why $Q \neq 1$? Adjustment costs, $\Psi(I, K) = (\psi/2)(I^2/K)$

Firm's program

$$\max_I Q \cdot (K + I) - (I + \Psi(I, K))$$

First-order condition

$$\begin{aligned} Q &= 1 + \psi I/K \lesseqqgtr 1 \\ \Rightarrow I &= \frac{K}{\psi}(Q - 1) \lesseqqgtr 0 \end{aligned}$$

Tobin's Q and investment

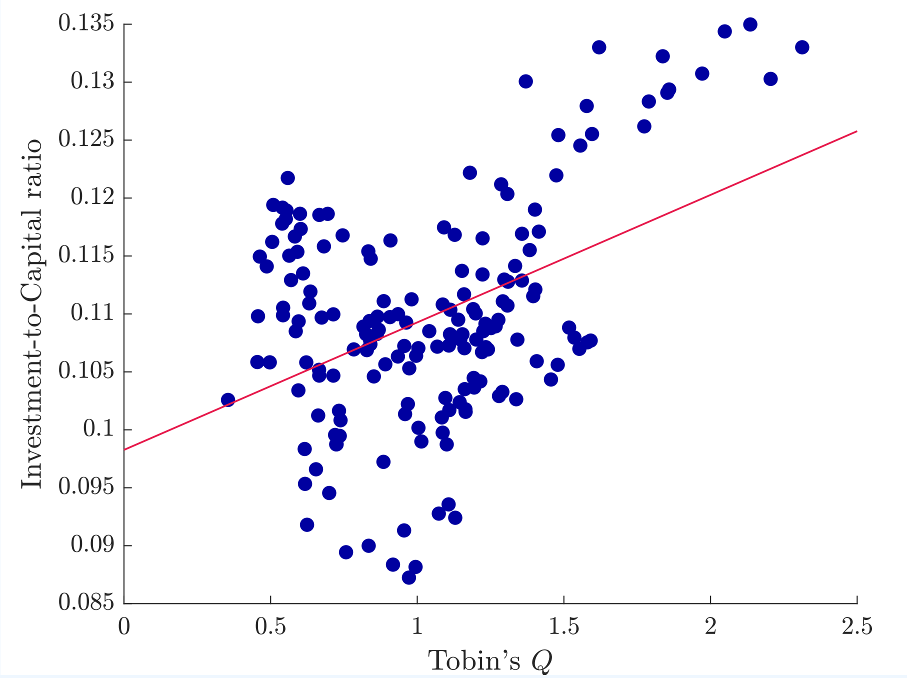


Fig. 8.1.1: *Tobin's Q and investment. Source Andrei et al. (2019).*

Kurlat (2020)

8.2 Risk

How to discount risky dividends?

- At what price are investors willing to invest in, hold asset?

Consider household choosing a, I given $r, p, \{p(s) + d(s), \pi(s)\}_s$

Household's program

$$\max_{a,I} u(y_1 - a - pI) + \beta \sum_s \pi(s) u\left(y_2(s) + a(1+r) + I(p(s) + d(s))\right)$$

First-order conditions

$$
\begin{aligned}
u'(c_1) &= \beta(1+r)\mathbb{E}_1[u'(c_2(s))] \\
pu'(c_1) &= \beta\mathbb{E}_1[u'(c_2(s))(p(s)+d(s))]
\end{aligned}
$$

First-order conditions, rewritten

$$
\begin{aligned}
u'(c_1) &= \beta\mathbb{E}_1[u'(c_2(s))(1+r)] \\
u'(c_1) &= \beta\mathbb{E}_1\left[u'(c_2(s))\frac{p(s)+d(s)}{p}\right]
\end{aligned}
$$

Price discounts contingent payoffs—but *not* uniformly at $1+r$

$$\begin{aligned} p &= \frac{\beta}{u'(c_1)}\mathbb{E}_1[u'(c_2(s))(p(s)+d(s))] \\ &= \frac{1}{1+r}\frac{\mathbb{E}_1[u'(c_2(s))(p(s)+d(s))]}{\mathbb{E}_1[u'(c_2(s))]} \neq \frac{1}{1+r}\mathbb{E}_1[p(s)+d(s)] \end{aligned}$$

Use $\mathbb{C}\text{ov}[x,y] = \mathbb{E}[xy] - \mathbb{E}[x]\mathbb{E}[y]$

$$\Rightarrow \; p = \frac{1}{1+r}\left\{\mathbb{E}_1[p(s)+d(s)] + \frac{\mathbb{C}\text{ov}_1[u'(c_2(s)), p(s)+d(s)]}{\mathbb{E}_1[u'(c_2(s))]}\right\}$$

Due to risk aversion, price reflects in which states payoffs materialize

Asset pricing/finance is just the Euler equation

$$
\begin{aligned}
u'(c_1) &= \beta \mathbb{E}_1 \left[u'(c_2(s)) \frac{p(s)+d(s)}{p} \right] \\
\Rightarrow \ p &= \mathbb{E}_1 \left[\beta \frac{u'(c_2(s))}{u'(c_1)} (p(s)+d(s)) \right] \\
&= \mathbb{E}_1 \left[\frac{\mathrm{MRS}_2(s)}{\mathrm{prob}(s)} (p(s)+d(s)) \right]
\end{aligned}
$$

Special cases

- No risk
- No risk aversion

8.3 The Marginal Product of Capital and Aggregate Investment

Investment at date t yields dividend, price at date $t+1$

- Date $t+1$'s rental rate of capital, $r^K_{t+1} = F_K(K_{t+1}, L_{t+1})$
- Resale value of capital net of depreciation, $1-\delta$ (neglecting adjustment costs)

Firms invest until marginal investment's NPV = 0

$$\text{NPV} = -1 + \frac{F_K(K_{t+1}, L_{t+1}) + 1 - \delta}{1 + r_{t+1}}$$
$$\Rightarrow F_K(K_{t+1}, L_{t+1}) - \delta = r_{t+1}$$

Interest rate determines investment ($F_K - \delta = r$)

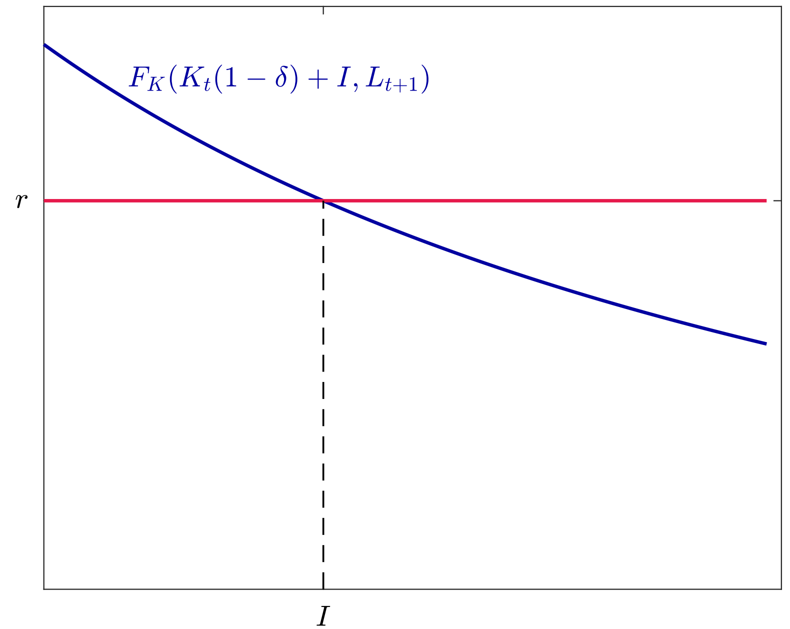


Fig. 8.3.1: *The determination of aggregate investment.*

Kurlat (2020)

Response to productivity increase (left), interest increase (right)

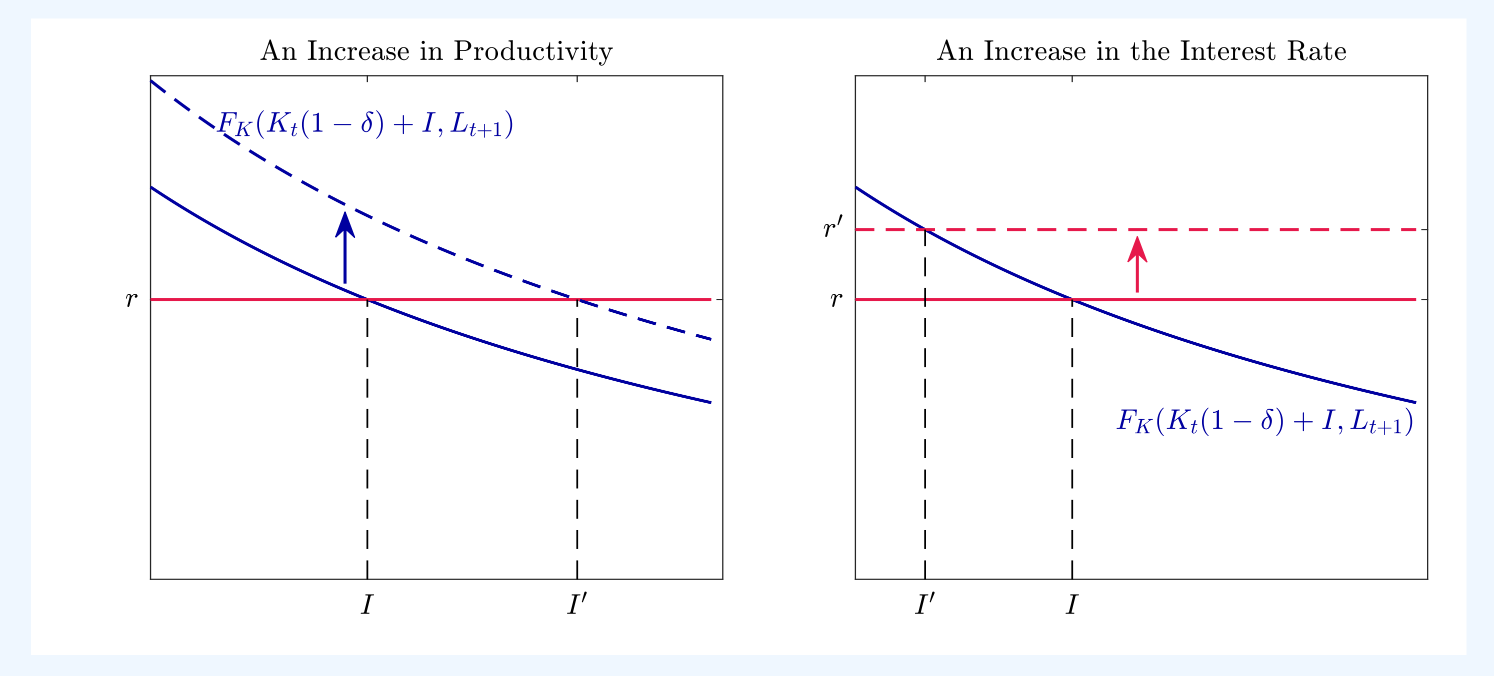


Fig. 8.3.2: *Investment response to changes in productivity and interest rates.*

Kurlat (2020)

9 General Equilibrium

9.1 General Equilibrium in a Two-Period Economy

Model (new)

- Representative household works, consumes, saves
  Owns initial capital stock, firms, investment firms
- Representative firm rents capital, labor to produce output
- Representative investment firm produces investment
- All agents optimize taking prices, profit incomes as given
- Equilibrium prices clear markets

Household's program

$$\max_{c_1,l_1,c_2,l_2} \quad u(c_1) + v(l_1) + \beta[u(c_2) + v(l_2)] \text{ s.t.}$$

$$c_1 + \frac{c_2}{1+r} = w_1(1-l_1) + \frac{w_2(1-l_2)}{1+r} + K_1(r_1^K + 1 - \delta) + \text{profits}$$

Firm's program (in each t)

$$\max_{K,L} \; F(K,L) - w_t L - r_t^K K$$

Investment firm's program

full depreciation in last period

$$\max_{I} \; \left\{ \frac{r_2^K + 1 - 1}{1+r} - 1 \right\} [(1-\delta)K_1 + I]$$

Definition 9.1 *Competitive equilibrium* conditional on K_1: Allocation $(c_1, c_2, l_1, l_2, I, K_2, L_1, L_2)$, price system $(w_1, w_2, r_1^K, r_2^K, r)$ such that (c_1, c_2, l_1, l_2) solves household's program; (K_t, L_t) solves firm's program at t; I solves investment firm's program; markets clear.

Market clearing

$$\begin{aligned} \text{Goods}: \quad & F(K_1, L_1) = c_1 + I \\ & F(K_2, L_2) = c_2 \ \text{(no investment in last period)} \\ \text{Capital}: \quad & K_2 = K_1(1-\delta) + I \\ \text{Labor}: \quad & L_t = 1 - l_t,\ t = 1, 2 \end{aligned}$$

First-order conditions of household, firm, investment firm

$$\frac{u'(c_1)}{\beta u'(c_2)} = 1 + r = r_2^K = F_K(K_2, L_2)$$
$$\frac{v'(l_t)}{u'(c_t)} = w_t = F_L(K_t, L_t),\ t = 1, 2$$
$$r_1^K = F_K(K_1, L_1)$$

13 FOCs & market clearing conditions, 13 endogenous variables

9.2 The First Welfare Theorem

Benevolent social planner allocation as benchmark

Planner program

$$\max_{c_1,l_1,c_2,l_2,L_1,L_2,K_2} \quad u(c_1)+v(l_1)+\beta[u(c_2)+v(l_2)] \text{ s.t.}$$
$$K_2=(1-\delta)K_1+F(K_1,L_1)-c_1,\ K_1 \text{ given}$$
$$c_2=F(K_2,L_2)$$
$$L_t=1-l_t,\ t=1,2$$

Planner commands allocation s.t. resource constraints only

First-order conditions

$$\frac{u'(c_1)}{\beta u'(c_2)} = F_K(K_2, L_2)$$

$$\frac{v'(l_t)}{u'(c_t)} = F_L(K_t, L_t),\ t = 1, 2$$

Competitive equilibrium, planner allocations coincide!

- CE: Household, firm choose MRS = price, price = MRT
- Planner chooses MRS = MRT

Result generalizes

Proposition 9.1, First Welfare Theorem Competitive equilibrium allocation (solves a social planner problem, that is, it) is Pareto efficient

Allows for many goods, technological change, heterogeneity, risk

Key requirements

- Competitive price taking (e.g., no monopoly)
- Complete markets (e.g., no externalities, no incomplete financial markets)

If requirements are satisfied there is no efficiency rationale to change market outcome (but maybe "fairness" rationale)

9.3 General Equilibrium in an Infinite-Period Economy

First-order conditions essentially unchanged

previously $\delta = 1$

$$\frac{u'(c_t)}{\beta u'(c_{t+1})} = F_K(K_{t+1}, L_{t+1}) + 1 - \delta \quad \forall t$$

$$\frac{v'(l_t)}{u'(c_t)} = F_L(K_t, L_t) \ \ \forall t$$

Core equilibrium conditions, assuming exogenous $L_t = 1$

$$u'(c_t) = \beta \left(F_K(K_{t+1}, 1) + 1 - \delta\right) u'(c_{t+1}) \ \ \forall t$$

$$K_{t+1} = K_t(1 - \delta) + F(K_t, 1) - c_t \ \ \forall t$$

transversality condition

Solow (1956) model plus endogenous savings rate

Core equilibrium conditions, also assuming $u(c) = c^{1-\sigma}/(1-\sigma)$

$$\left(\frac{c_{t+1}}{c_t}\right)^\sigma = \beta\left(F_K(K_{t+1},1) + 1 - \delta\right) \quad \forall t$$

$$K_{t+1} = K_t(1-\delta) + F(K_t,1) - c_t \ \ \forall t$$

transversality condition

Steady state

$$\begin{aligned} c_{t+1} = c_t \quad &\Rightarrow \quad 1 = \beta\left(F_K(K_{t+1},1) + 1 - \delta\right) \\ K_{t+1} = K_t \quad &\Rightarrow \quad c_t = F(K_t,1) - \delta K_t \end{aligned}$$

Steady-state relations, phase diagram

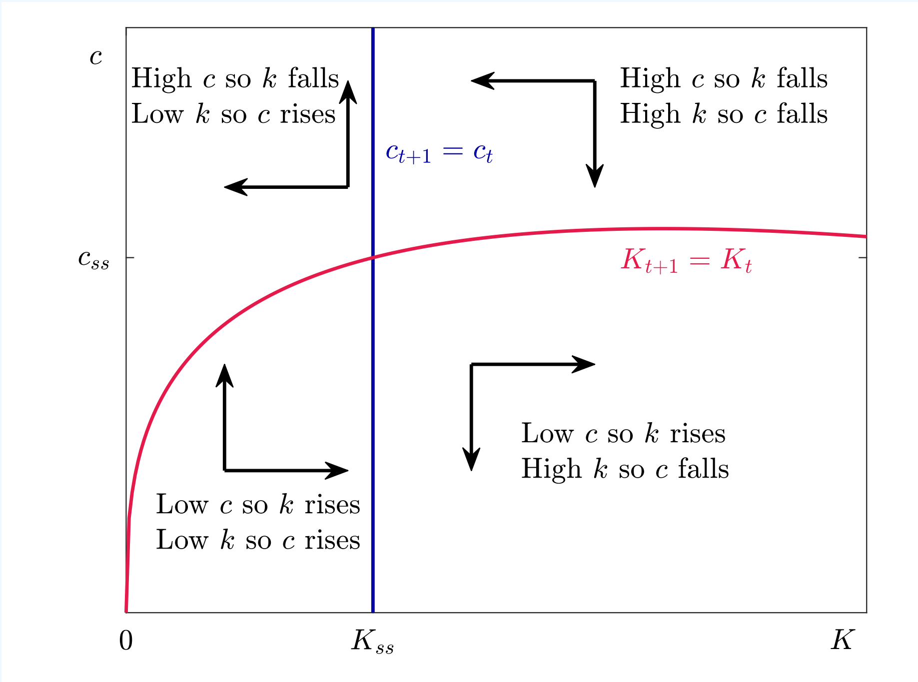


Fig. 9.3.1: *Dynamics of the Neoclassical Growth Model*

Kurlat (2020)

Equilibrium c_0 given K_0, saddle path

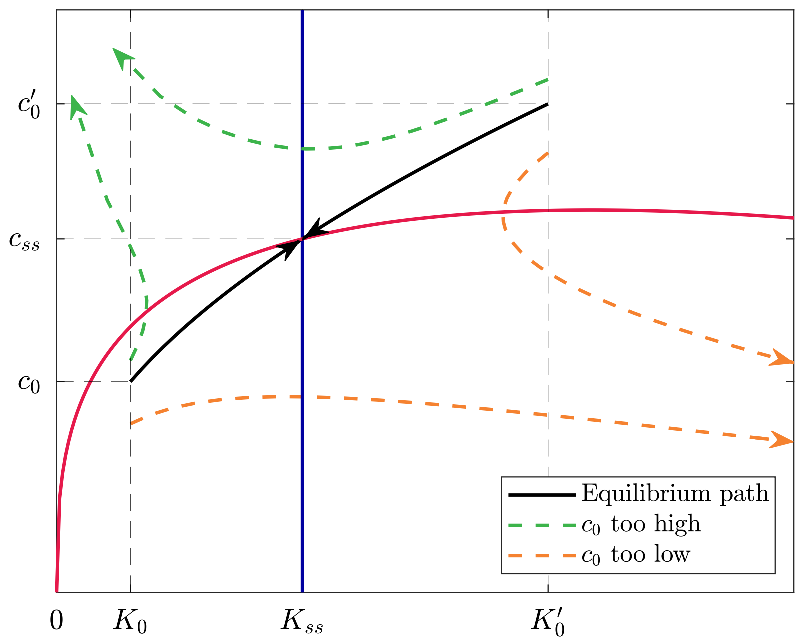


Fig. 9.3.2: *Paths for the economy dictated by equations (9.3.14) and (9.3.15), starting from different levels of c_0 and K_0.*

Kurlat (2020)

$K_{ss} < K_{gr}$ since $\beta < 1$ $\beta^{-1} - 1 + \delta = F_K(K_{ss}, 1)$ vs. $F_K(K_{gr}, 1) = \delta$; Pareto optimality

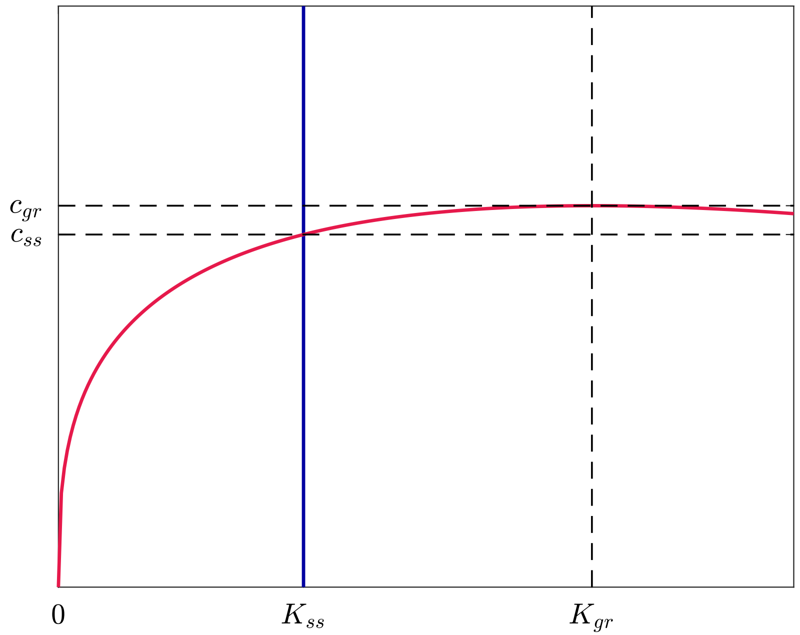


Fig. 9.3.3: *How the steady state compares to the Golden Rule.*

Kurlat (2020)

Anticipated productivity increase at date T

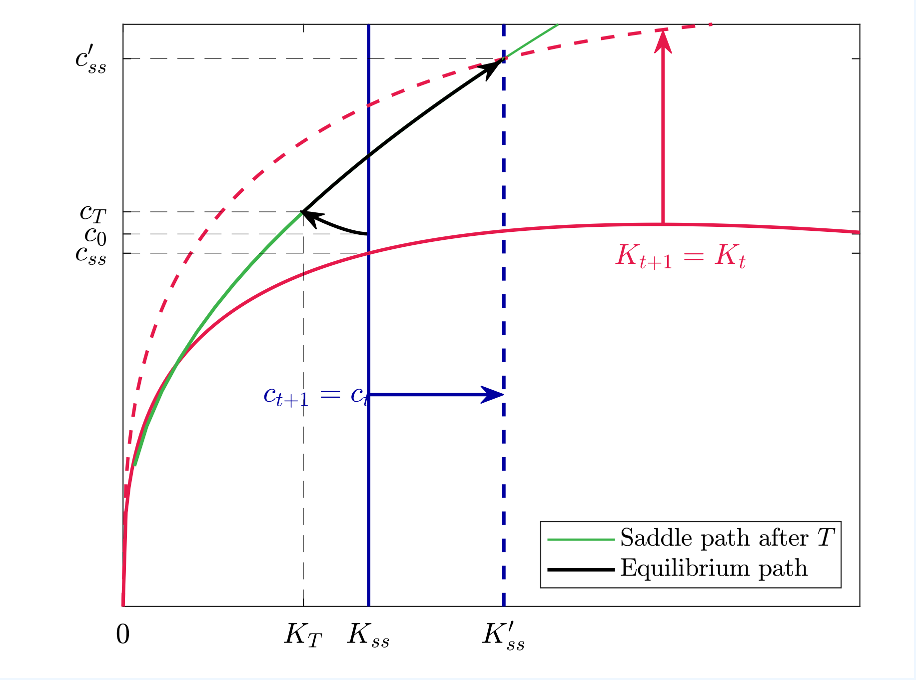


Fig. 9.3.4: *An anticipated technological improvement.*

Kurlat (2020)

10 Money

10.1 What is Money?

Anything that serves as

- Medium of exchange
- Store of value
- Unit of account

Solves “double coincidence of wants” problem

Gold, silver, shells, rocks, cigarettes, paper, digital entries, …

Useful features

Hard to counterfeit, commonly accepted, durable, easy to carry, divisible

‘Moneyness’

> …it has been rather a misfortune that we describe money by a noun, and that it would be more helpful for the explanation of monetary phenomena if ‘money’ were an adjective describing a property which different things could possess to varying degrees. ‘Currency’ is, for this reason, more appropriate, since objects can ‘have currency’ to varying degrees and through different regions or sectors of the population.

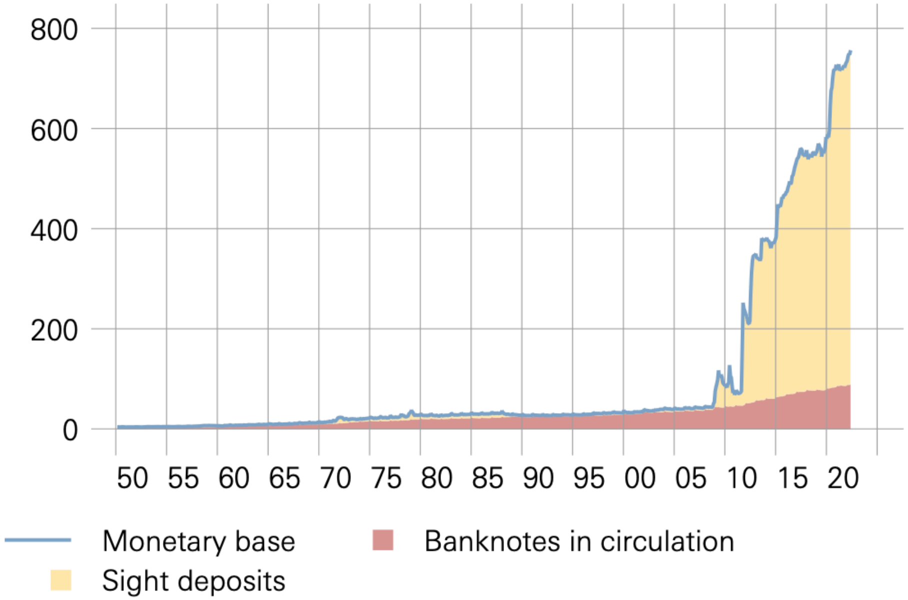
Hayek (1990, p. 56)

US monetary aggregates (supplier) [CB denotes “central bank”]

- Monetary base (CB): Physical currency + reserves
- M0 (CB): Physical currency
- M1 (CB, banks): M0 + demand deposits
- M2 (CB, banks): M1 + savings deposits + MMMF shares

MONETARY BASE

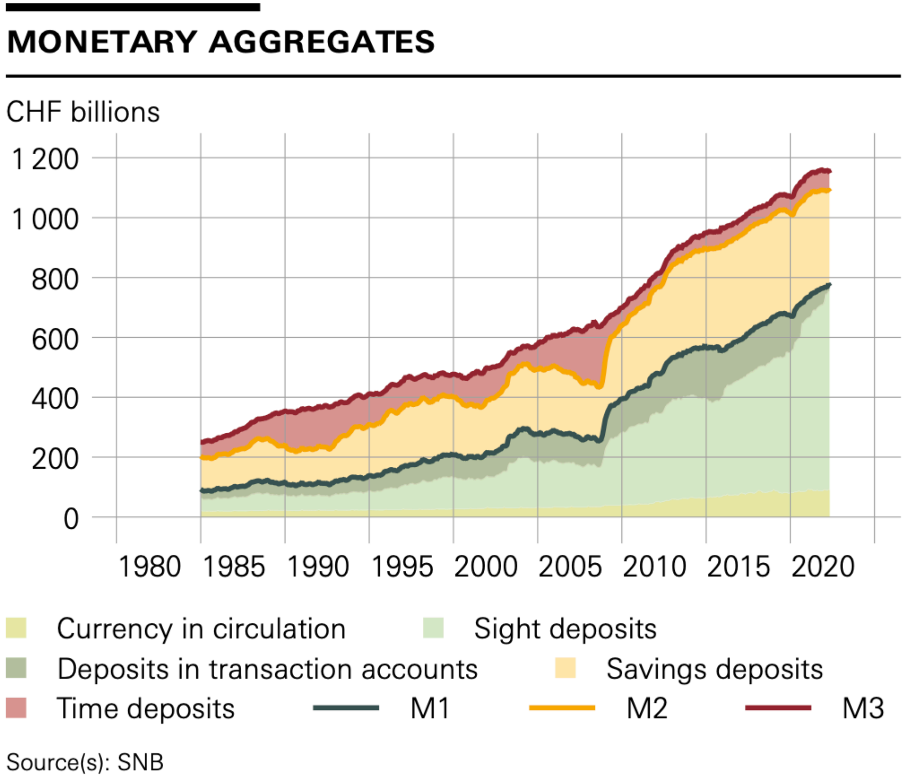
In CHF billions



Source(s): SNB

The calculation of monetary aggregates is based on the 1995 definition (cf. Notes).

SNB



The calculation of monetary aggregates is based on the 1995 definition (cf. Notes).

SNB

10.2 The Supply of Money

Banks hold reserves to

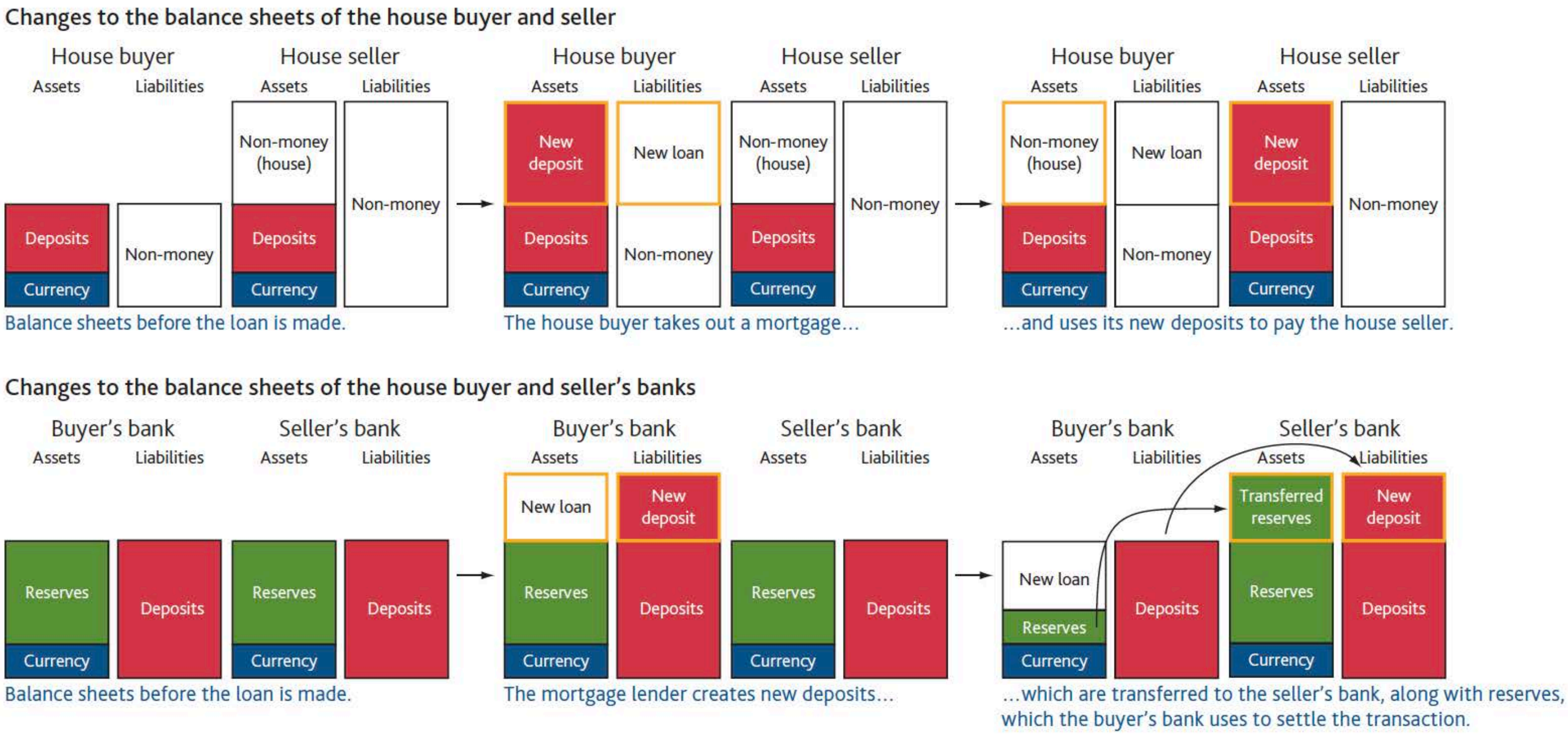
- Make payments to each other
- Prepare for cash withdrawals
- Satisfy regulation (e.g., minimum reserve requirements)

Banks create deposits

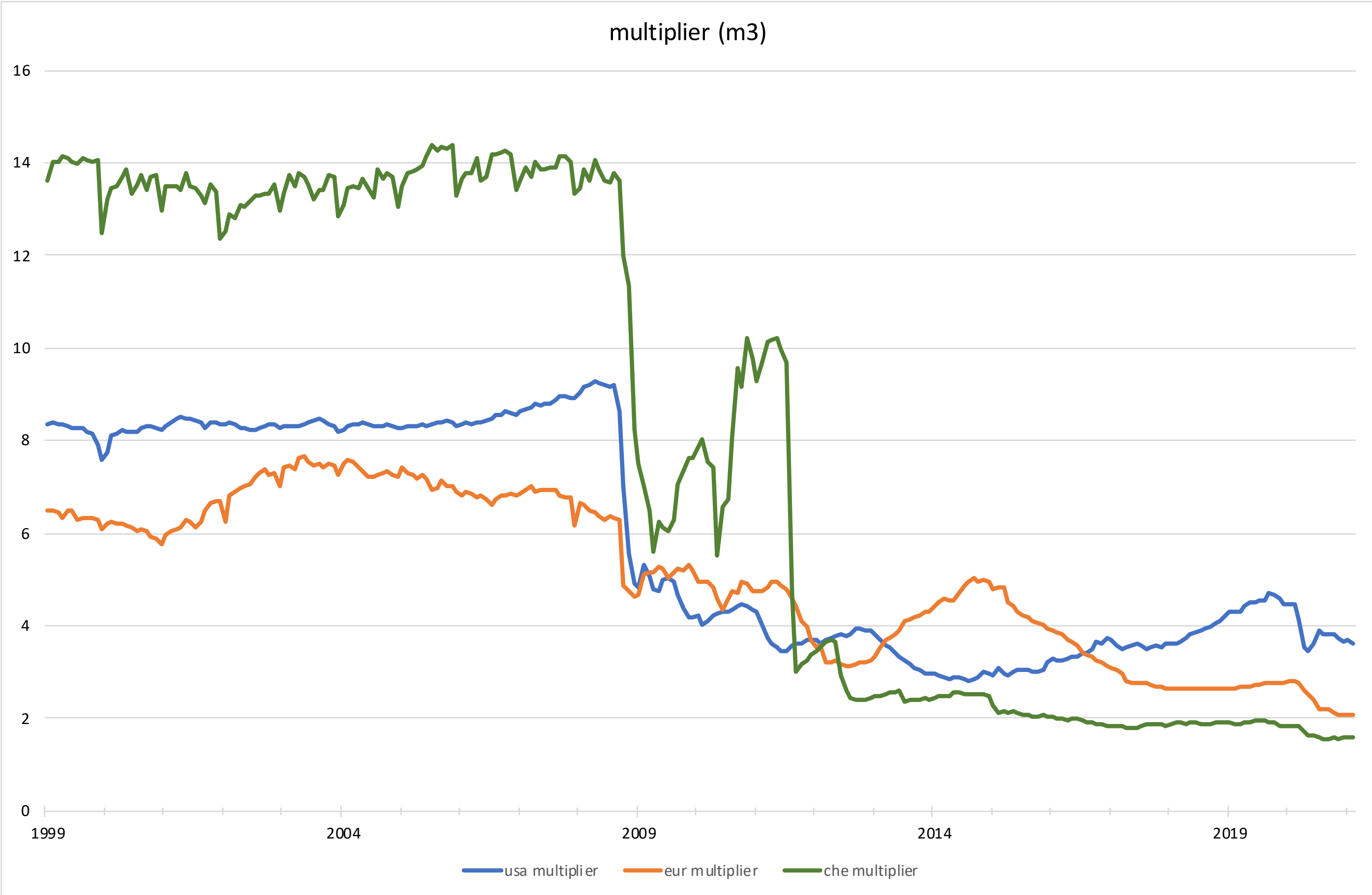
- By accepting cash deposits
- "Out of thin air" (criticized by "Vollgeld" proponents)

$\Rightarrow$ "Money multiplier" typically exceeds unity

Figure 2 Money creation for an individual bank making an additional loan[a]



McLeay et al. (2014)



FRED, SNB, own calculations

10.3 Changing the Supply of Money

Open market operation

- Central bank buys/sells bonds from/to banks against reserves
- If banks maintain money multiplier, changed reserves translate into changed M1, M2, e.g., due to changed loans

Special situation without opportunity cost of reserves ($i^R = i$)

- E.g., i at zero lower bound and $i^R = 0$
- Banks have no incentive to minimize reserve holdings, indeterminate money multiplier

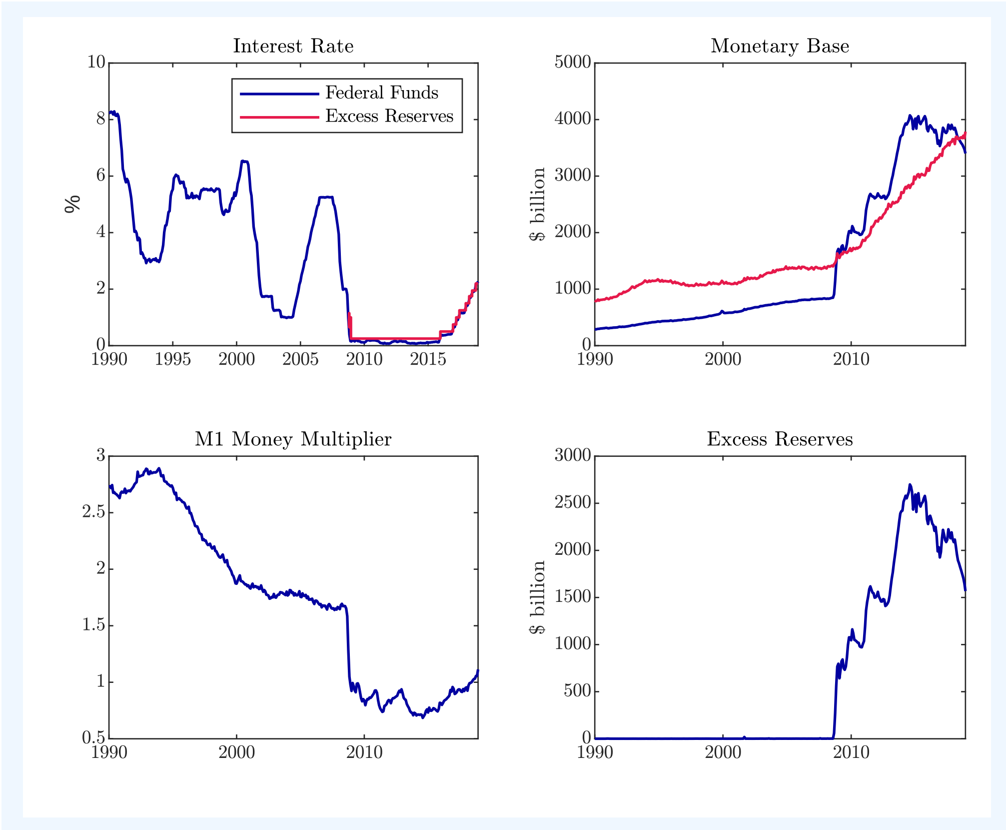


Fig. 10.3.1: *Monetary Aggregates in the US when nominal interest rates reached zero. Source: Board of Governors of the Federal Reserve System.*

Kurlat (2020)

10.4 The Demand for Money

Household money demand (e.g., for M1)

- Increases in transactions volume, Y
- Decreases in opportunity cost, nominal interest rate i

Example micro foundation (Baumol, 1952; Tobin, 1956)

- Interest bearing assets swapped into money N times, at fixed cost F, implying average money holdings $M = pY/(2N)$
- Household solves $\min_N pFN + ipY/(2N)$
- Optimal N implies $M/p = \sqrt{YF/(2i)}$

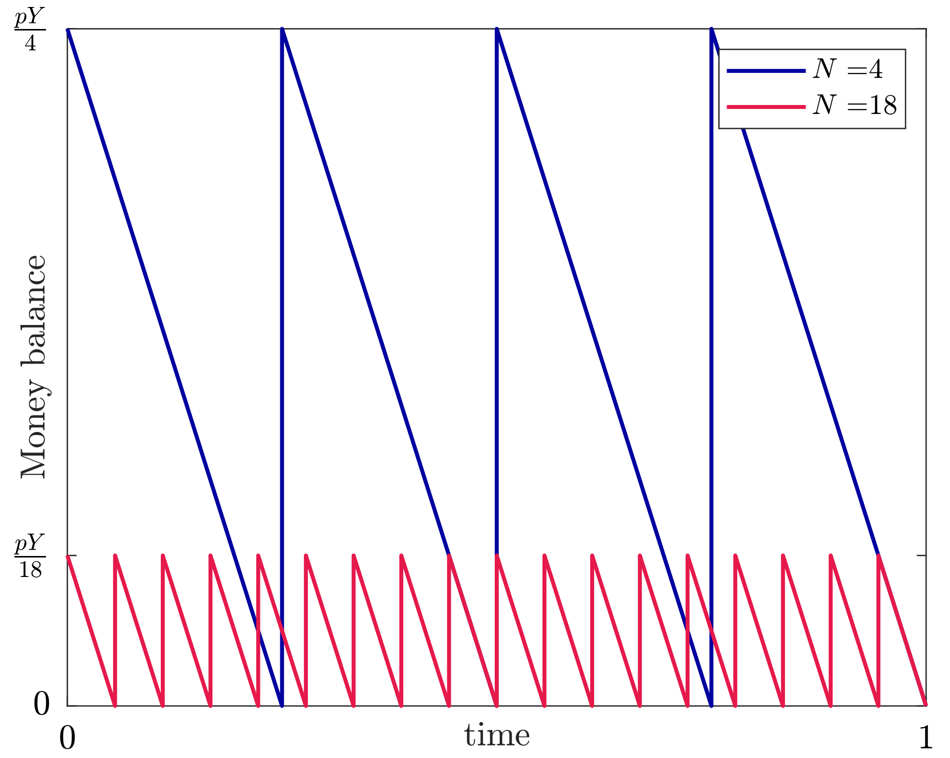


Fig. 10.4.1: *Money balances over time in the Baumol-Tobin model.*

Kurlat (2020)

Generalized demand function reasonably stable (e.g. Kurlat, 2019)

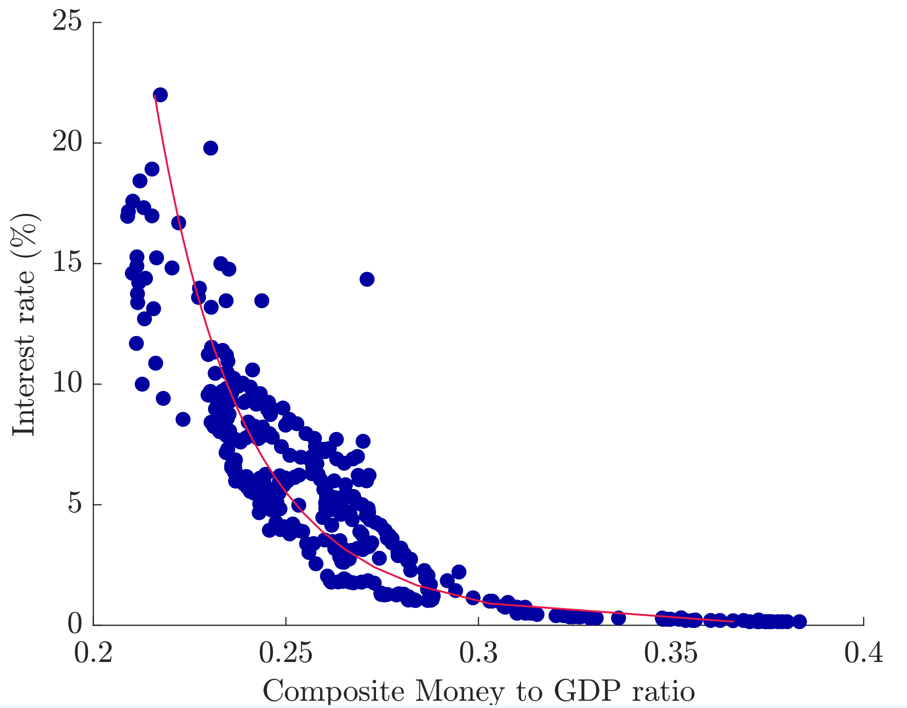


Fig. 10.4.3: *Money demand in the United States. Each dot represents one month between 1980 and 2013. Source: Kurlat (2019)*

Kurlat (2020)

11 The Price Level and Inflation

11.1 Measurement

Inflation is generalized growth in prices, $\pi_t = P_t / P_{t-1} - 1$

- Unequal growth across goods requires averaging (ch. 1)
- GDP deflator, consumer price index, ...
- Deflation = negative inflation

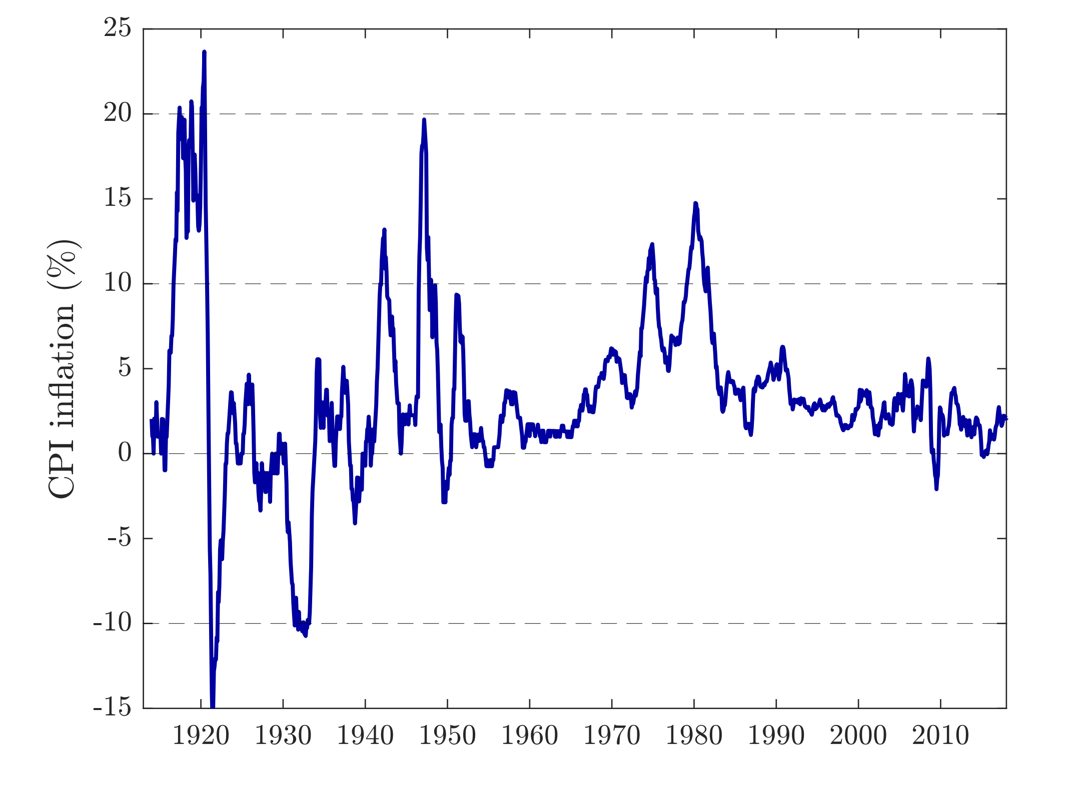
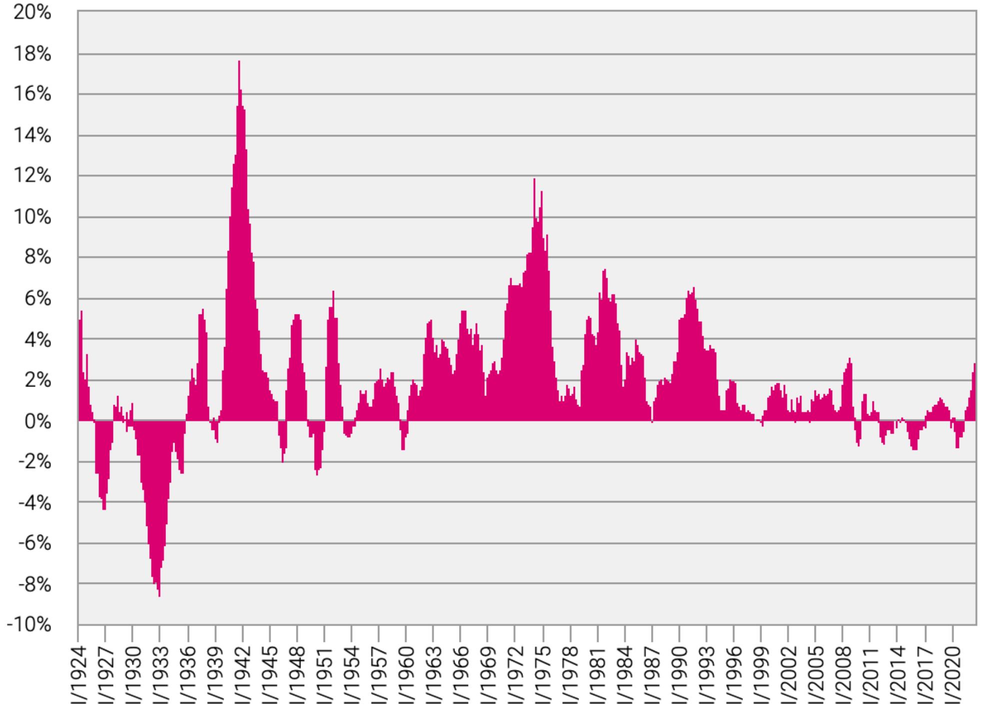


Fig. 11.1.1: *CPI inflation in the US. Source: BLS.*

Kurlat (2020)

Consumer Price Index

Percentage change with respect to the same month last year



Source: FSO – Consumer Price Index (CPI)

Federal Statistical Office

Nominal vs. real interest rates, Fisher (1896) equation

$$1 + r = \frac{1+i}{1+\pi} \;\Rightarrow\; r = i - \pi - r\pi \approx i - \pi$$

Ex-ante expected vs. ex-post realized real interest rate

$$\begin{aligned} @\, t: &\qquad \mathbb{E}_t[r_{t+1}] = i_{t+1} - \mathbb{E}_t[\pi_{t+1}] \\ @\, t+1: &\qquad r_{t+1} = i_{t+1} - \pi_{t+1} \end{aligned}$$

11.2 Equilibrium in the Money Market

Central bank (indirectly) supplies, households demand money

$$M^S = m^D(Y^+, i^-)p$$

Classical view: Real allocation $\perp$ money, money "neutral"

p, π under classical view when M^S grows at rate μ

- $\mu = 0 \ \Rightarrow \pi = 0,\ i = r + 0,\ p = M^S/m^D(Y, r)$
- $\mu > 0 \ \Rightarrow \pi = \mu,\ i = r + \mu,\ p = M^S/m^D(Y, i)$
- $g > 0 \ \Rightarrow \pi < \mu$, depending on elasticity m^D w.r.t. Y

(New Keynesian view: Money nonneutral, ch. 14)

Empirical support for $\pi \approx \mu$ in long run

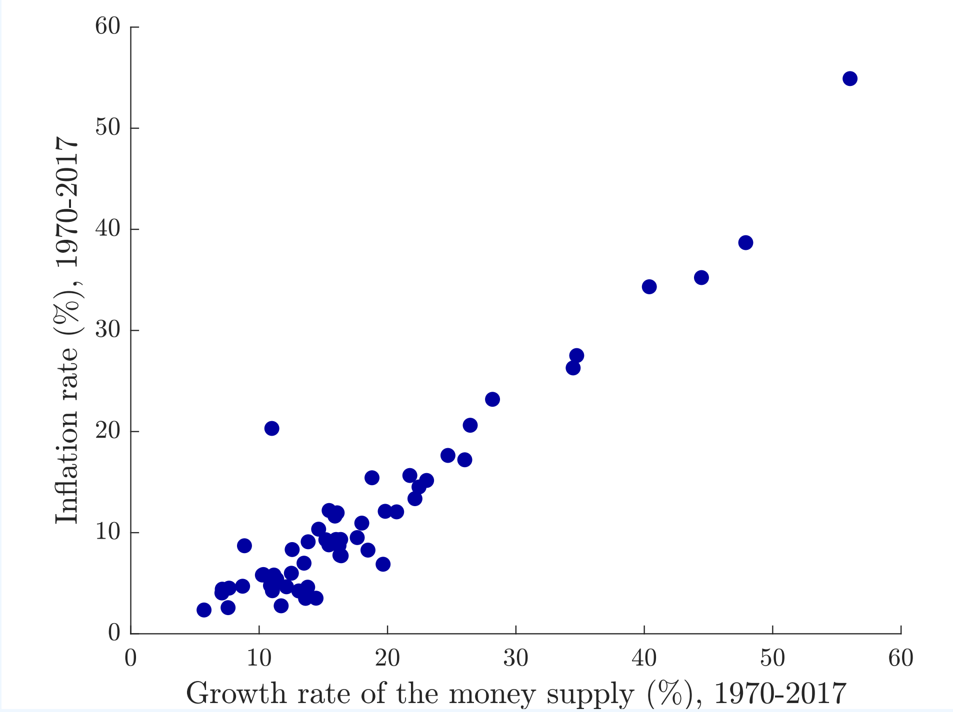


Fig. 11.2.1: *Inflation and the growth rate of the money supply in the long run. Each dot represents one country. Source: World Bank.*

Kurlat (2020)

Level vs. growth effects of M^S

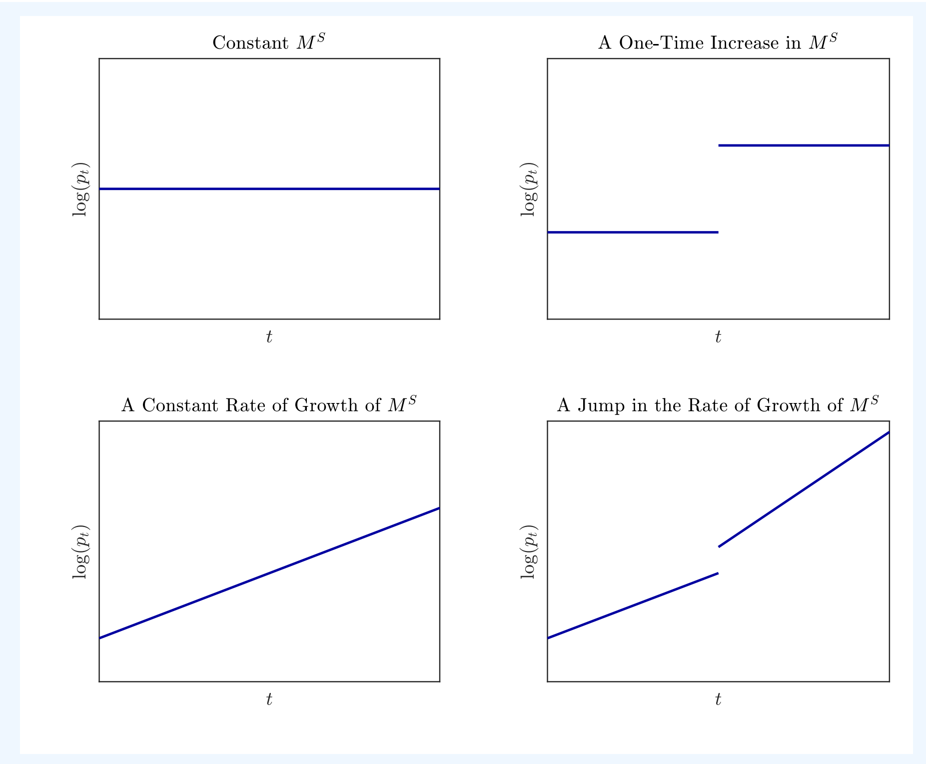


Fig. 11.2.2: *The evolution of prices in several examples.*

Kurlat (2020)

Velocity of money, quantity equation

$$V \equiv \frac{pY}{M} \;\Rightarrow\; VM = pY$$

Plus theory of money demand

$$V = \frac{Y}{m^D(Y,i)} \;\Rightarrow\; V \text{ increases in } i$$

Specific theory of money demand, $m^D \perp i \;\Rightarrow\; V \perp i$

$$p \propto M/Y$$

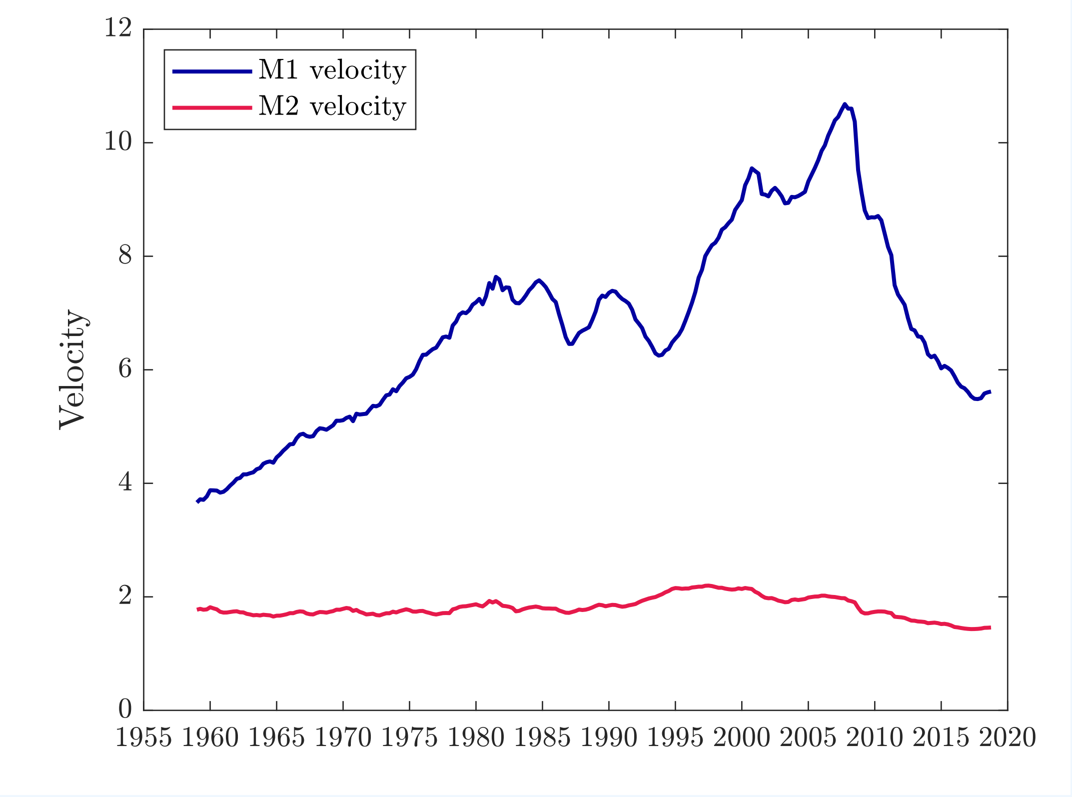


Fig. 11.2.3: *The velocity of money in the US, using M1 and M2 as definitions of money. Source: Federal Reserve Bank of St. Louis.*

Kurlat (2020)

11.3 Seignorage

Resources obtained by creating money

- "Seigneur" keeps share of silver when minting coins
- Today, base money issuance generates government revenue

  Alternative perspective: Low interest base money (= government debt) issuance finances high interest asset holdings
- Private money issuance generates commercial bank profit

Households hold low interest money because of liquidity services

Inflation taxes owners of outstanding base money, subject to "Laffer curve"

11.4 The Cost of Inflation

High inflation induces households to reduce money holdings

- Generates costs from, e.g., swapping assets into money more often (Baumol, 1952; Tobin, 1956), lower liquidity benefits
- Minimum costs when no opportunity cost of holding money, Friedman (1969) rule: $i = 0$

Inflation, deflation requires costly price adjustments (menu costs), creates uncertainty about relative prices, distorting choices

- Minimum costs when $\pi = 0$: $i = r$

B The Open Economy

B.1 Trade Balance, Current Account and Net Foreign Assets

Trade balance enters GDP identity, resource constraint

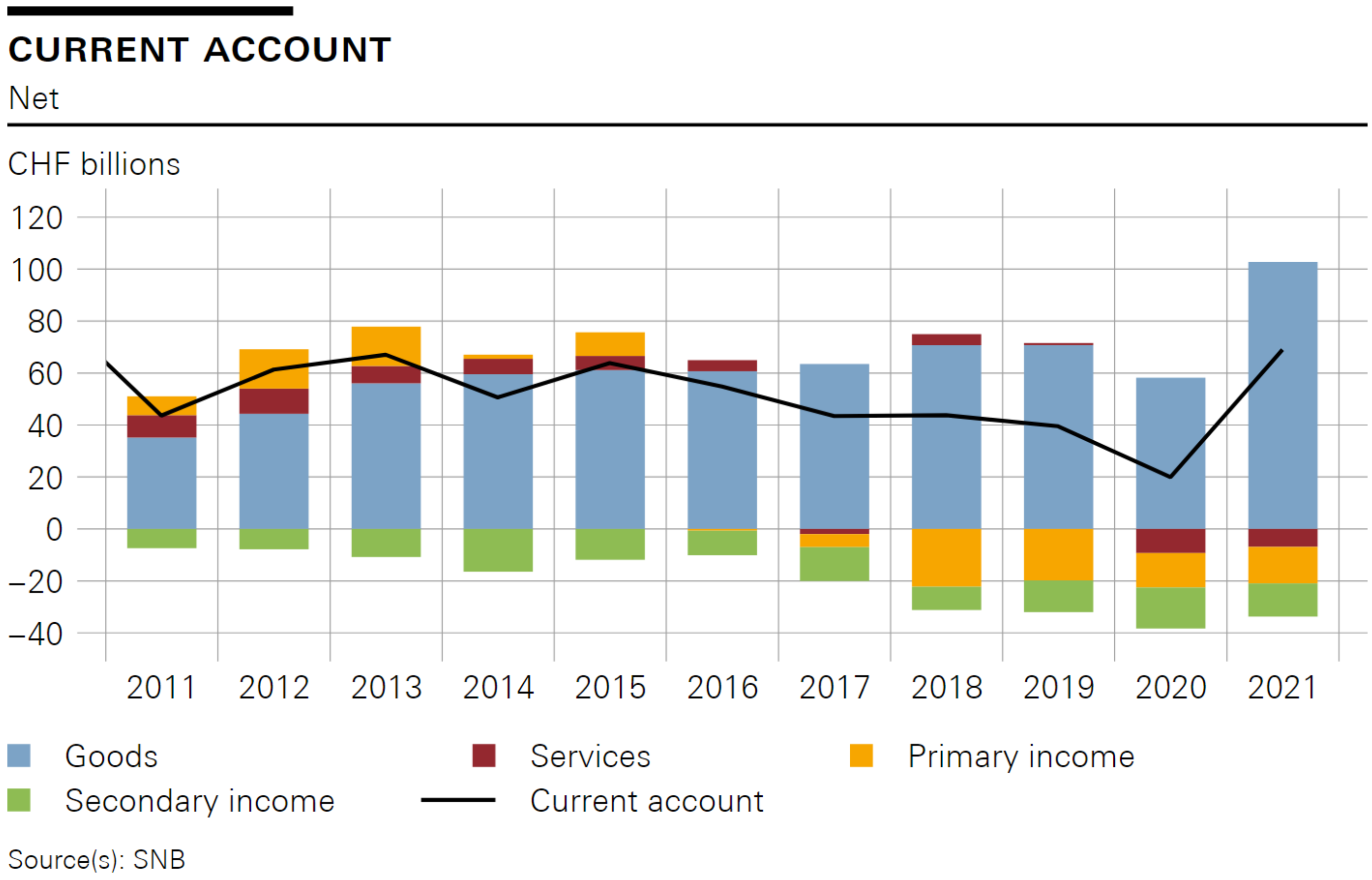
$F(K_t, 1) = c_t + K_{t+1} - K_t(1-\delta) + TB_t$ (see ch. 1, 9, assuming $G = 0$)

Current account also includes net foreign asset income (and cross-border labor income), transfers

$$CA_t = TB_t + r_t NFA_t + TR_t$$

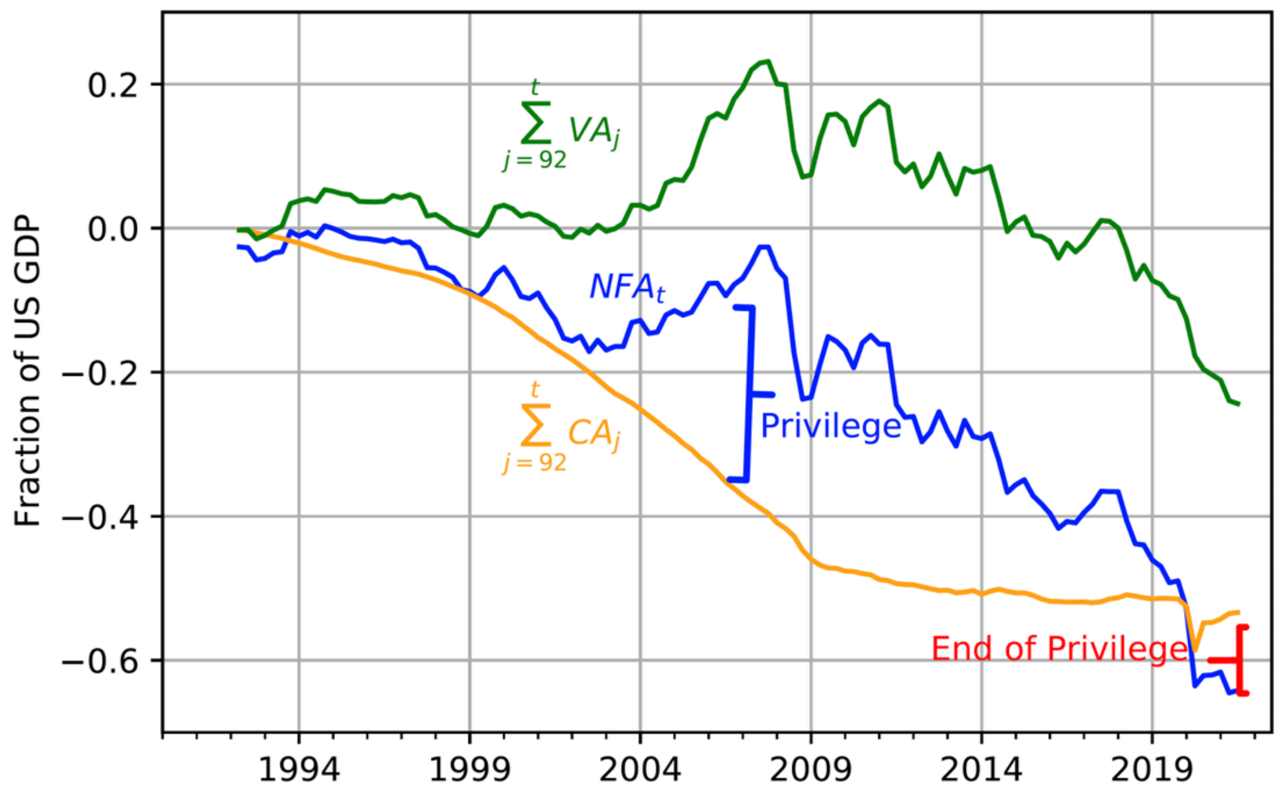
Net foreign asset change reflects current account, capital gains

$$NFA_{t+1} - NFA_t = CA_t + \Delta\text{price of } NFA_t$$



SNB (for Swiss balance of payment statistics see SNB website)

Figure 1 The US net foreign asset position (NFA), cumulative current account (CA) deficits, and cumulative valuation effects (VA)



Atkeson, Heathcote, Perri on VoxEU, July 2022

Example: Two periods, no risk

$$\begin{aligned} NFA_2 &= TB_1 + (1 + r_1)NFA_1 + TR_1 \\ 0 &= TB_2 + (1 + r_2)NFA_2 + TR_2 \end{aligned}$$

Solving forward yields country's inter temporal budget constraint

$$-(1 + r_1)NFA_1 = (TB_1 + TR_1) + \frac{TB_2 + TR_2}{1 + r_2}$$

$$\text{or } \ c_1 + \frac{c_2}{1 + r_2} = (1 + r_1)NFA_1 + (Y_1 - I_1 + TR_1) + \frac{Y_2 - I_2 + TR_2}{1 + r_2}$$

Net assets decoupled from capital, $\Delta A_t = \Delta NFA_t + \Delta K_t$

- Factor prices decoupled from national saving, investment
- In small open economy with free capital mobility, domestic factor prices given by international factor prices

$\Rightarrow$ Equilibrium consumption smoothing as in partial equilibrium model (ch. 6), not closed economy general equilibrium model (ch. 9)

B.2 Gains From Trade

Trade allows countries to exploit comparative advantage, resulting from relative productivity, endowment differences

- Static gains (international trade theory)
- Intertemporal gains from borrowing, lending

  Opening up economy with low (high) K/L generates capital inflow (outflow), always yields $(r - F_K(K,1))dNFA > 0$
- Conflicts when households differentially exposed to capital, labor income

B.3 Real Exchange Rate

Price of domestic consumption relative to consumption abroad

- Driven to unity if goods can be traded at no cost (cf. PPP exchange rate, Big Mac index)
- Different from unity with trade costs, nontraded goods
- Expensive nontraded goods appreciate real exchange rate

For given nontradable production higher wealth increases price of nontradables (market clearing), appreciates real exchange rate

In long run, firms move between tradable, nontradable sectors, supply factors determine real exchange rate

- Productivity growth in tradable sector increases wage in *all* sectors (domestic labor mobility)
- To cover costs, prices in nontradable sector rise

⇒ Increase of relative price of nontradables, Baumol and Bowen (1966) effect

⇒ Real appreciation in countries with faster productivity growth, Harrod (1933)-Balassa (1964)-Samuelson (1964) effect

B.4 Nominal Exchange Rate, Interest Parity and Purchasing Power Parity

Nominal exchange rate, E, price of foreign currency

Interest parity condition

- Indifference between foreign, domestic investment requires equal currency adjusted returns

$$1 + i_{t+1} = (1 + i^{\star}_{t+1}) E_{t+1} / E_t$$

- Interest rate differential compensates for ap/depreciation
- With risk, additional risk premium

Purchasing power parity (PPP)

- Law of one price, absent impediments to trade: Goods priced identically internationally
- Implies unity real exchange rate, (absolute) PPP

$$E_t = P_t / P_t^\star$$

Exchange rate determination

- $M^\star / M$ determine $P^\star / P$ (money market, long term), determine E (PPP, long term)
- E_∞, interest parity sequence determine current E (short term)
- Possibly nonmonotone exchange rate dynamics, "overshooting" (Dornbusch, 1976)

B.5 Further Readings

See, e.g., Niepelt (2019, ch. 7, 9.1), Obstfeld and Rogoff (1996)

12 Facts about Business Cycles

12.1 What are Business Cycles?

Deviations from trend

Expansion, peak, recession, trough

Recession

- Technical definition: GDP reduction for ≥ 2 quarters
- NBER dated

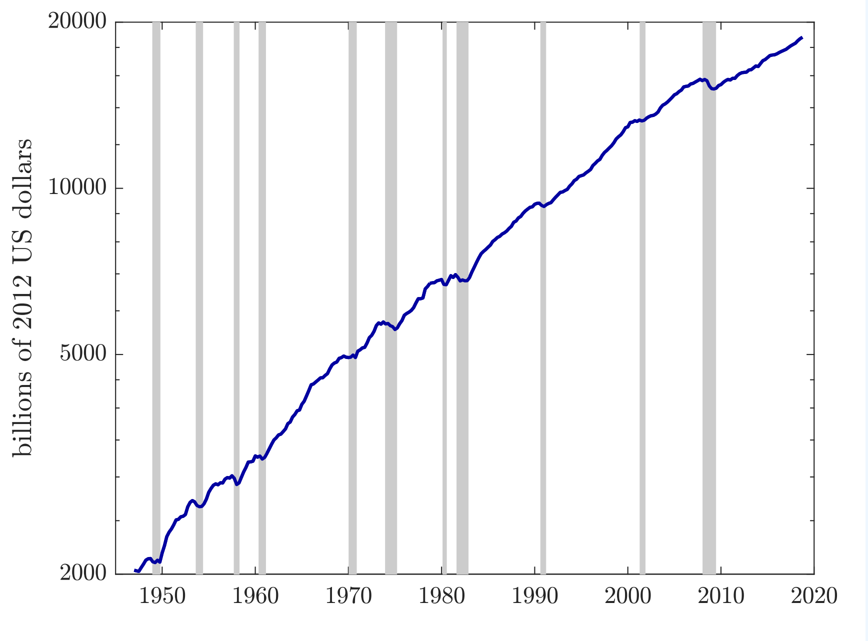


Fig. 12.1.2: *Real GDP in the US since 1947 and NBER recessions. Source: NIPA and NBER.*

Kurlat (2020)

Hodrick and Prescott (1997) filter separates time series, $\{x_t\}_{t=1}^T$, into "trend," $\{\hat{x}_t\}_{t=1}^T$, and "cycle," $\{x_t - \hat{x}_t\}_{t=1}^T$

$$\min_{\{\hat{x}_t\}_{t=1}^T} \sum_{t=1}^{T} (x_t - \hat{x}_t)^2 + \lambda \sum_{t=2}^{T-1} \left[(\hat{x}_{t+1} - \hat{x}_t) - (\hat{x}_t - \hat{x}_{t-1}) \right]^2$$

For quarterly data typically set $\lambda = 1600$

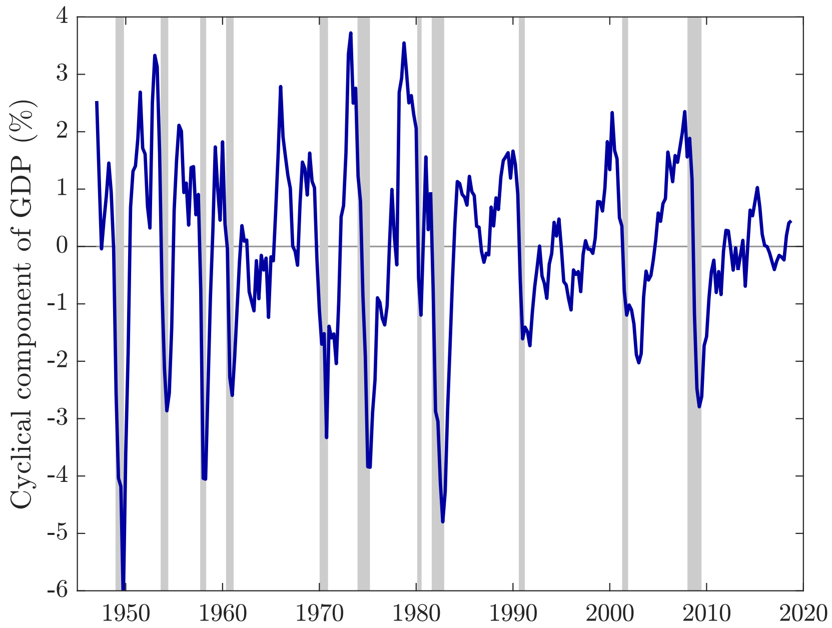


Fig. 12.1.4: *Cyclical component of real GDP in the US since 1947 obtained with HP filter.*

Kurlat (2020)

12.2 Patterns in Business Cycles

US data, cyclical components

Table 12.1: *Business cycle properties of macroeconomic variables. Y, C, I, G, M, X, total hours, TFP and real wages are measured in log scale so the units are comparable. All variables are detrended using an HP filter with $\lambda = 1,600$. Sources: NIPA for GDP and its components; BLS for labor market data including wages and for inflation; Fernald (2014) for TFP; Board of Governors of the Federal Reserve System for interest rates.*

Variable	Standard deviation	Relative standard deviation	Correlation with GDP
GDP	1.6%	1	1
Consumption	1.2%	0.74	0.78
Durable Goods	4.7%	2.93	0.60
Non-durable Goods	1.5%	0.95	0.58
Services	0.8%	0.54	0.57
Investment	7.3%	4.59	0.83
Government spending	3.3%	2.06	0.16
Exports	5.3%	3.31	0.42
Imports	5.0%	3.12	0.72
Total hours of work	1.8%	1.13	0.85
TFP (Solow residual)	1.3%	0.78	0.80
Real wages	0.7%	0.47	0.31
Unemployment rate	0.8%		−0.86
Inflation	3.2%		0.26
Nominal Interest Rate	1.1%		0.38

Kurlat (2020)

US data

- GDP typically differs 1.6% from trend
- Consumption less volatile than GDP, except for durables
- Investment much more volatile than GDP
- Consumption, investment, productivity, hours of work strongly positively correlated with GDP, unemployment negatively
- Real wages weakly positively correlated with GDP
- Inflation, nominal interest rates weakly positively correlated with GDP

Similar regularities in CH, Europe (Danthine and Girardin, 1989; Danthine and Donaldson, 1993)

"Phillips curve" relation between activity, inflation

- Phillips (1958) documented negative relationship between wage inflation, unemployment rate
- Stable Phillips curve?

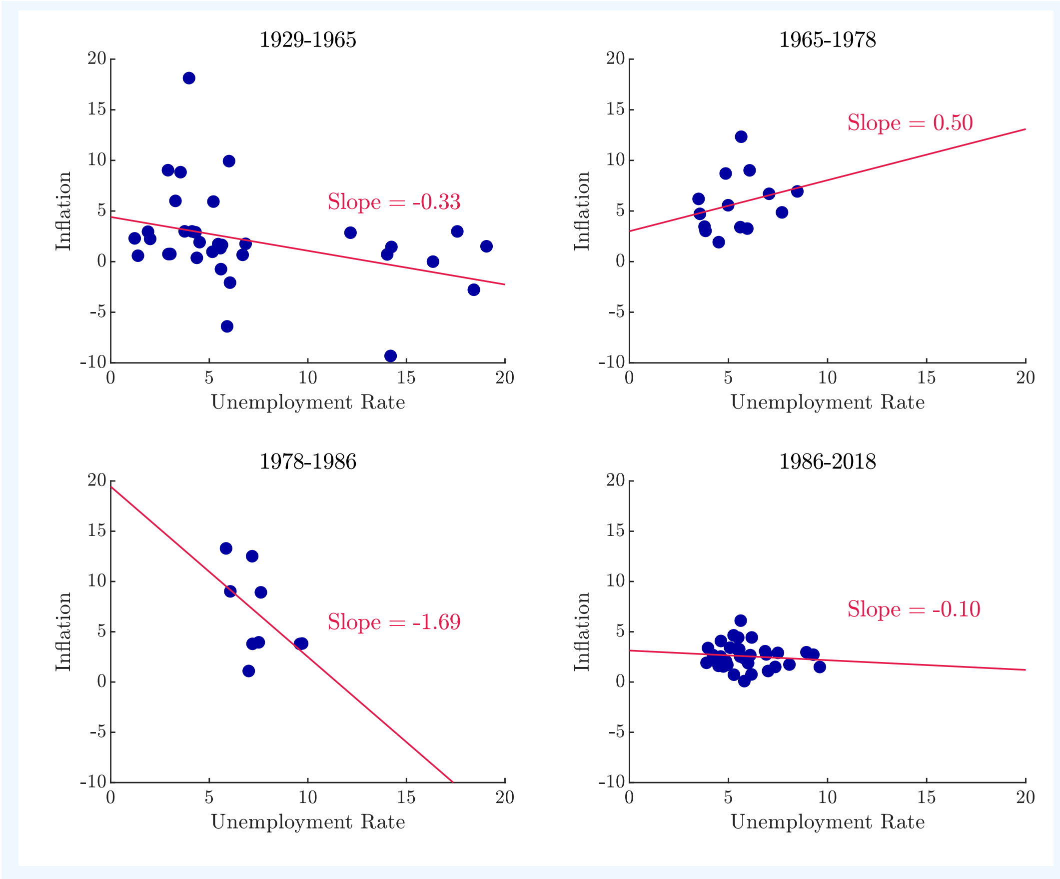


Fig. 12.2.3: Cyclical component of unemployment and CPI inflation in the US. Source: BLS.

Kurlat (2020)

Great depression, 1929–1933

- Typical recession, only much stronger
- Macroeconomics (Keynes, 1936; Hicks, 1939)

12.3 Who Cares about the Business Cycle?

Lucas (1987) stipulates utility function, compares utility of trend vs. actual consumption, infers tiny welfare losses from cycles

Criticism

- Loss from average consumption risk underestimates average loss from concentrated risk (heterogeneity)
- Mismeasured trend (peaks = potential output?)
- Small losses need not imply useless stabilization policy—losses may be low *because* of stabilization policy

13 The Real Business Cycle Model

Focus on “real” rather than “nominal” factors as drivers of business cycle

Dynamic general equilibrium model with stochastic technology

Here: Stripped down model of ch. 9 plus technology shocks

13.1 A Two-Period Model

No initial capital, first-period production only uses labor

$$Y_1 = F_1(L)$$

Second-period production only uses capital

$$Y_2 = F_2(K)$$

Focus on first-period labor supply, investment, consumption

First welfare theorem applies (competition, no externalities)

Social planner allocation coincides with equilibrium allocation

Social planner problem

$$\max_{c_1,c_2,L,K,Y_1} \quad u(c_1) + v(1-L) + \beta u(c_2)$$
$$\text{s.t.} \quad c_1 + K = Y_1 = F_1(L), \;\; c_2 = F_2(K) \;\; (\delta = 1)$$

First-order conditions (as usual, MRS = MRT)

$$\frac{v'(1-L)}{u'(c_1)} = F_1'(L) \qquad \text{(consumption vs. leisure)}$$
$$u'(c_1) = \beta F_2'(K) u'(c_2) \qquad \text{(Euler equation)}$$

5 equations, 5 unknows

Substituting out c_2

$$Y_1 = F_1(L) \tag{1}$$

$$\frac{v'(1-L)}{u'(c_1)} = F_1'(L) \tag{2}$$

$$u'(c_1) = \beta F_2'(K) u'(F_2(K)) \tag{3}$$

$$Y_1 = (u')^{-1}[\beta F_2'(K) u'(F_2(K))] + K \tag{4}$$

4 equations, 4 unknows

Two endogenous variables in each equation

Graphical illustration

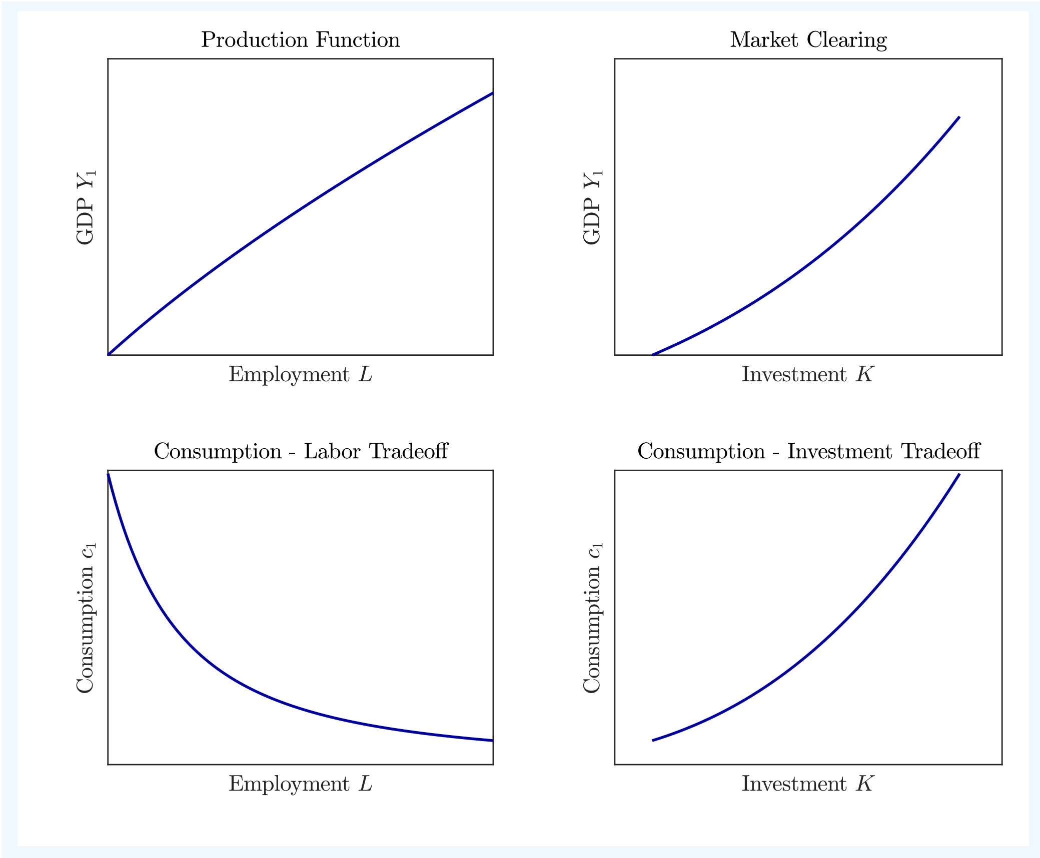


Fig. 13.1.1: *Equilibrium conditions in the RBC model.*

Kurlat (2020)

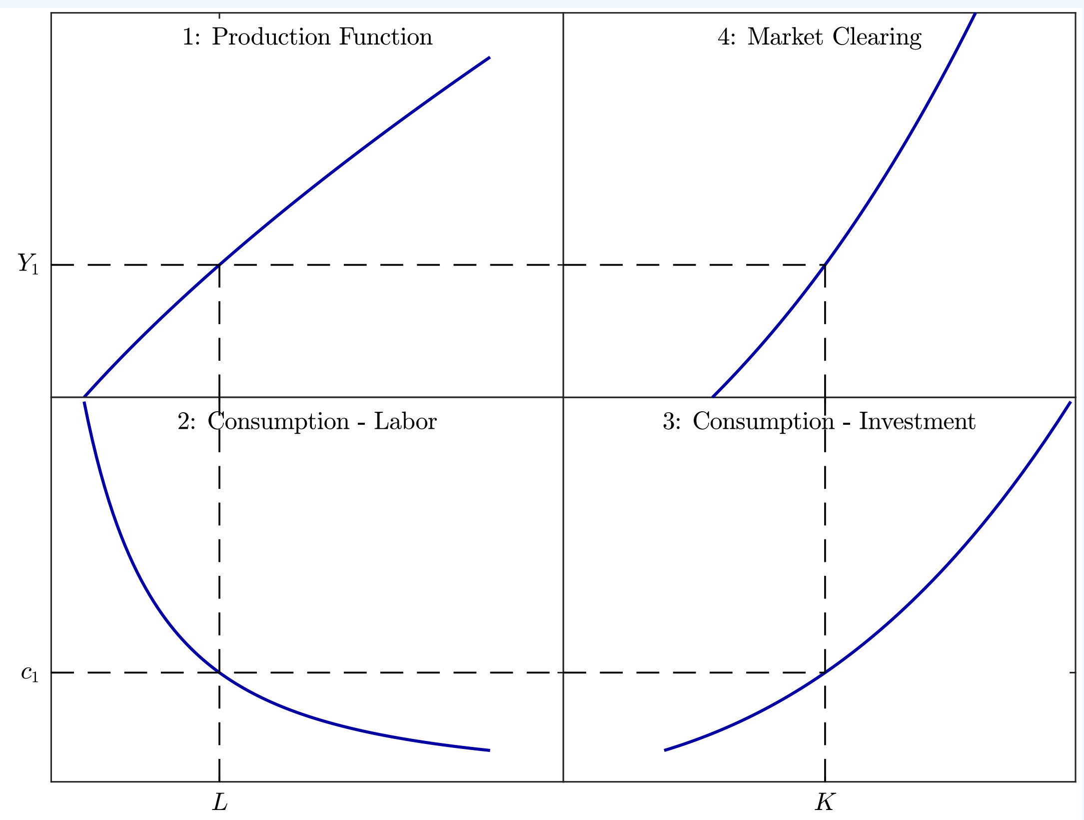


Fig. 13.1.2: *Graphical Solution of the RBC model.*

Kurlat (2020)

13.2 Markets

Have found social planner allocation, equilibrium allocation

Equilibrium also features prices

Competitive equilibrium prices satisfy price = MRS, MRT (ch. 9)

$$w = \frac{v'(1-L)}{u'(c_1)} = F_1'(L)$$

$$1+r = \frac{u'(c_1)}{\beta u'(c_2)} = F_2'(K) = r^K$$

(Consistent with general result, $1+r = 1+F_2'(K) - \delta = 1+r^K - \delta$)

here $\delta = 1$

13.3 Productivity Shocks

Production function changes to

$$Y_1 = AF_1(L), \;\; A > 1$$

Affects schedules (1), (2)

Channels

- Wealth effect $\Rightarrow$ higher c_1, c_2, lower L
- Substitution effect $\Rightarrow$ higher L (dominates in figure)
- Higher Y_1, consumption smoothing $\Rightarrow$ higher K

Responses consistent with data

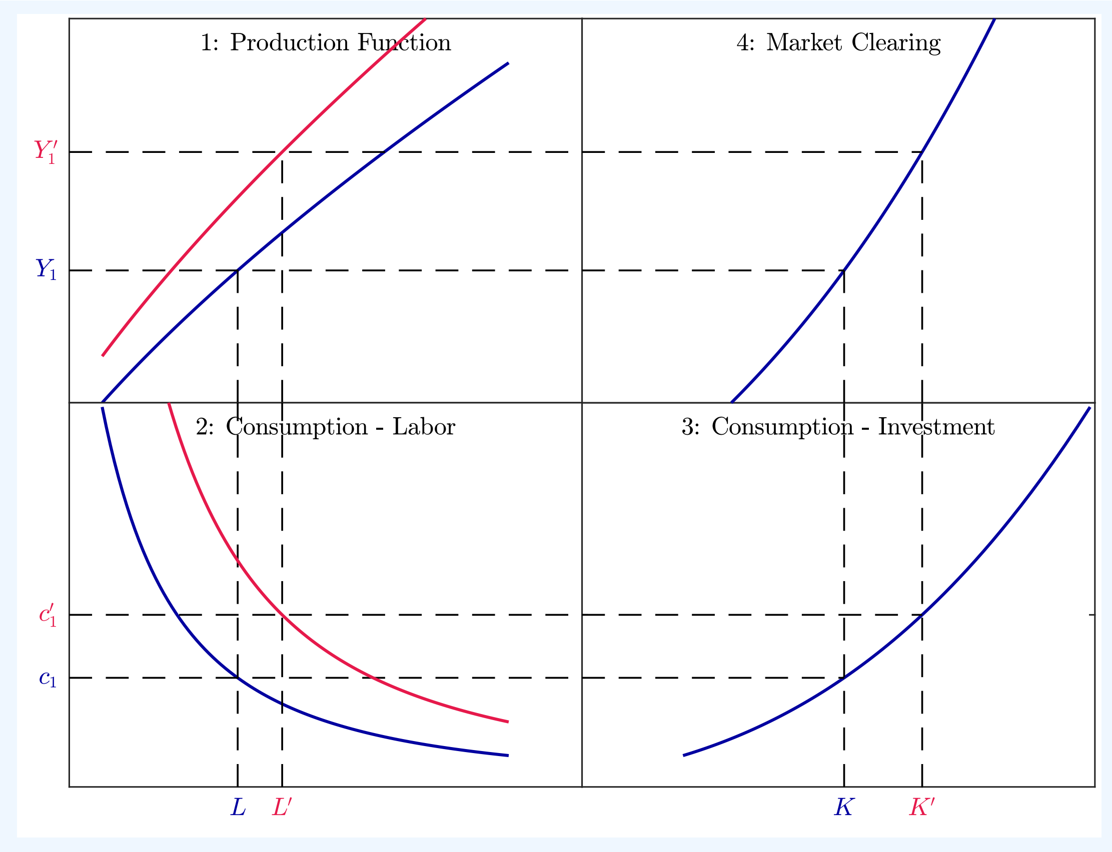


Fig. 13.3.1: *The economy's reaction to a productivity shock.*

Kurlat (2020)

13.4 Other Shocks

Impatience shock, fall in β

Affects schedules (3), (4)

Consumption moves opposite to investment, unlike in data

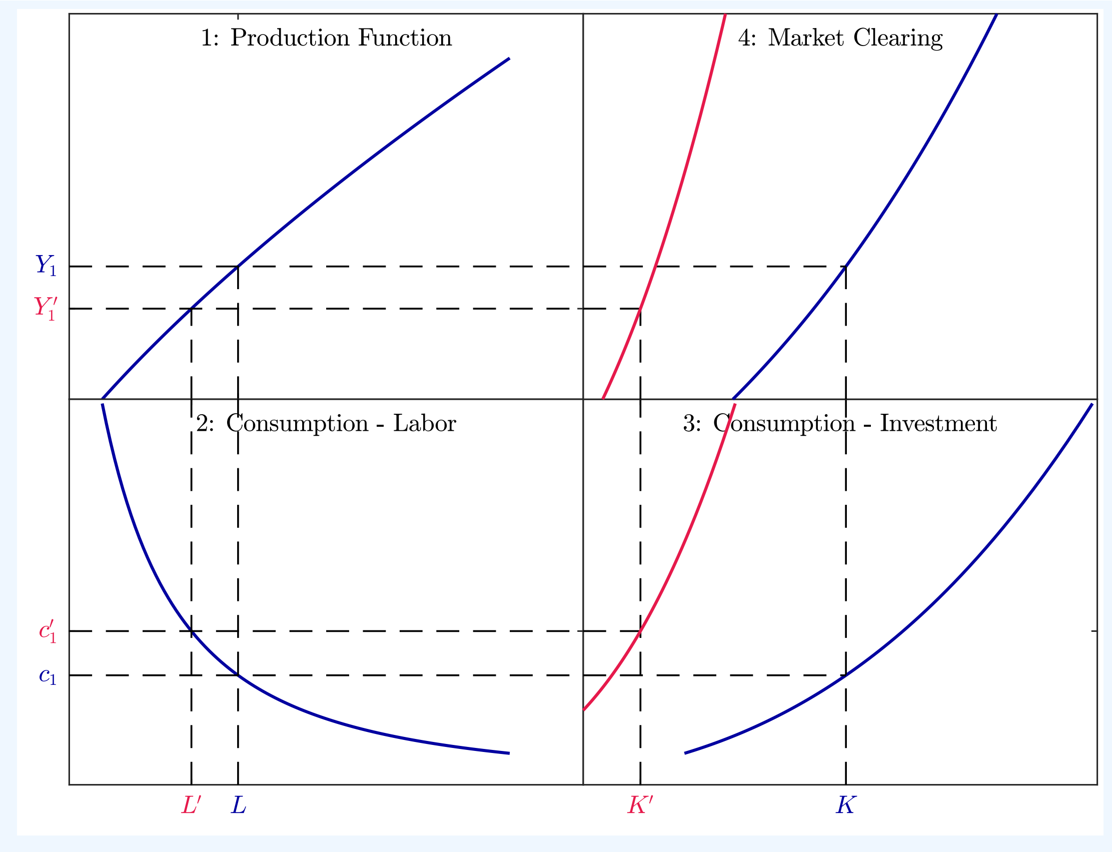


Fig. 13.4.1: The economy's reaction to an increase in impatience.

Kurlat (2020)

Optimism shock, (expected) production function changes to

$$Y_2 = AF_2(K), \;\; A > 1$$

Affects schedules (3) [ambiguous, higher return on investment but lower $u'(c_2)$], (4)

Counter-cyclical consumption, unlike in data (or counter-cyclical labor supply, unlike in data)

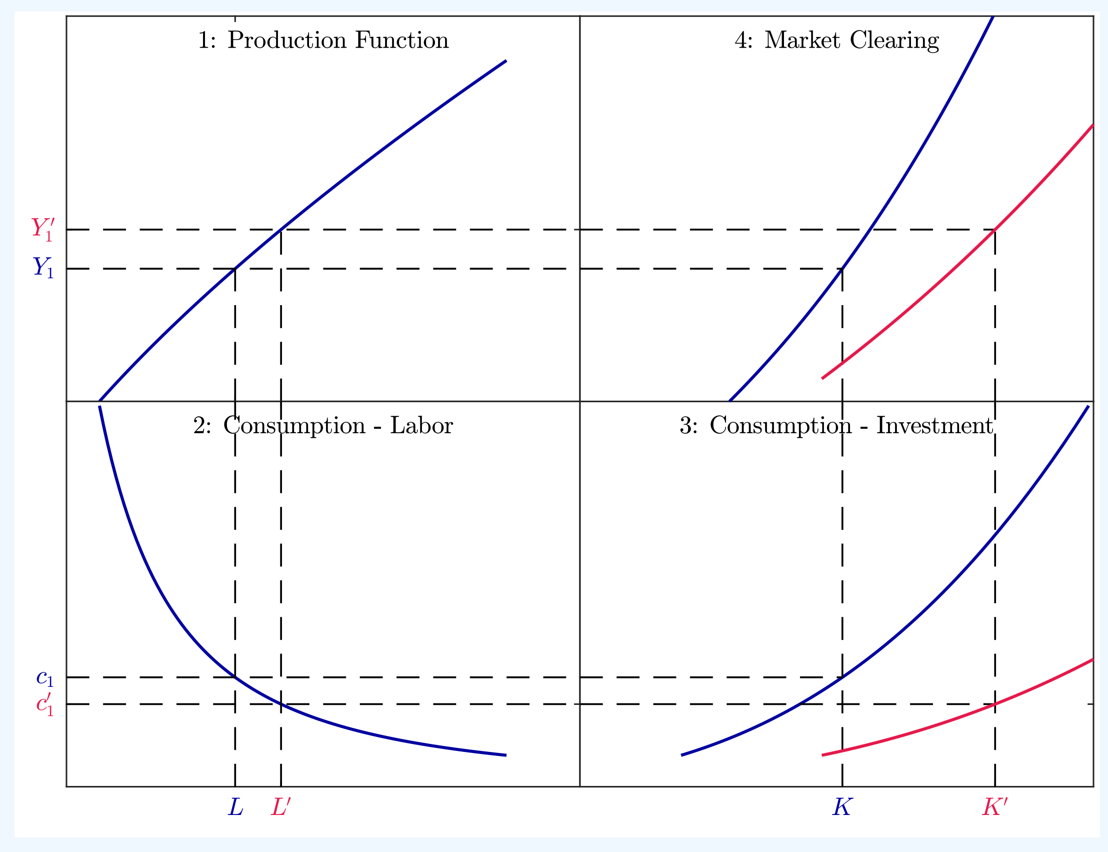


Fig. 13.4.2: *The economy's reaction to optimism about future productivity.*

Kurlat (2020)

Increased preference for leisure

$$\theta v(1-L), \ \ \theta > 1$$

Affects schedule (2)

Responses consistent with data (but implausible?)

Increased labor-income taxes produce same result

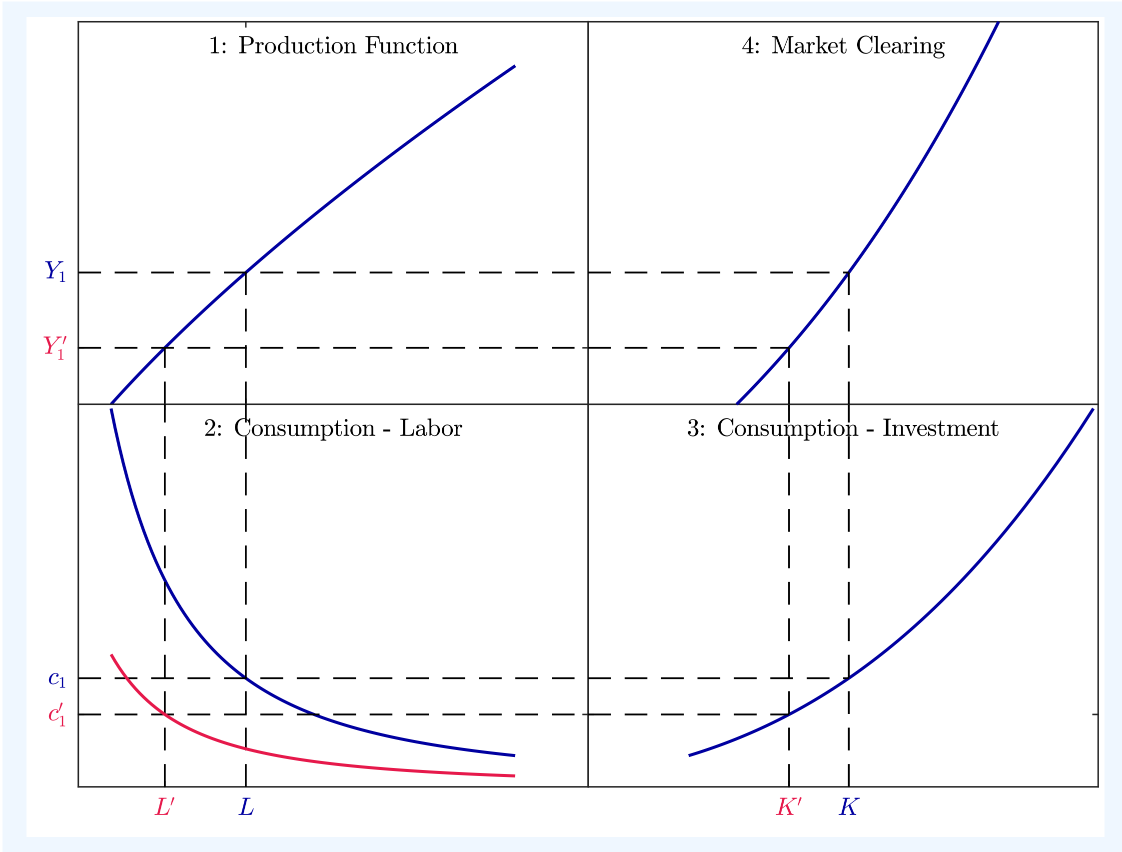


Fig. 13.4.3: *The economy's reaction to an increase in preference for leisure or an increase in income taxes.*

Kurlat (2020)

13.5 Assessing the RBC Model

Co-movement of c_1, L requires shift of schedule (2)

Not a model of unemployment (but of labor supply)

Quantitative assessment (Kydland and Prescott, 1982)

- Infinite horizon model, no simplifications
- Calibrated parameters
- Comparison data with moments of model predictions

Policy implications: Government interventions, stabilization not needed

Criticism

- Negative technology shocks?
- Disagreement about calibration, specifically high elasticity of labor supply
- Model implies too high volatility of real wages
- No theory of unemployment
- Solow residual misrepresents productivity due to changing capacity utilization (e.g., labor hoarding)

14 The New Keynesian Model

14.1 A Historical and Methodological Note

Keynes (1936) suggests lack of demand generates inefficient outcomes; Hicks's (1939) IS-LM model formalizes narratives

RBC model (ch. 13) in stark contrast to IS-LM

- Household, firm optimization ("microfoundations", response to Lucas (1976) critique), no ad-hoc relationships
- Efficient business cycles

New Keynesian model adopts RBC-type methodology, allows for frictions generating inefficient outcomes

14.2 Monopoly Power

Non-competitive supplier maximizes $qp(q) - c(q)$

First-order condition

$$p(q) + p'(q)q = c'(q) \;\Rightarrow\; p = c'(q) \underbrace{\frac{\eta}{\eta - 1}}_{\text{markup}}, \quad \eta \equiv -\frac{q'(p)p}{q(p)}$$

Elasticity of demand determines markup

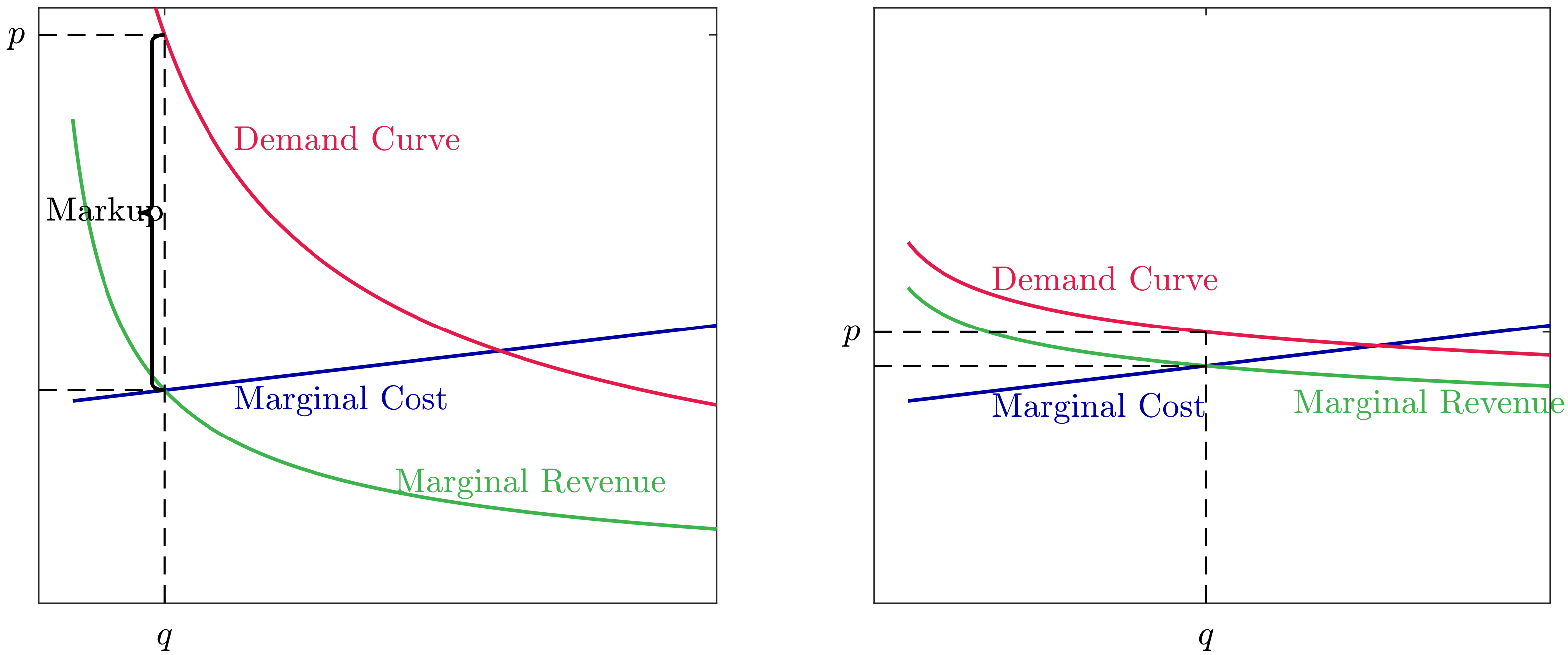


Fig. 14.2.1: *The monpolist's price-and-quantity decision.*

Kurlat (2020)

Workers (=suppliers) charge markup

Relative to RBC model, wedge in consumption-labor condition

$$\frac{v'(1-L)}{u'(c_1)} = F_1'(L)\frac{\eta - 1}{\eta}$$

Schedule (2) in ch. 13 shifts left, as with labor-income tax

Distorted allocation (workers work too little)—welfare theorems do not apply

14.3 Sticky Prices

Higher demand with flexible prices: Workers supply more, raise prices (decreasing $F_1'(L)$, $u'(c_1)$, increasing disutility of labor)

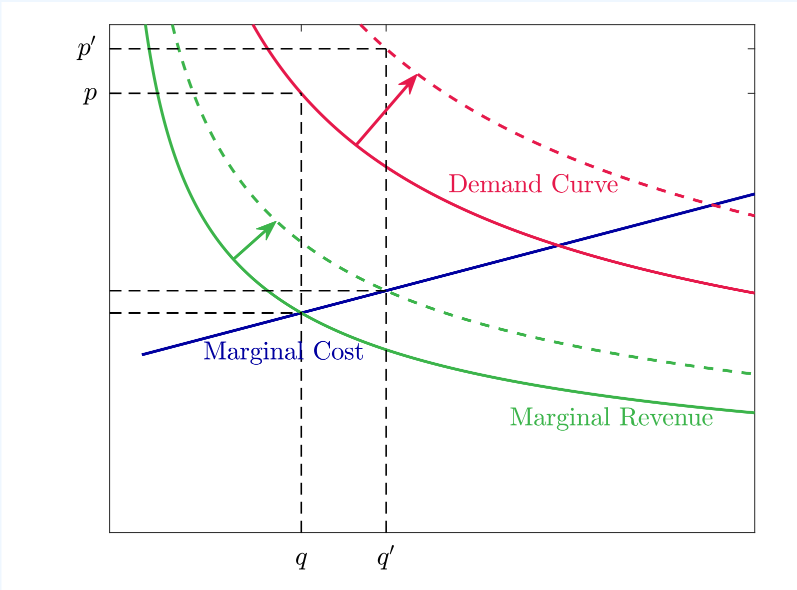


Fig. 14.3.1: *The monpolist's reaction to higher demand.*

Kurlat (2020)

Higher demand with *sticky* prices: Workers supply more, do not raise prices

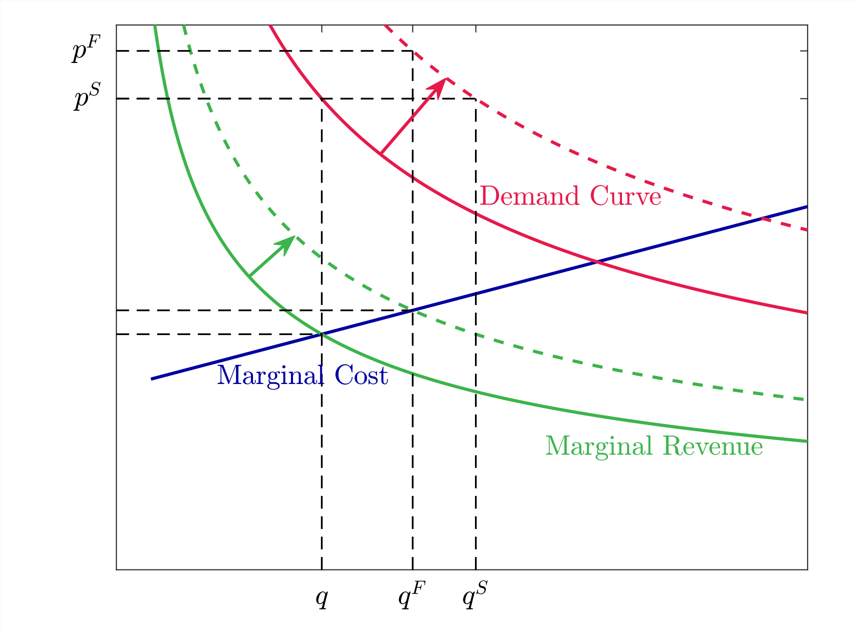


Fig. 14.3.2: *A monopolist with sticky prices.*

Kurlat (2020)

14.4 Putting Everything Together

Timing

- Workers set (nominal) p_1 for their output
- Central bank chooses money supply, M^S
- Households save, $u'(c_1) = \beta(1+r)u'(c_2)$ (as in RBC model)

  Firms invest ($\delta = 1$), $F_2'(K) = 1 + r$ (as in RBC model)

  Households choose (real) money holdings, $m^D(Y_1, i)$

p_2 depends on M_2^S; $\pi \equiv p_2/p_1 - 1$

Market clearing

$$
\begin{aligned}
Y_1 &= c_1 + K \text{ (as in RBC model)} \\
c_2 &= F_2(K) \text{ (as in RBC model)} \\
L &= F_1^{-1}(Y_1) \text{ (demand determined, unlike in RBC model)} \\
M^S &= m^D(Y_1, i) \cdot p_1
\end{aligned}
$$

Reduce conditions to two schedules (IS, LM) plus labor demand (L given Y_1)

IS: Euler & market clearing $t = 1, 2$ & investment & Fisher

$$u'(Y_1 - K(i - \pi)) = \beta(1 + i - \pi)u'(F_2(K(i - \pi)))$$

Negative relation between Y_1, i (given π)

$$i \uparrow \Rightarrow \; r \uparrow \Rightarrow \; K \downarrow, c_1/c_2 \downarrow \Rightarrow \; c_2 \downarrow \Rightarrow \; c_1 \downarrow \Rightarrow \; Y_1 \downarrow$$

LM: Money market clearing (given p_1)

$$M^S = m^D(Y_1, i) \cdot p_1$$

Positive relation between Y_1, i

p_1, π, M^S, IS, LM determine Y_1, i, other endogenous variables

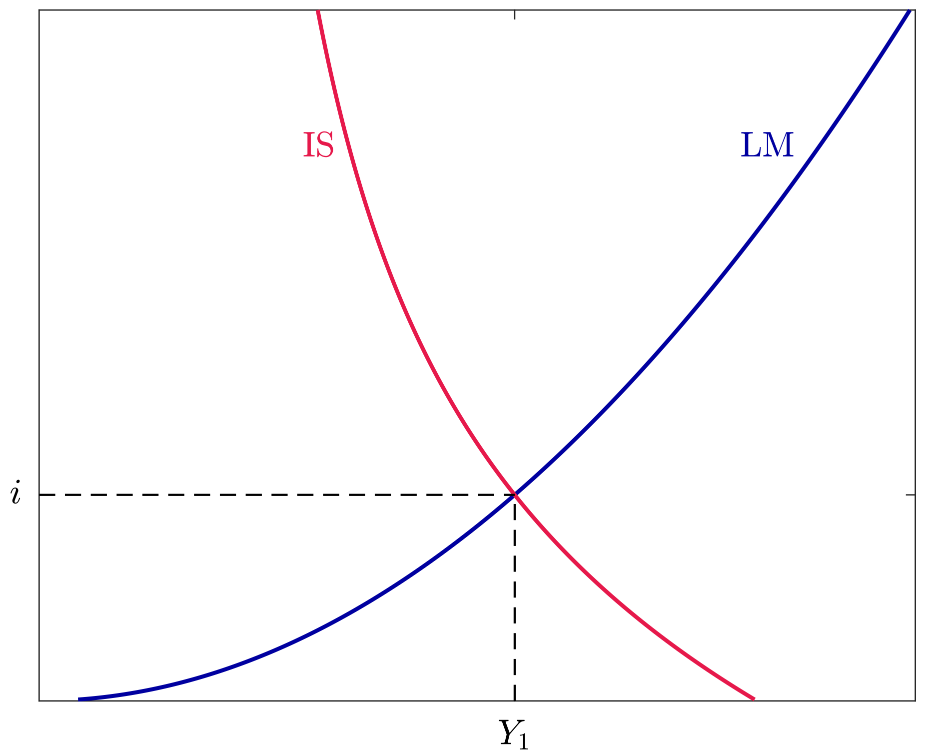


Fig. 14.4.1: *Equilibrium in the IS-LM representation of the New Keynesian Model.*

Kurlat (2020)

14.5 Shocks

Productivity shock (“supply shock”)

- No effect on IS, LM as productivity does not affect demand; no effect on Y_1 contrary to RBC model
- L falls as Y_1 remains constant

Impatience shock (“demand shock”)

- Lower β implies right shift of IS as c_1 demand rises
- K falls as i increases, contrary to c_1-K co-movement in data
- L rises (as Y_1 rises), contrary to negative L-c_1 correlation in RBC model due to labor supply condition

Optimism shock, higher anticipated future productivity

- Higher K demand, shifting IS right, amplified by higher c_1 demand due to higher c_2
- Increased Y_1 raises i (LM), dampens effect on K, c_1
- Co-movement of K, c_1, Y_1, L consistent with data, unlike in RBC model where labor supply condition averts L increase
- Consistent with some narrative in Keynes (1936)

Leisure preference (or labor-income tax) shock

- No effect on IS, LM as labor supply condition does not bind; no effect on Y_1 contrary to RBC model

Money supply shock

- Higher M^S implies right shift of LM
- Higher Y_1, lower i increase money demand, clear money market
- Lower i stimulates K, c_1, raises Y_1
- Co-movement of K, c_1, Y_1, L consistent with data
- Money *not neutral*

Increased expected inflation, π

- Upward shift of IS as i maps into lower r (which enters IS)
- Higher Y_1, i, lower r, higher K, c_1

14.6 Simplified Versions of IS-LM

Exogenous investment yields simplified IS, consumption focus

$$\text{exogenous } \bar{K} \;\Rightarrow\; \text{IS}:\; i = \frac{u'(Y_1 - \bar{K})}{\beta u'(F_2(\bar{K}))} - 1 + \pi$$

Old Keynesian model, based on ad-hoc c_1 function

$$c_1 = c(Y_1) \;\Rightarrow\; \text{IS}:\; Y_1 = c(Y_1) + K(i - \pi) \;\Rightarrow\; i = \dots$$

14.7 Partially Sticky Prices and the Phillips Curve

Share μ of workers adjusts prices, share $1-\mu$ does not

$$p_1 = \mu p_1^{\text{sticky}} + (1-\mu) p_1^{\text{flex}}$$

For simplicity assume exogenous investment, $c_1(L) = F_1(L) - \bar{K}$

"Flexible" workers satisfy their labor supply condition

$$p_1^{\text{flex}} = p_1 \underbrace{\frac{v'(1-L)}{u'(c_1(L))F_1'(L)}}_{\text{real marginal cost}} \cdot \underbrace{\frac{\eta}{\eta-1}}_{\text{markup}}$$

Combining yields

$$p_1 = \frac{\mu p_1^{\text{sticky}}}{1-(1-\mu)\cdot \text{real marginal cost}\cdot \text{markup}} = \text{fct}(L^+)$$

For given p_0 this constitutes a Phillips curve

- Positive relation between employment and inflation if $\mu > 0$
- “Flexible” workers increase supply only at higher price
- Note for later (ch. 15): p_1^{sticky} shifts Phillips curve

Relative to basic IS-LM model partial price stickiness adds third key endogenous variable, p_1

- IS with exogenous investment, $i = \frac{u'(Y_1 - \bar{K})}{\beta u'(F_2(\bar{K}))} - 1 + \pi$
- Phillips curve, $p_1 = \text{fct}(\overset{+}{L})$ or $p_1 = \tilde{\text{fct}}(\overset{+}{Y_1})$
- LM (incorporating Phillips curve), $i = \text{FCT}(\overset{+}{Y_1})$

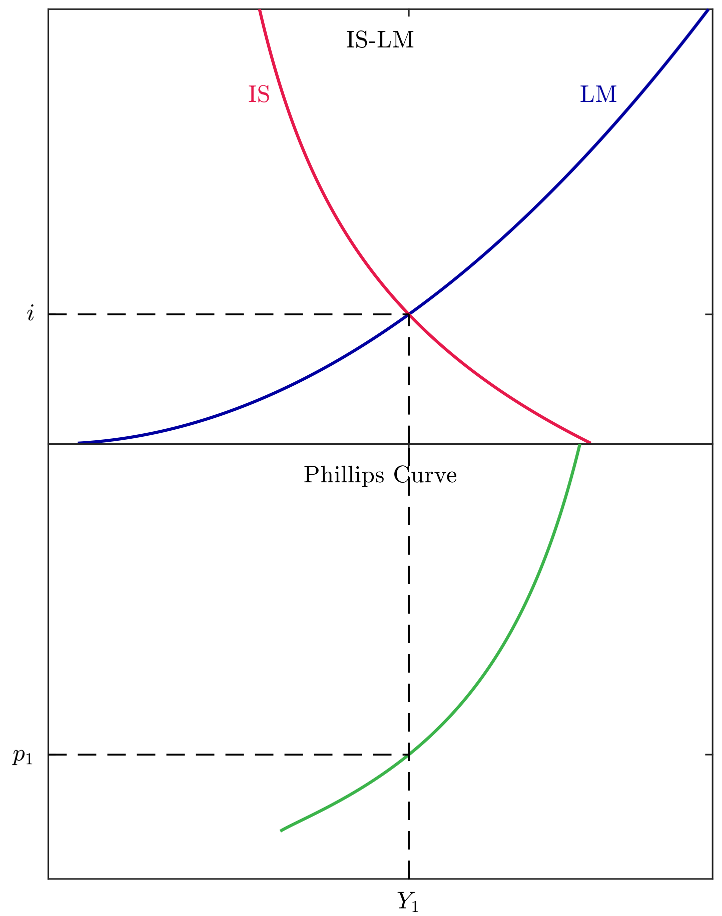


Fig. 14.7.1: *How the IS-LM curves and the Phillips Curve fit together.*

Kurlat (2020)

Response to shocks

- Unchanged effects on IS as Phillips curve does not alter IS
- Qualitatively unchanged effects on LM as Phillips curve only modifies LM
- Phillips curve implies higher p_1 when shock increases Y_1 at given productivity

  Higher productivity implies lower p_1 as “flexible” workers lower prices in response to lower marginal costs

15 Monetary and Fiscal Policy

Introduce policy in New Keynesian model (ch. 14)

15.1 Fiscal Policy

Government spending (cspt, inv), G, enters resource constraint

$$Y_1 = c_1 + K + G \quad (\text{assume } G_2 = 0)$$

Lump-sum tax, timing irrelevant (Ricardian equivalence)

Modified IS equation (assuming G does not directly enter u)

$$u'(Y_1 - G - K(i - \pi)) = \beta(1 + i - \pi)u'(F_2(K(i - \pi)))$$

Fiscal stimulus shifts IS right, Y_1, i rise

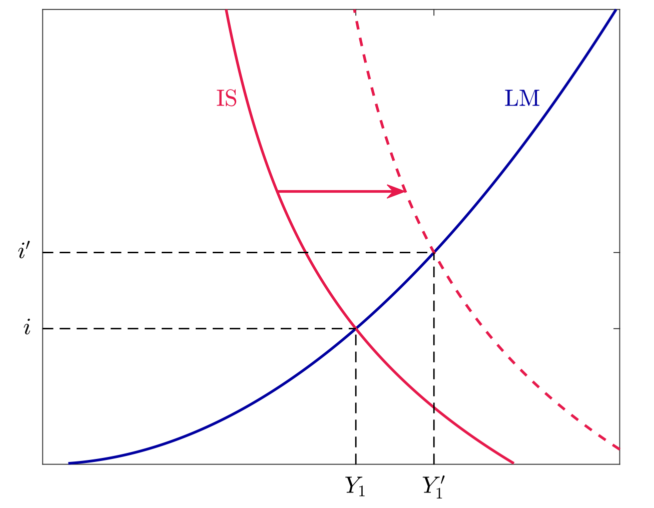


Fig. 15.1.1: *The effects of an increase in government spending.*

Kurlat (2020)

Government spending multiplier, holding i constant

$$\frac{\partial Y_1}{\partial G}|_i = -\frac{-u''(Y_1 - G - K(i - \pi))}{u''(Y_1 - G - K(i - \pi))} = 1$$

- Constant $Y_1 - G, i \Rightarrow$ unchanged consumption, investment
- No wealth effect as taxes increase with G

Compare with Old Keynesian model ($Y_1 = c(Y_1) + K + G$)

$$\frac{\partial Y_1}{\partial G}|_i = \frac{1}{1 - c'(Y_1)} > 1$$

- Wealth effect as consumption does not reflect taxes (myopia or no Ricardian equivalence)

Government spending multiplier with endogenous i

- Also take LM into account
- Stimulus raises output but also money demand, i (holding M^S constant), crowds out c_1, K
- Steep LM $\Rightarrow$ small effect on Y_1, large effect on i
- Flat LM $\Rightarrow$ near unity effect on Y_1, small effect on i
- Different multiplier when M^S adjusts, e.g., to stabilize i
- Ramey (2011) survey evidence suggests multiplier $\in [0.8, 1.5]$

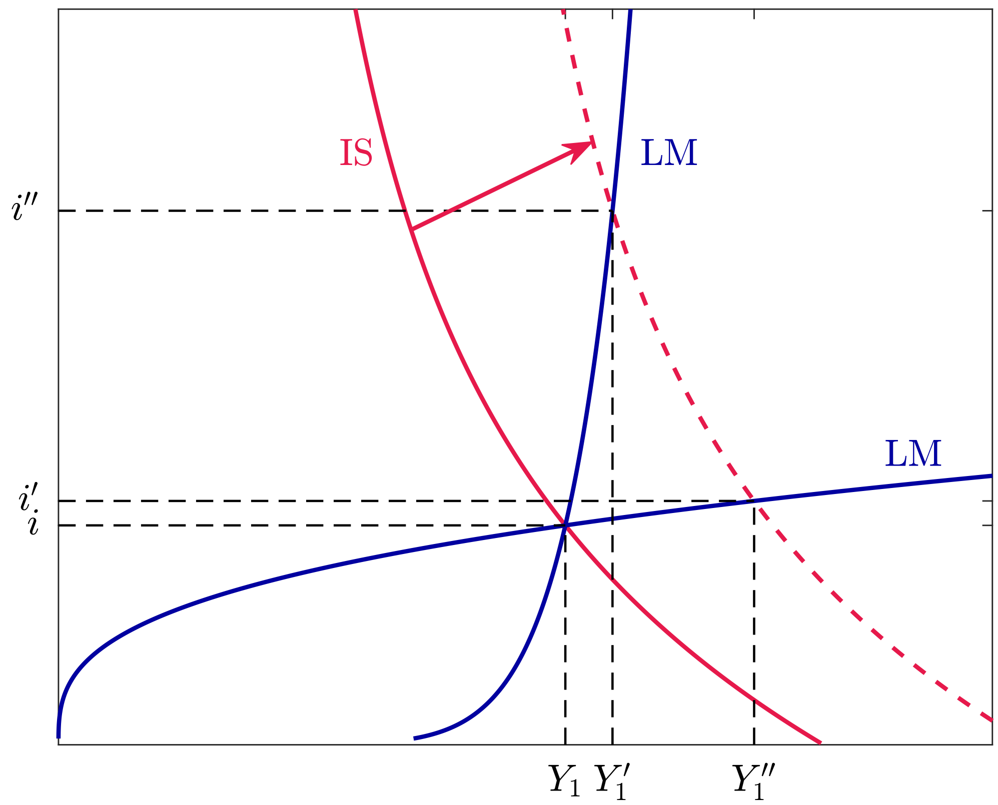


Fig. 15.1.2: *Crowding out.*

Kurlat (2020)

15.2 Monetary Policy

Monetary stimulus shifts LM right, i falls, Y_1 rises

- Higher M^S lowers i (given Y_1)
- Lower i stimulates c_1, K
- Firms supply quantity demanded, Y_1 increases

  (Higher Y_1 partly counteracts stimulus)
- Real-world central banks directly set i rather than M^S

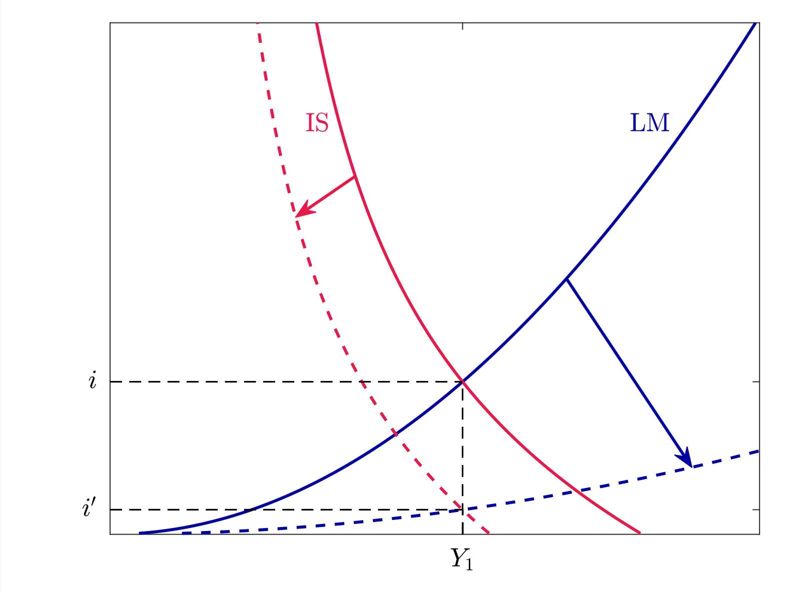


Fig. 15.2.1: *Using monetary policy to counteract a negative shock.*

Kurlat (2020)

Expectations-augmented Phillips curve

- Ch. 14: Phillips curve with flexible and sticky price setters

$$p_1 = \frac{\mu p_1^{\text{sticky}}}{1 - (1-\mu) \cdot \text{real marginal cost} \cdot \text{markup}}$$

  "Naive" interpretation suggests inflation-activity menu

- New: "Sticky" agents set prices optimally, $p_1^{\text{sticky}} = \mathbb{E}[p_1^{\text{flex}}]$

  Yields expectations-augmented Phillips curve

$$\frac{p_1/\mathbb{E}[p_1] - \mu}{1-\mu} = \text{real marginal cost} \cdot \text{markup}$$

  "Inflation surprise"-activity menu

The “Natural Rate”

- Rational (model consistent) expectations imply “natural” rate of (un)employment, output, except after surprise shock
- Vertical Phillips curve—output, employment independent of inflation, except for surprise
- Allocation as with flexible prices, except for surprise

  (With markup neutralizing subsidy, RBC allocation, except for surprise)

Temptation, value of commitment (Barro and Gordon, 1983)

- Expectations-augmented Phillips curve (simplified)

$$\pi_1 - \mathbb{E}[\pi_1] = a(Y_1 - Y_1^N)$$

- Central bank targets $Y_1^\star > Y_1^N$, dislikes inflation

$$\text{loss} = (Y_1 - Y_1^\star)^2 + \phi\pi_1^2$$

- Ex-post incentive to "surprise," conditional on $\mathbb{E}[\pi_1]$

$$\min_{Y_1,\pi_1} \text{loss s.t. Phillips curve} \quad \Rightarrow \quad \pi_1 = \chi\mathbb{E}[\pi_1] + \psi(Y_1^\star - Y_1^N)$$

- Ex ante, agents form rational expectations

$$\mathbb{E}[\pi_1] = \pi_1 \quad \Rightarrow \quad Y_1 = Y_1^N,\ \pi_1 = \varphi(Y_1^\star - Y_1^N) > 0$$

Conclusion

- Inflationary bias: High equilibrium π_1 but still $Y_1 = Y_1^N$

  Ex-post temptation leads to high $\mathbb{E}[\pi_1]$ ex ante

  Conditional on high $\mathbb{E}[\pi_1]$ central bank chooses $\pi_1 = \mathbb{E}[\pi_1]$
- If central bank could credibly promise $\pi_1 = 0$ then better outcome with $\mathbb{E}[\pi_1] = \pi_1 = 0$, $Y_1 = Y_1^N$

  But time-inconsistency problem
- Central bank independence (from government, voters), "conservative central banker" as commitment devices (Rogoff, 1985)

15.3 Monetary Policy Regimes

Norms, objectives, procedures steer expectations

- Discretion (ex-post optimization—not ex-ante rule) generates inflation bias (Barro and Gordon, 1983)
- Rules eliminate bias but reduce flexibility (commitment-flexibility tradeoff)

  Money growth rule problematic when money demand changes

  Gold standard, exchange rate peg problematic when relative gold price, real exchange rate changes

  Inflation targeting, Taylor rules

Policy regimes and Phillips curve

- Surprise shocks to IS, LM but constant inflation expectations imply output, inflation movements along stable Phillips curve (US until 1960s?)
- Credible inflation targeting (central bank stabilizes π), shocks to productivity imply flat Phillips curve (US post 1980s?)
- Central bank countering changing inflation expectations by opposite inflation surprises implies negatively sloped Phillips curve (US 1970s to 1980s?)

15.4 The Liquidity Trap

Shifting LM right in order to lower i, expand Y_1 has its limits

Lower bound at $i \approx 0$ where holding money becomes costless

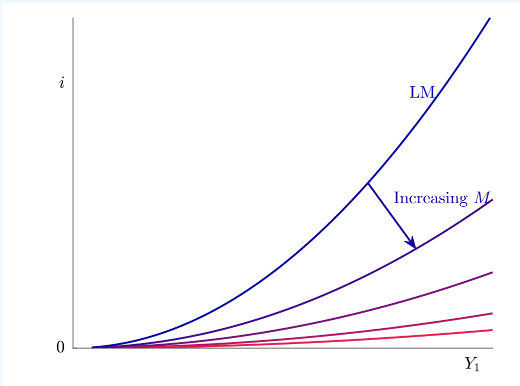


Fig. 15.4.1: *The LM curve and the zero-lower-bound on interest rates.*

Kurlat (2020)

Liquidity trap: LM shift cannot undo output effect of IS shock

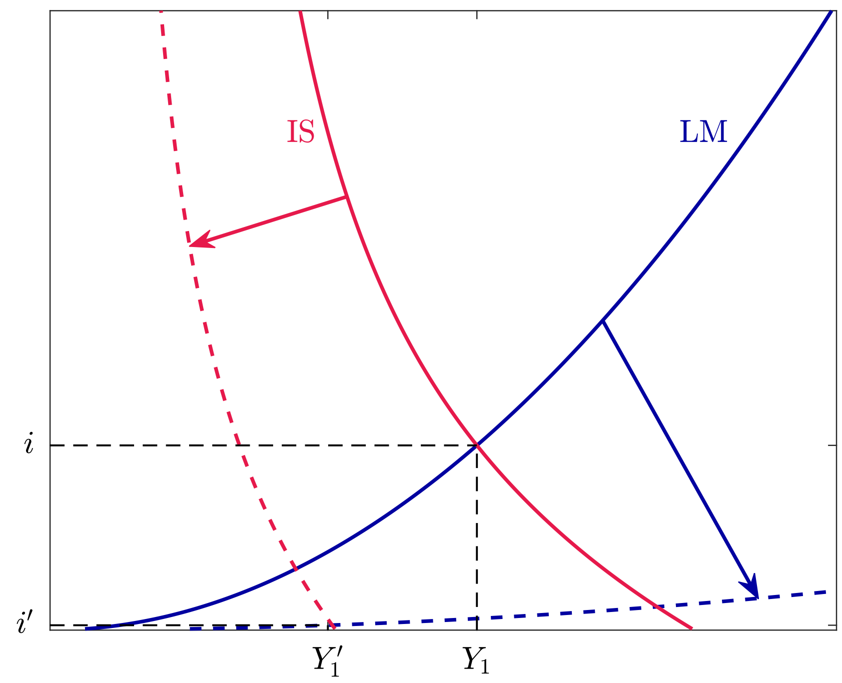


Fig. 15.4.2: The liquidity trap.

Kurlat (2020)

Fiscal policy in liquidity trap

- Increase in G remains effective
- In fact, more so than outside liquidity trap because no crowding out

Forward guidance as alternative monetary policy instrument (Krugman, 1998)

- Central bank "promises" high future inflation (treated as given so far) [Fed, ECB in 2020–21]

  Lowers real interest rate ($i \approx 0$), stimulates c_1, K
- More generally, "forward guidance" to affect expectations

C Financial Crises

C.1 Shocks vs. Crises

Negative shocks affect prices, allocation

- Without frictions, shocks impair welfare but optimal private sector responses limit damage
- With frictions, privately optimal but socially suboptimal responses amplify effects, trigger crises, motivate government intervention

Bank crises particularly costly as banks play key role for payments, investment (financial crisis 2007–08)

C.2 Banks

Firm financing costs, role of banks

- Financial structure irrelevant (Modigliani and Miller, 1958)
- Unless it affects incentives (asymmetric information), ...
- Only banks, not markets may fund firms at affordable rates, bank lending channel (Bernanke and Blinder, 1988)
- When banks also face financial frictions, shocks to bank net worth get amplified (Bernanke and Gertler, 1989)
- Bank net worth responds to asset prices

Government support

- Deposit insurance, central bank lender-of-last-resort support for illiquid (money creation), not insolvent banks (Bagehot)
- Government bailouts of "too-big-to-fail" banks make taxpayer implicit bank creditor
- Anticipated support breeds moral hazard, requires supervision, regulation (e.g., Glass-Steagall Act of 1933)
- Deregulation in 1980–90s

C.3 Asset Prices With Financial Frictions

Important to understand because asset prices affect bank net worth (see above)

Borrowing constraints and asset prices (Kiyotaki and Moore, 1997)

- Investor borrows to invest in productive asset
- Maximum borrowing constrained by pledgeable net worth
- Pledgeable net worth reflects asset value, which falls if other, unproductive agents hold/price asset
- Shock to investor net worth forces asset sale to other agents, lowers asset value, further reduces investor net worth, forces additional asset sales ...

Borrowing constraints and asset prices (2) (Geanakoplos, 2010)

- Investors with heterogeneous beliefs about outlook for stock hold portfolio of stock, safe asset
- In equilibrium, optimists only hold stock, pessimists only hold safe asset

  If investors may borrow, marginal stock owner is even more optimistic type, stock price higher
- Negative shock tightens borrowing constraint, makes more pessimistic type marginal stock owner, implies stock price collapse

Borrowing constraints and pecuniary externalities

- Asset price affects borrowing constraint (see above)
- Investors take future asset price as given when investing but investment choices affect future asset price in crisis, e.g., due to "fire sales" to other agents (see above)
- Pecuniary externality: Agent's action affects equilibrium price

  Always present in general equilibrium
- With borrowing constraints pecuniary externalities generate welfare losses, unlike with complete markets (e.g., Lorenzoni, 2008)

C.4 Further Readings

See, e.g., Brunnermeier et al. (2012), Moore (2013)

References

Acemoglu, D. (2009). *Introduction to Modern Economic Growth*, Princeton University Press, Princeton.

Balassa, B. (1964). The purchasing-power parity doctrine: A reappraisal, *Journal of Political Economy* **72**(6): 584–596.

Barro, R. J. and Gordon, D. B. (1983). Rules, discretion, and reputation in a model of monetary policy, *Journal of Monetary Economics* **12**: 101–121.

Baumol, W. J. (1952). The transactions demand for cash, *Quarterly Journal of Economics* **67**(4): 545–556.

Baumol, W. J. and Bowen, W. G. (1966). *Performing Arts—The Economic Dilemma: A Study of Problems common to The-*

ater, Opera, Music and Dance, MIT Press, Cambridge, Massachusetts.

Bernanke, B. S. and Blinder, A. S. (1988). Credit, money, and aggregate demand, *American Economic Review* **78**(2): 435–439.

Bernanke, B. S. and Gertler, M. (1989). Agency costs, net worth, and business fluctuations, *American Economic Review* **79**(1): 14–31.

Brunnermeier, M. K., Eisenbach, T. M. and Sannikov, Y. (2012). Macroeconomics with financial frictions: A survey, *Working Paper 18102*, NBER, Cambridge, Massachusetts.

Danthine, J.-P. and Donaldson, J. B. (1993). Methodological and empirical issues in real business cycle theory, *European Economic Review* **37**(1): 1–35.

Danthine, J.-P. and Girardin, M. (1989). Business cycles in Switzerland: A comparative study, *European Economic Review* **33**(1): 31–50.

Dornbusch, R. (1976). Expectations and exchange rate dynamics, *Journal of Political Economy* **84**(6): 1161–1176.

Fisher, I. (1896). Appreciation and interest, *Publications of the American Economic Association* **11**(4): 1–98.

Föllmi, R. and Martínez, I. (2017). Die Verteilung von Einkommen und Vermögen in der Schweiz, *Public Paper 6*, UBS Center, Zurich.

Friedman, M. (1957). *A Theory of the Consumption Function*, Princeton University Press, Princeton.

Friedman, M. (1969). The optimum quantity of money, *in* M. Friedman (ed.), *The Optimum Quantity of Money and Other Essays*, Aldine, Chicago, chapter 1, pp. 1–50.

Geanakoplos, J. (2010). The leverage cycle, *in* D. Acemoglu, K. Rogoff and M. Woodford (eds), *NBER Macroeconomics Annual 2009*, Vol. 24, MIT Press, Cambridge, Massachusetts, chapter 1, pp. 1–66.

Harrod, R. F. (1933). *International Economics*, Cambridge University Press, Cambridge, England.

Hayek, F. A. v. (1990). *Denationalisation of Money—The Argument Refined*, 3. edn, Institute of Economic Affairs, London.

Hicks, J. R. (1939). *Value and Capital: An Inquiry into Some Fundamental Principles of Economic Theory*, Clarendon Press, Oxford.

Hodrick, R. J. and Prescott, E. C. (1997). Postwar U.S. business cycles: An empirical investigation, *Journal of Money, Credit, and Banking* **29**(1): 1–16.

Jones, C. I. and Klenow, P. J. (2016). Beyond GDP? welfare across countries and time, *American Economic Review* **106**(9): 2426–2457.

Kaldor, N. (1957). A model of economic growth, *Economic Journal* **67**(268): 591–624.

Keynes, J. M. (1936). *The General Theory of Employment, Interest and Money*, Macmillan, London.

Kiyotaki, N. and Moore, J. (1997). Credit cycles, *Journal of Political Economy* **105**(2): 211–248.

Krugman, P. (1998). It's baaack: Japan's slump and the return of the liquidity trap, *in* W. C. Brainard and G. L. Perry (eds), *Brookings Papers on Economic Activity*, Vol. 2, Brookings Institution, Washington, pp. 137–205.

Kurlat, P. (2019). Deposit spreads and the welfare cost of inflation, *Journal of Monetary Economics* **106**: 78–93.

Kurlat, P. (2020). *A Course in Modern Macroeconomics*, Independently published.

Kydland, F. E. and Prescott, E. C. (1982). Time to build and aggregate fluctuations, *Econometrica* **50**(6): 1345–1370.

Ljungqvist, L. and Sargent, T. J. (2018). *Recursive Macroeconomic Theory*, 4. edn, MIT Press, Cambridge, Massachusetts.

Lorenzoni, G. (2008). Inefficient credit booms, *Review of Economic Studies* **75**(3): 809–833.

Lucas, R. E. (1976). Econometric policy evaluation: A critique, *Carnegie-Rochester Conference Series on Public Policy* pp. 19–46.

Lucas, R. E. (1987). *Models of Business Cycles*, Basil Blackwell, New York.

Marti, S., Martínez, I. and Scheuer, F. (2023). Does a progressive wealth tax reduce top wealth inequality? Evidence from Switzerland, *Discussion Paper 17989*, CEPR, London.

McLeay, M., Radia, A. and Thomas, R. (2014). Money creation in the modern economy, *Quarterly Bulletin* **2014**(Q1): 14–27.

Modigliani, F. and Miller, M. H. (1958). The cost of capital, corporation finance and the theory of investment, *American Economic Review* **48**(3): 261–297.

Moore, J. (2013). Pecuniary externality through credit constraints: Two examples without uncertainty. Unpublished.

Niepelt, D. (2019). *Macroeconomic Analysis*, MIT Press, Cambridge, Massachusetts.

Nordhaus, W. (2019). Climate change: The ultimate challenge for economics, *American Economic Review* **109**(6): 1991–2014.

Obstfeld, M. and Rogoff, K. (1996). *Foundations of International Macroeconomics*, MIT Press, Cambridge, Massachusetts.

Phillips, A. W. (1958). The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861–1957, *Economica* **25**(100): 283–299.

Piketty, T. and Saez, E. (2003). Income inequality in the United States, 1913–1998, *Quarterly Journal of Economics* **118**(1): 1–39.

Piketty, T. and Saez, E. (2014). Inequality in the long run, *Science* **344**(6186): 838–843.

Ramey, V. A. (2011). Can government purchases stimulate the economy?, *Journal of Economic Literature* **49**(3): 673–685.

Rogoff, K. (1985). The optimal degree of commitment to an intermediate monetary target, *Quarterly Journal of Economics* **100**: 1169–1190.

Romer, P. M. (1986). Increasing returns and long-run growth, *Journal of Political Economy* **94**(5): 1002–1037.

Samuelson, P. A. (1964). Theoretical notes on trade problems, *Review of Economics and Statistics* **46**(2): 145–154.

Solow, R. M. (1956). A contribution to the theory of economic growth, *Quarterly Journal of Economics* **70**(1): 65–94.

Tobin, J. (1956). The interest elasticity of the transactions demand for cash, *Review of Economics and Statistics* **38**(3): 241–247.