Part III. Cycles and Growth:
UMSL

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AS-AD, Relative Prices & Business Cycles

- Facts: Nominal Prices are Not Real Prices
- Price of goods in nominal terms: eg. Consumer Price Index (CPI).
  - Not useful for making choice because not real price of goods.
  - Real price in microeconomics only what we call *relative price*,
  - or the opportunity cost of the purchase of the good.
- Nominal wage for working also nominal, or market, price; not real.

- Real Price of Goods Relative to Time
  - Nominal price of goods (CPI), call it P,
  - divided by nominal wage rate, call it W, gives result of P/W.
  - Relative price of goods to labor (or to Leisure).
- P/W, or $1/w$, where w is the real wage (W/P).
- Have data on CPI divided by Nominal Wage.
  - FRED's quarterly data from 1979:1 to 2015:3,
  - shows large swings upward & downwards.
  - And significant trend downwards.

Real Price of Goods Relative to Labor (Leisure)

Figure: US Nominal Price of Goods (CPI) Divided by the Nominal Wage Rate (average weekly wage and salary, full time, 16 and over): P/W, 1979 to 2015

Trends and Cycles in 1/w

- Trend : price of goods falls relative to price of labor over time.
  - Inverse: Real wage relative to goods price is rising over time.
  - Rising real wage: real income rises, buy more goods,
  - economy experiences economic growth.
- Cyclical evidence: 1/w mixed evidence; countercyclical.
  - after deep 1981 recession, price of goods fell relative to wages,
  - as real wage increased.
  - Real wage rise typical of expansion: Procyclic
  - & consistent with real business cycle theory.
- After 22% crash of Dow Jones Stocks October 19, 1987,
  - price of goods relative to labor rising.
  - Implies real wage began falling,
  - & continued to fall until 1991 recession.
  - During 1998 to 2001 expansion, price of goods relative to labor fell.
  - However Great Recession period has many usual factors.

Real Wage and GDP Growth

- *Nominal wage growth rate minus inflation rate*
- for US data from 1966 to 2014, graphed in Blue.
- Real GDP growth graphed in Red.
- Real wage growth rate matches detrended real GDP growth rate
- so looks very procyclic from 1966 until 2000.
- After that, two series move inversely!
- Perhaps part of pathology induced during Great Recession.

Procyclic Real Wage Growth: 1966-2000

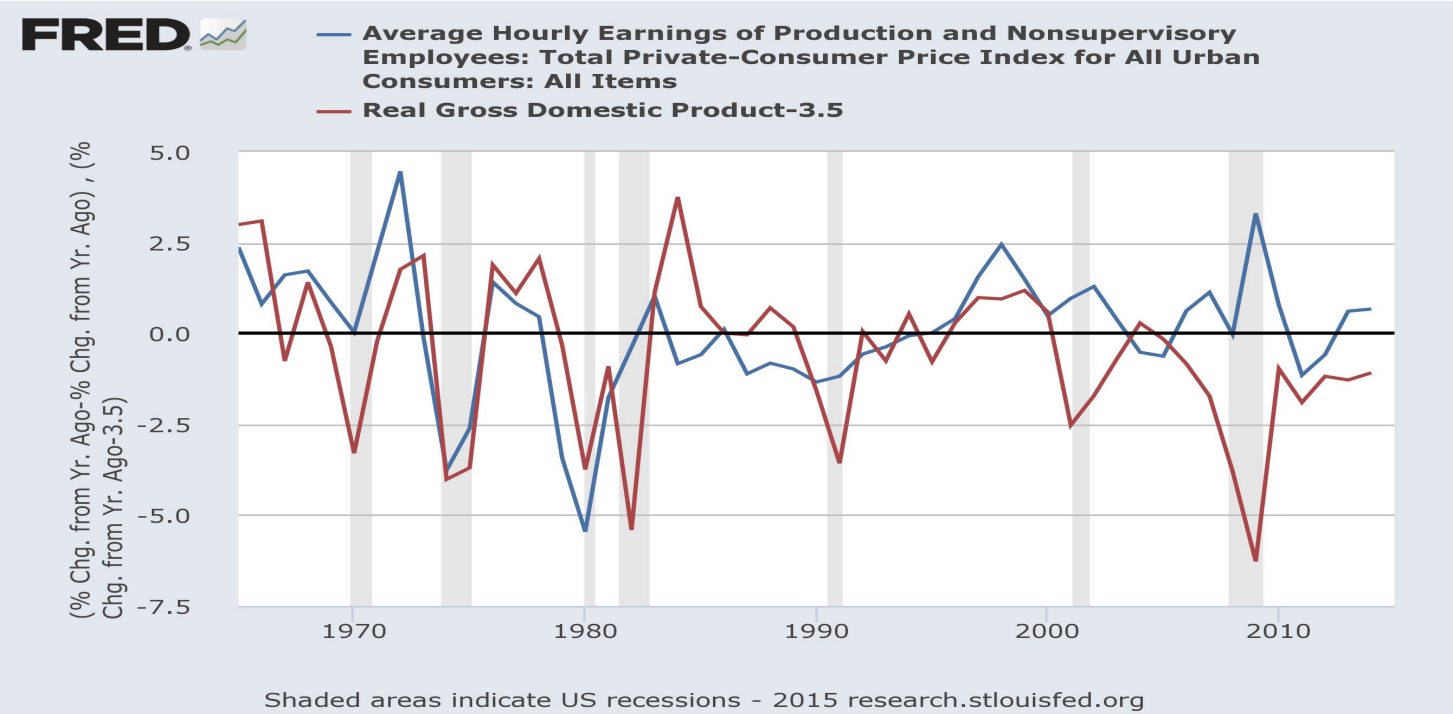
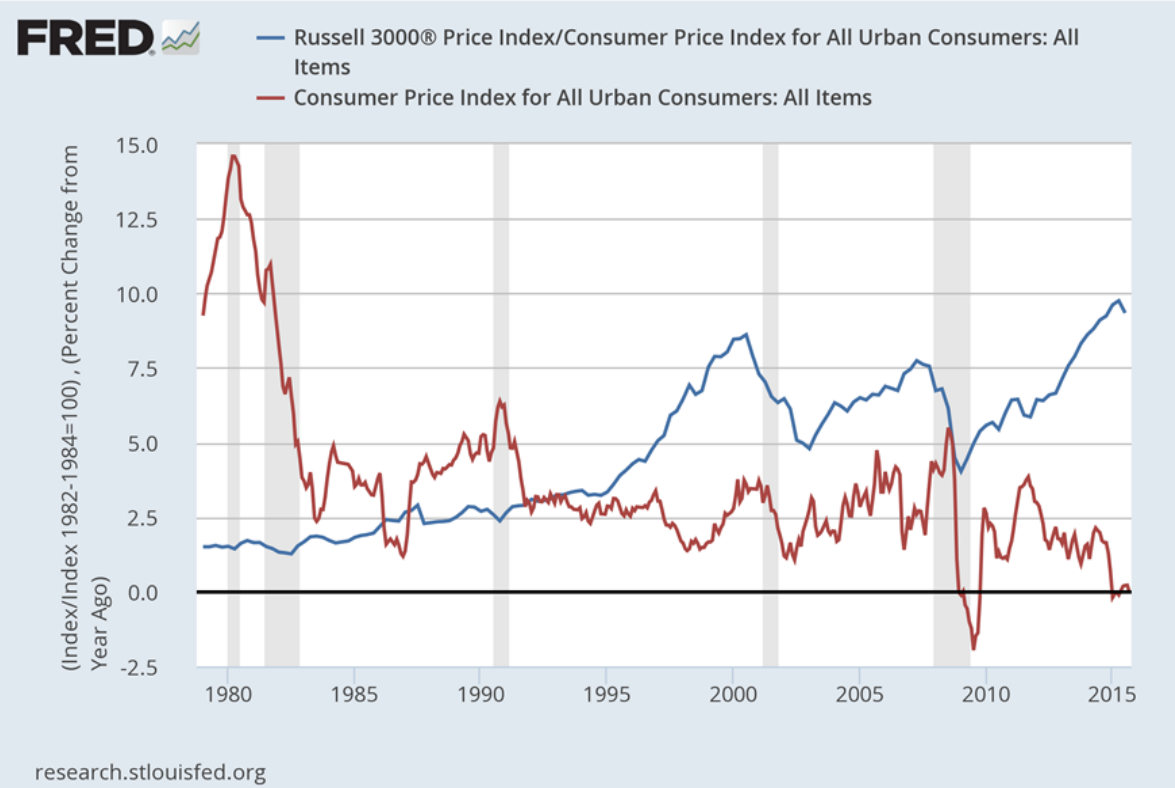


Figure: Annual Growth Rate of Real Wage Rate and Trend-Adjusted Real GDP, US 1965:6-2014.

Real Wage in Post 2000 Period

- Real wage rose substantially during Great Recession,
- & during fixed, below inflation rate, nominal interest rate
- period from 2001 to 2004.
- Establishes Two fixed nominal interest rate periods
- with an induced negative real interest rate
- that are associated with *countercyclic movement in wages*
- in these unusual recent episodes.
- Rest of US period: real wages are rather procyclic.
- Excluding post 2001 period as one heavily distorted by Fed policy
- that induced negative real interest rates,
- stylized fact seems to confirm *procyclic real wage growth*.

Real Price of Capital to Goods, Inflation, and Debt-Deflation



Debt-Deflation Applies to Great Depression?

- *Nominal price of capital relative to nominal price of goods*
- presents *real price of capital relative to goods*.
- Major recession coincides with real asset decline typically.
- Real price of capital Compared to CPI based inflation rate,
  - 1979 to 2015 period.
- Real asset price measured by *Russell 3000* index.
- During recessions some positive correlation
  - between Real Asset price and Inflation.
- Eg. 1) 1981 recession's real asset price decline,
  - & during both 2) 2001 and 3) 2008-2010 recessions.
- Consistent with but not proof of "debt-deflation" theory:
  - Consider simply as cost of capital falls during recessions,
  - price of goods falls as cost of production due to capital falls.
- Deflation during recessions can be described with Phillips curves,
  - and coinciding asset price declines.

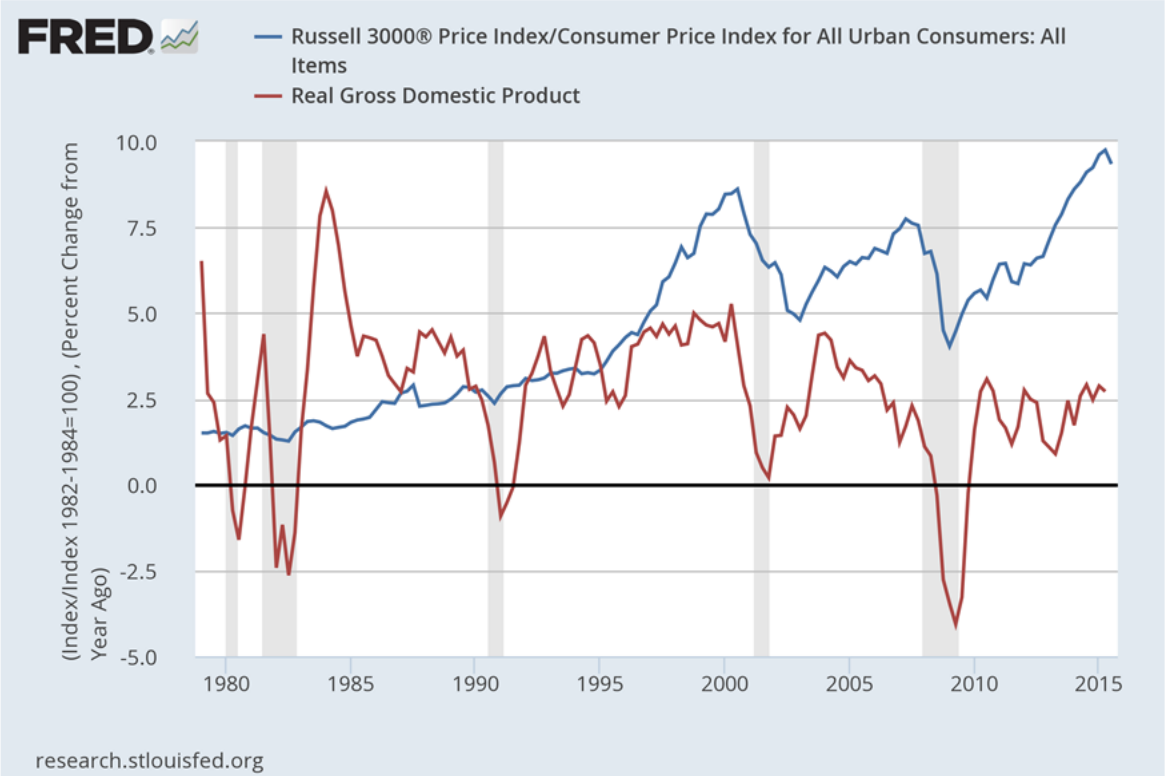
Eg. in terms of Composition of GDP

- GDP includes residential investment: about 5% of GDP
- & durable goods consumption at around 8%
- for average total of 13%.
- These are capital intensive goods & decrease in real price
- relative to labor when capital values fall.
- Can cause measured inflation rate to fall,
- even if fall is due to a real decline in goods relative to labor.

Real Price of Capital vs Real GDP Growth

- *Debt-deflation* theory: how asset prices fall
  - as private bank money supply (demand deposits)
  - and investment collapse.
  - And inflation rate falls
- Makes it money-based theory of reduction in inflation rate
  - to extent that private bank deposits, & real value of capital,
  - both decline together as appears likely in bank crisis periods.
- Much asset price data is proprietary (not freely available);
  - FRED data only back to end of 1978:
  - Russell 1000, 2000 & 3000 indices.
  - Russell 3000 in Figures.
- 2001 & 2008-2010 "debt-deflation" episodes seen.
- Post-2000: *real price of capital relative to goods*,
- especially procyclic as compared to real GDP growth

Real Asset Price relative to Goods & GDP Growth



Real Asset Price and RBC Facts

- Procyclic real asset prices consistent with
- real business cycle theory:
- since real interest rate should be procyclic.
- Procyclic real asset prices imply procyclic "equity return" to capital,
- which is one measure of real interest rate.
- So both real interest rates & real wages appear procyclic.

Labor Force Participation Rate and Real GDP

- Civilian Labor Force Participation Rate: 1958 to 2014
- Compare to : Detrended Real GDP growth rate in Red.
- Shows Labor Force Participation Rate is regularly procyclic.
- How: *Labor force participation growth rate*
- generally positively correlated with real *GDP* growth rate,
- rising with business expansions & falling
- (relative to its trend) in business contractions.
- Here *GDP* growth normalized by dividing by 2.5,
- & and then a subtracting by 1.4 so comparable
- in magnitude to labor force participation growth rate.

Labor Force Participation Rate & Real GDP

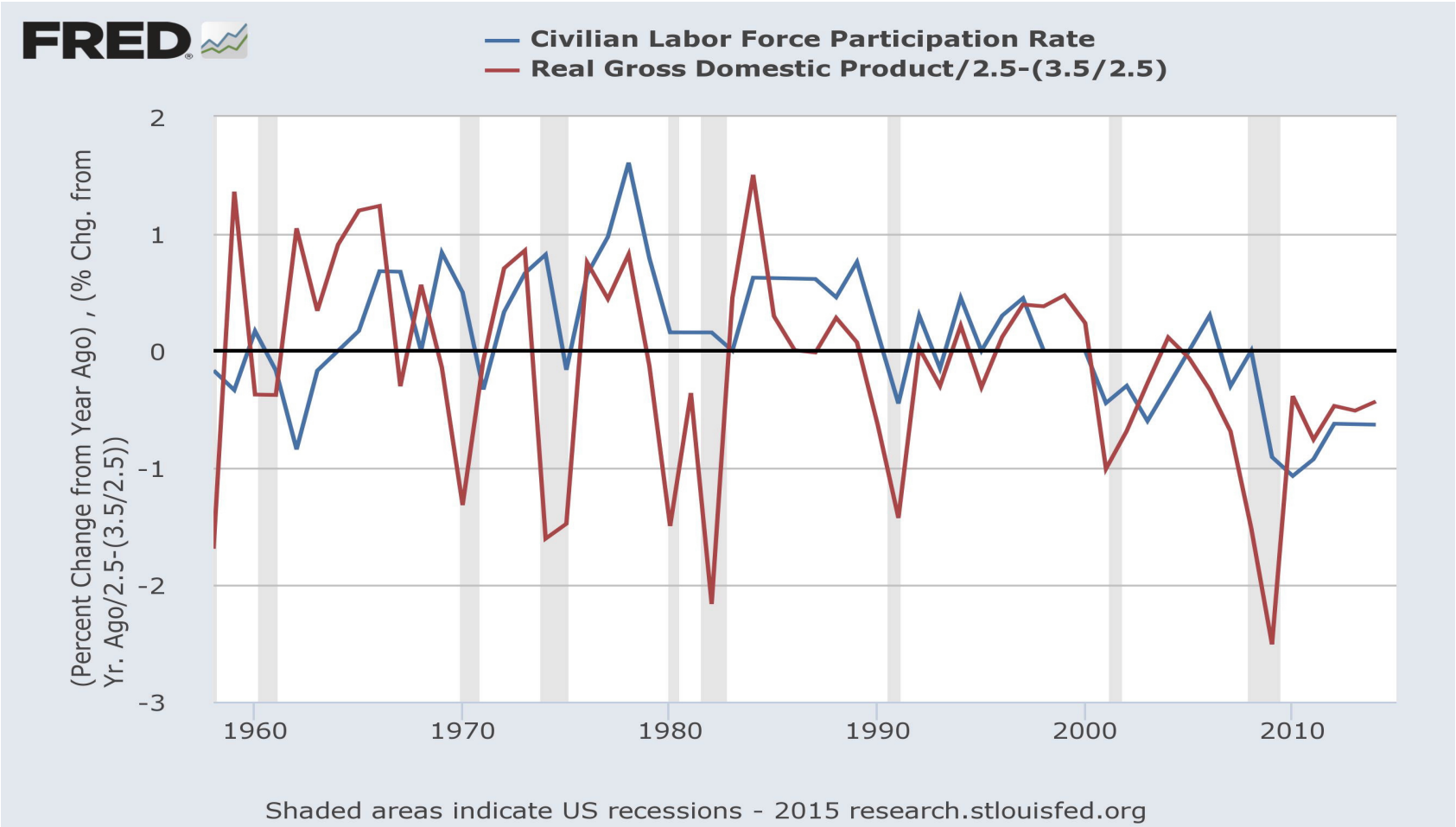


Figure: Annual Average Growth Rates of US Civilian Labor Force Participation Rate, 1957:7-2015.14, (Blue) and Normalized Real GDP (Red).

Equity Premium Evidence?

- Equity premium: difference between risky equity return
- & average "risk-free" government bond return.
- Use real capital price appreciation of Rusell 3000 equity index
  - (the natural log of *Russell 3000* divided by the CPI index)
  - but do not include dividend yields on Russell 3000 stocks
  - as data not available;
- Both capital gains on price index plus dividend yield give equity return,
  - so missing dividend yield (which tends to be steady).
- "Risk-free" government bond rate is
  - 3-month Treasury bills minus CPI annual inflation rate.
- Difference shows wide variations: Notable:
- equity premium relatively very high in post 2007 period.

Equity Return Graph

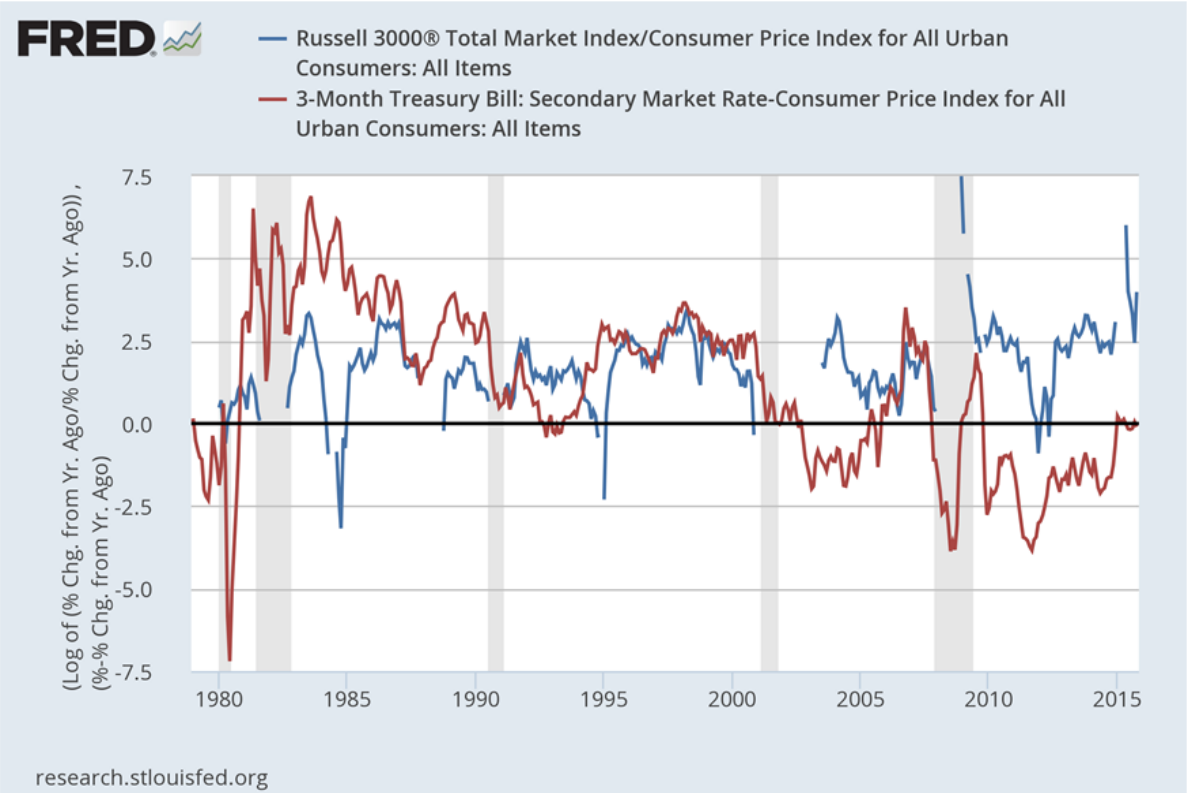


Figure: Equity Premium as Difference Between Blue line of Annual Percentage Change in Russell 3000 Index Minus Red line of Annual Real Yield of Treasury 3-month Bill (found by substracting the CPI annual Inflation Rate).

Why High Equity Return Post 2007

- May be Fed kept real interest rates negative,
- for much of Great Recession,
- leading to more holding of risky equity
- than would be normal in business cycle.
- Holding more risky equity would allow investors
- to make up "lost return" of "lost decade" of Great Recession
- from negative return earned from holding "risk-free" Treasury debt.
- Policy can Distort:
- *portfolio balance between risky equity & risk-free debt.*

Theory: Stylized Facts Of Cycles

- Expect *stylized facts from theory of business cycles* to explain
  - with *aggregate supply for output (AS) & aggregate demand (AD)*.
- Real wage & real interest rate rise in expansions & fall in contractions.
- Evidence on factor input prices mixed possibly due
  - to "rare events" as lost decades & Great Recessions.
- Evidence can become mixed during
  - distortionary macroeconomic policies :
  - eg. Fed driving down real interest rate to negative levels.
  - Act to subsidize capital inputs while taxing labor inputs
  - (and so causing prolonged low labor force participation).
- Expect investment & Employment to be procyclic:
  - rise with expansions & fall with contractions.
- Procyclic movement in real prices & quantities of capital & labor inputs.

Ramsey's World with AS-AD

- Construct *aggregate demand and supply* ($AS - AD$)
  - for goods & labor markets with capital accumulation.
- Capital accumulation brings in time element.
- Capital accumulation with time accomplished by Frank Ramsey,
  - student of John Maynard Keynes's graduate lectures.
  - Ramsey published his 1928 article in Economic Journal
  - when Keynes was Editor (from 1911 until 1945).
- Ramsey (1928) built structure of modern dynamic economics.
- Extension of Fisher's 2-period model to unlimited future horizon.
  - while also including labor decision & standard production function
  - for output that required both capital & labor inputs.
  - Allows an equilibrium capital stock at same time
  - as labor is chosen in equilibrium.
  - Uses price of leisure as "shadow price" equal to real wage.

Real Price of Goods Relative to Labor

- Nominal price of goods: represented by CPI index,
  - since is cost of representative basket of consumption goods.
  - "Normalized" to be 100 in base year.
- We can take this one step further &
  - normalize nominal price of one good to be 1.
- Divide nominal price of 1 dollar for one good by
- dollars received per hour as our wage rate.
- Gives dollars per good divided by dollars per hour.
- Dollars cancel out: left with hours required per good.
- Is *real price of goods:*
- *amount of time required to produce one good.*

Units of Relative Price of Good to Leisure

- Units of measurement for prices.
- \$1 per one good can be written as $\frac{\$1}{good}$.
- Nominal wage rate is X dollars per one hour.
- Represented as $\frac{\$X}{hour}$.
- Relative price of goods to labor is ratio of two prices.
- Ratio is $\frac{\frac{\$1}{good}}{\frac{\$X}{hour}}$. Dollar sign \$ cancels out,
- leaving $\frac{1}{X}\frac{hours}{good}$: 1/X hours required to produce one good.

Relative price of goods

- Relative price of goods is nominal price of goods P
- divided by nominal price of labor W.
- P/W is relative price of goods for labor.
- Equivalent to inverse of real wage, or $1/w$,
- where real wage defined by nominal price of labor
- divided by nominal price of goods, or W/P.
- Use notation that W/P is real wage w ($W/P \equiv w$).
- Inversely, real price of labor relative to price of goods
- is $w/1$ which just equals w, the real wage.

Compared to IS-LM For Example

- Use $1/w$ instead of real interest rate r used in IS-LM.
- IS-LM: aggregate supply & demand for goods not derived:
- output level is *exogenous*, or just assumed,
- in both capital and & money market when IS-LM is constructed.
- Real interest rate in Ramsey analysis?
- Is relative price for current consumption
- versus future consumption as in Fisher two-period model.
- Further: is capital market in Ramsey world
- & real interest rate determines equilibrium
- supply & demand for capital, & equilibrium capital stock.

Production, Utility, & Supply & Demand

- Aggregate output production is $y = f(l, k)$:
- aggregate output y a function f of labor l & capital k.
- Also time dimension: $y_t = f(l_t, k_t)$, slight revision with t time period.
- And superscripts for supply $(^s)$ or demand $(^d)$.
- Aggregate output equilibrium still consistent
  - with National Income and Product Accounts (NIPA)
  - sourcing of aggregate output (Y=C+I+G+NX),
  - although assume no government (G=0)
  - & closed economy with no trade (NX=0).
- utility u_t is a function u of goods c_t^d and leisure x_t [or $u_t = u\left(c_t^d, x_t\right)$].

NIPA in Ramsey's World

- Aggregate demand consistent wth NIPA:
- Y=C+I, with G=0 & NX=0.
- Here investment is net new increase in capital,
  - arising from firm's demand for capital k_t^d.
  - Use notation of real investment as i_t as net increase in capital.
- Goods Constraint: Add consumer demand for goods
- c_t^d plus investment in capital i_t :

$$y_t^d = c_t^d + i_t.$$

- In equilibrium, markets "clear":
  - *quantity demanded equals quantity supplied*
  - *at equilibrium price in each market.*
  - Goods, labor & capital markets clear:
  - $y_t^d = y_t^s$, $l_t^d = l_t^s$, and $k_t^s = k_t^d$, so $y_t = c_t + i_t$.
- Total time T : equal to leisure time x plus working time l
  - (or $T = x + l$).

AD-AS Construction

- Relative price for goods to labor is $1/w_t$
  - or we can say the goods to leisure price
- Aggregate demand for goods depends upon relative price $1/w_t$.
  - & on equilibrium capital stock k_t.
- Aggregate demand for output, y_t^d, function AD of $1/w_t$, & k_t.
- Aggregate supply of output also depends on $1/w_t$ & on k_t.
- AD depends negatively on relative price $1/w_t$,
  - so "normal" downward sloping demand function.
- AS, depends positively on relative price,
  - so "normal" upward sloping supply function.
- Both AD & AS for output positively affected by capital stock k_t.
- Equilibrium output y_t where quantity supplied equals the quantity demanded.
  - at equilibrium relative price $1/w_t$, and k_t.

Comparative Static Change : AS-AD vs IS-LM

- IS-LM assumes both supply & demand for capital
  - depend positively on *exogenously* given level of income.
  - Exogenous increase in income shifts out both supply & demand for capital.
- Ramsey World: capital stock is equilibrium capital of full Ramsey World,
  - so k_t determined within model, *endogenously.*
- Change in k_t occurs if parameter such
  - as *productivity parameter* changes.
- Would be "*comparative static*" experiment :
  - shows new equilibrium after change in model's assumed parameters.
  - When productivity parameter rises, is increase in k_t.
  - & higher k causes shift out in both *AS* & *AD* curves.
- Ramsey: output productivity parameter changed.
  - Other parameter changed is total time for work & leisure.
  - As in Labor Force Participation Rate change.

Ramsey World with a Zero GDP Growth Rate Trend

- Ramsey World assume first *zero growth rate*.
  - Variables do not change over time, so drop time subscripts.
  - Good for Real Business Cycle Facts.
  - Assume positive growth from steady productivity increases
  - & then model stylized Growth Facts.
- *"Stationary", over time*, so investment is capital maintenance:
- enough investment to cover capital depreciation.
- $\delta \cdot k$ where δ is the depreciation rate.
- Maintenance for worn out, or *depreciated, capital.*
- "Fixed Capital Consumption" in NIPA accounts.
- Gives sum of $c^d + i = y$, as in NIPA accounting, using optimization.

Consumption Plus Investment

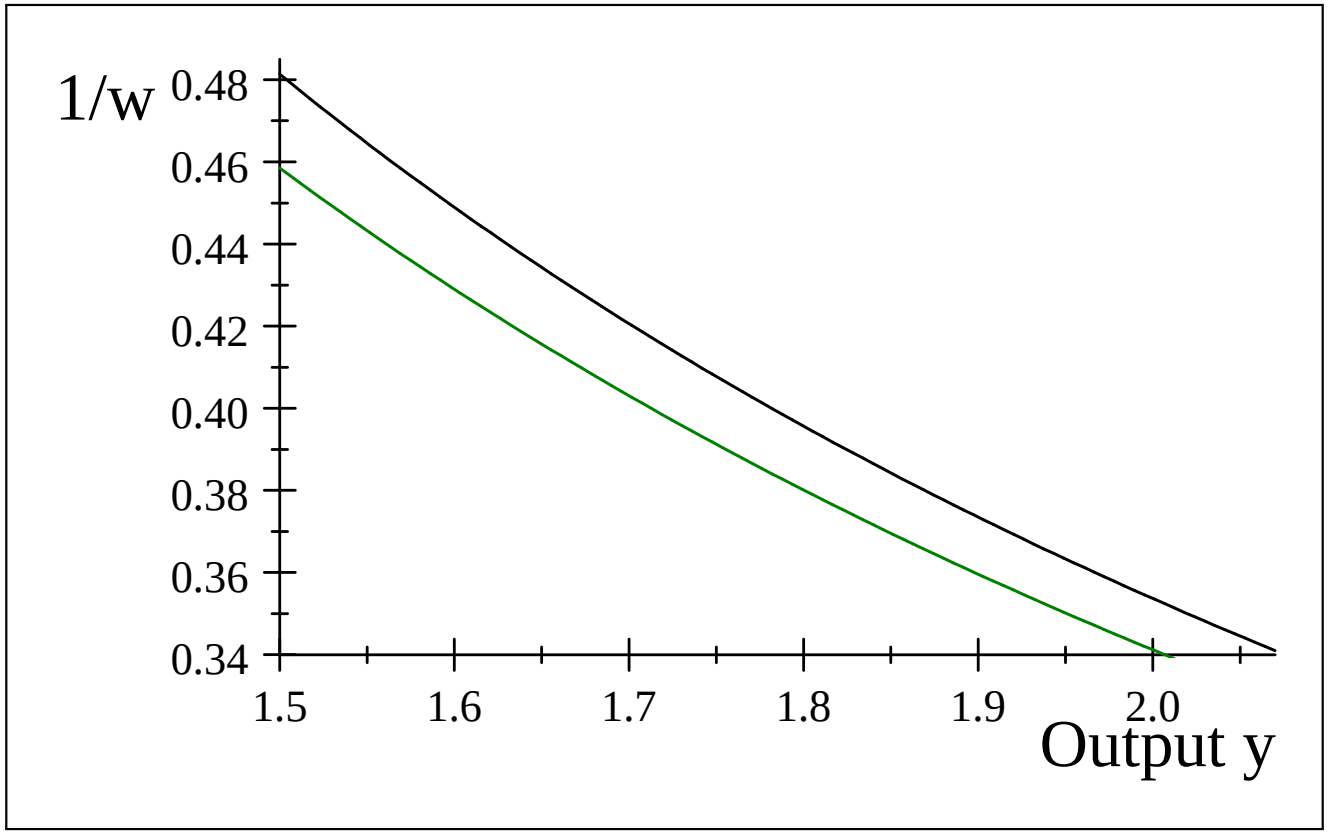


Figure: Example Aggregate Output Demand AD (Black) as Horizontal Summation of Consumption Demand (Green) and the Investment Demand δk, to get $c^d + i = y^d$ (Black).

Upward Sloping AS Curve

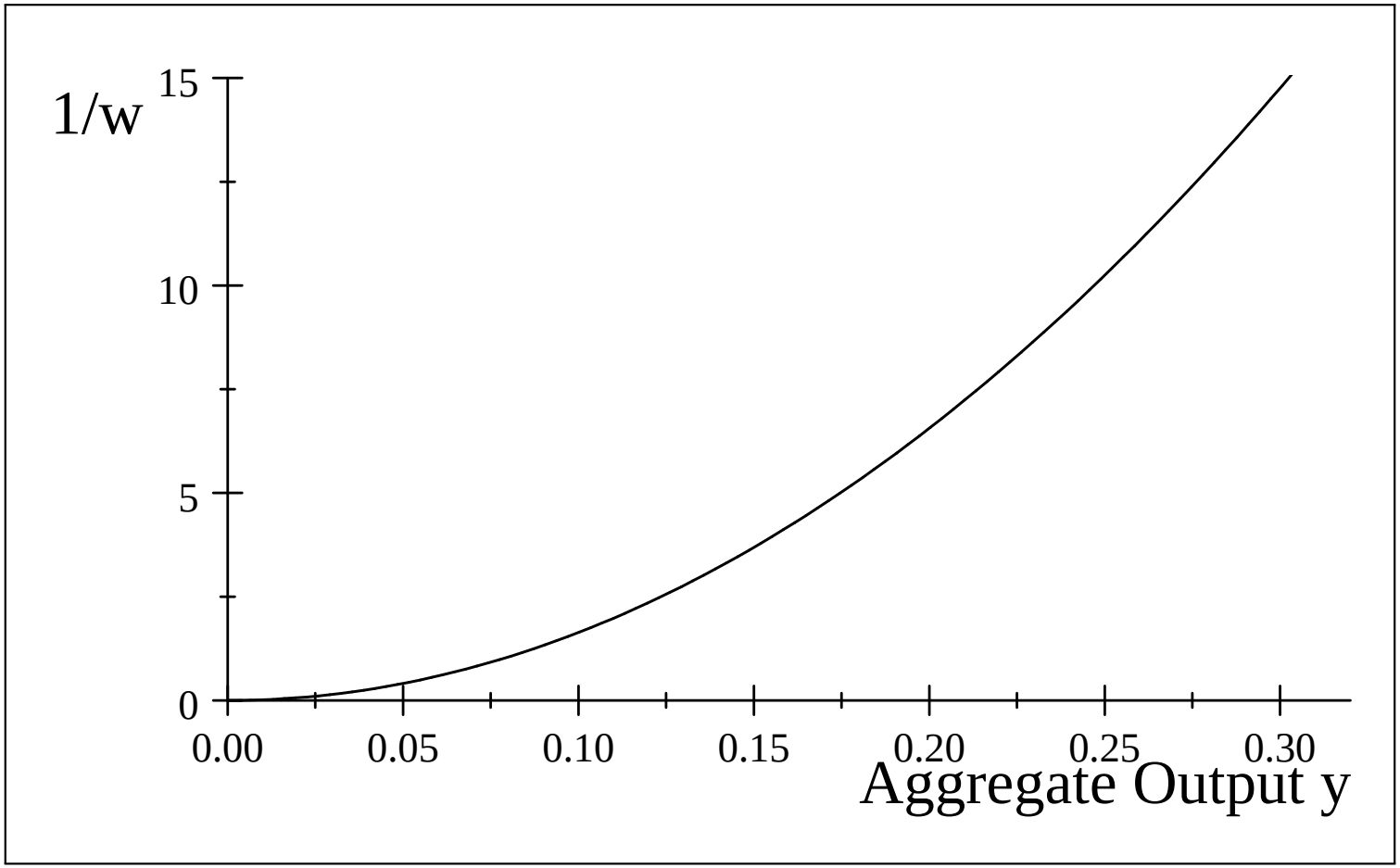


Figure: Example Ramsey *AS* Curve.

Eg. of Vertical AS: near-Zero Labor Share of Costs

Inconsistent with Data

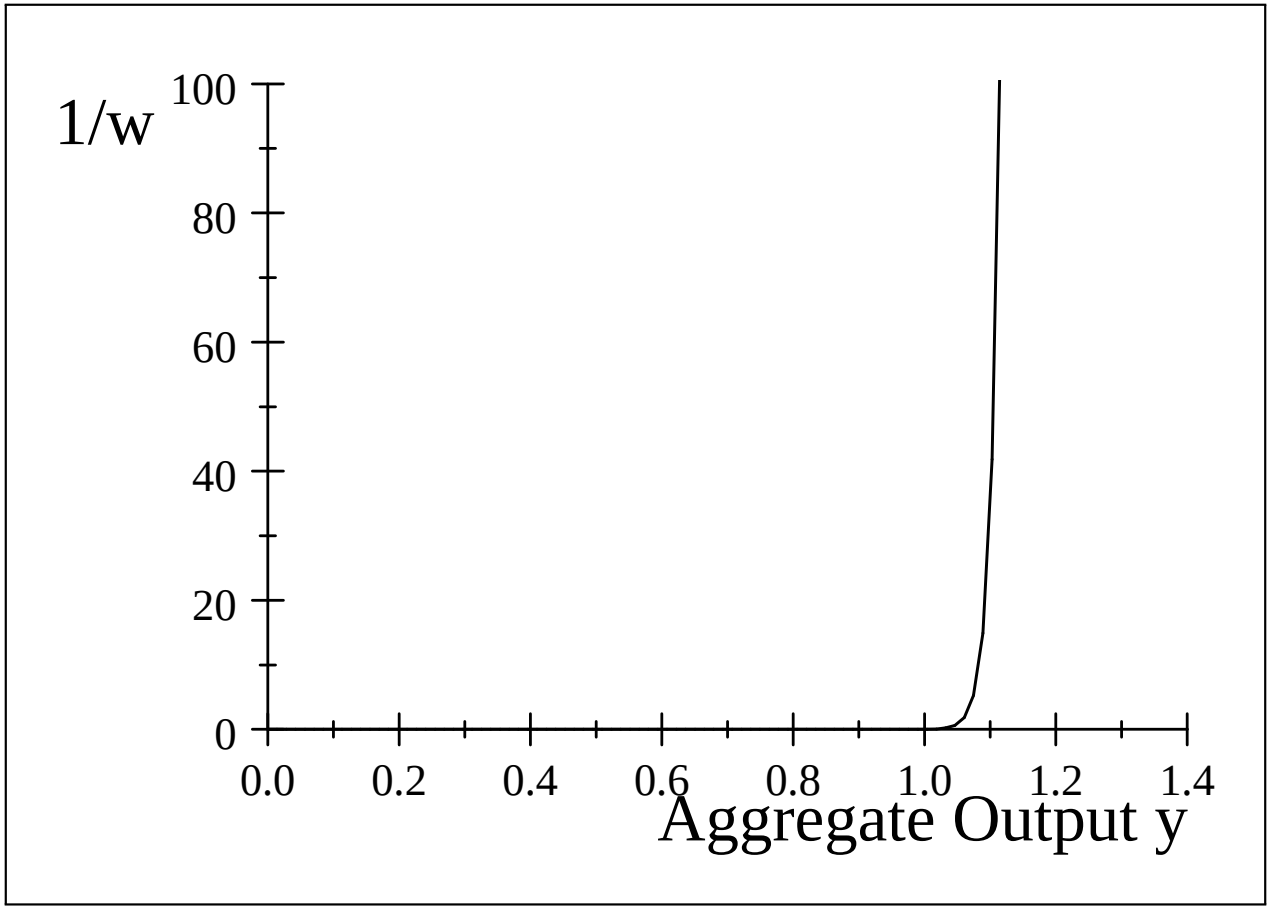


Figure: An *AS* Curve with Almost Zero Labor Share in Output.

Example Ramsey World AS-AD Goods Market

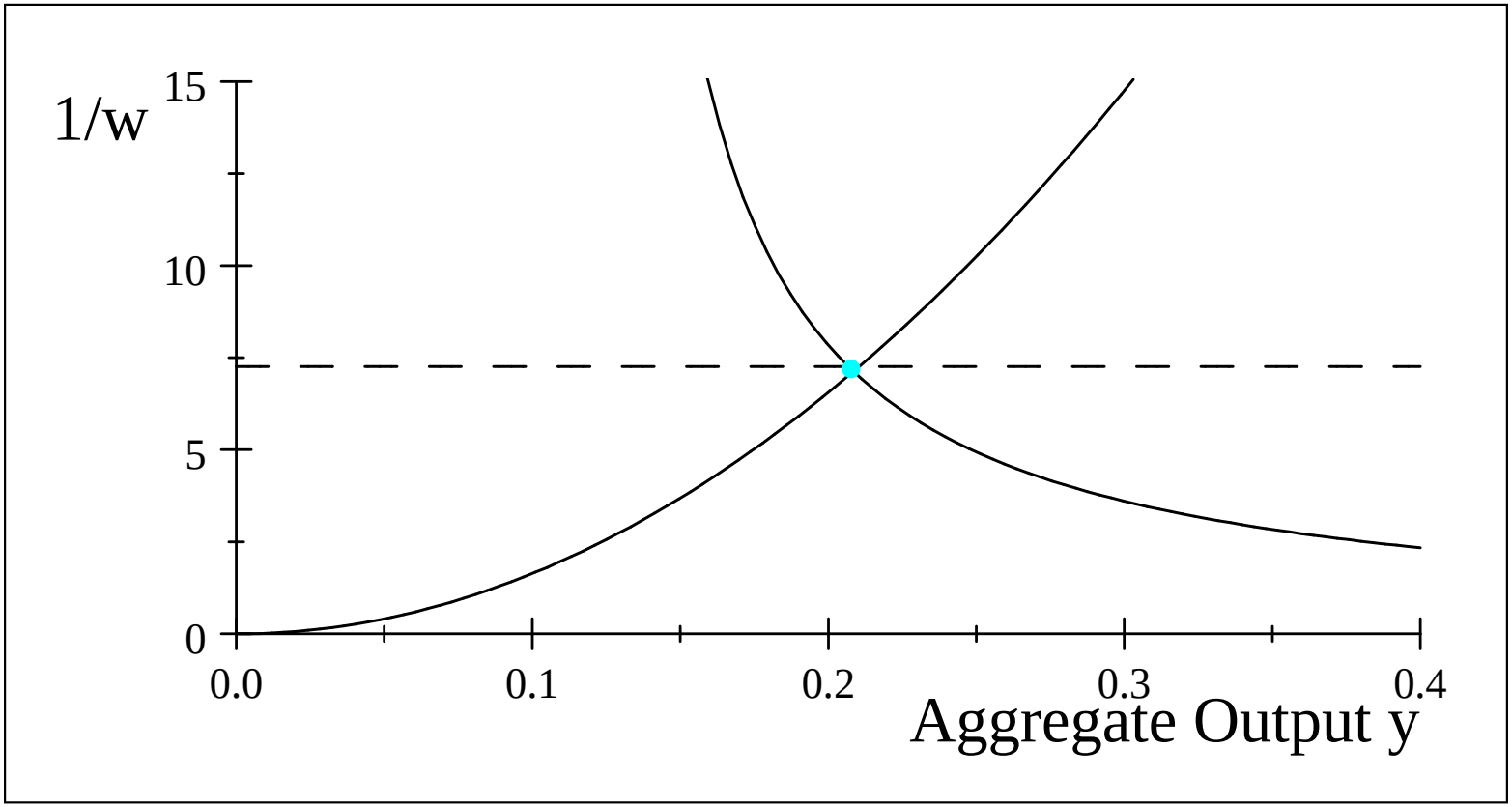


Figure: Example Ramsey $AS - AD$ Equilibrium.

Ramsey Labor Market

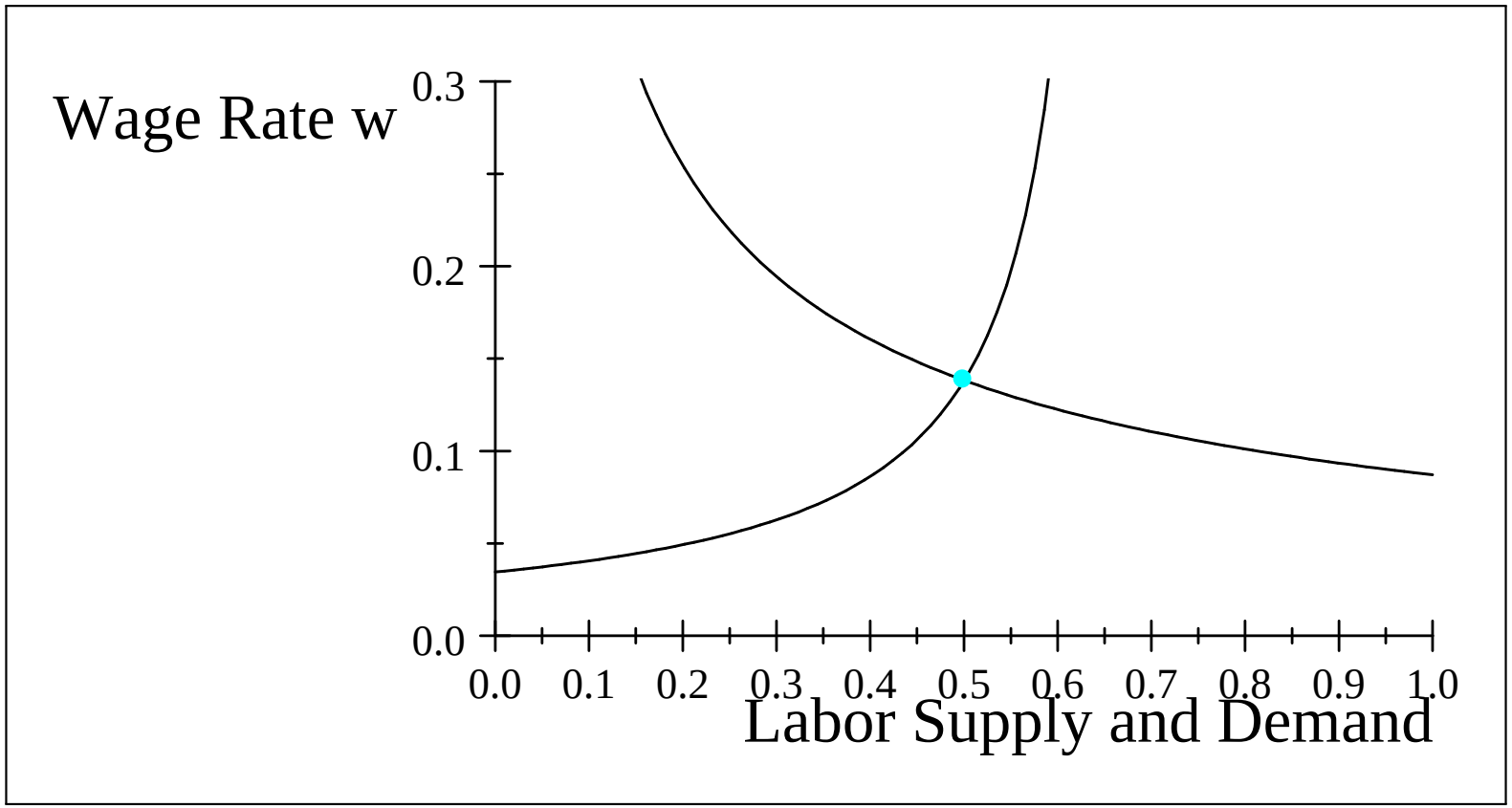


Figure: Labor Market in Example Ramsey Model.

Ramsey Capital Market

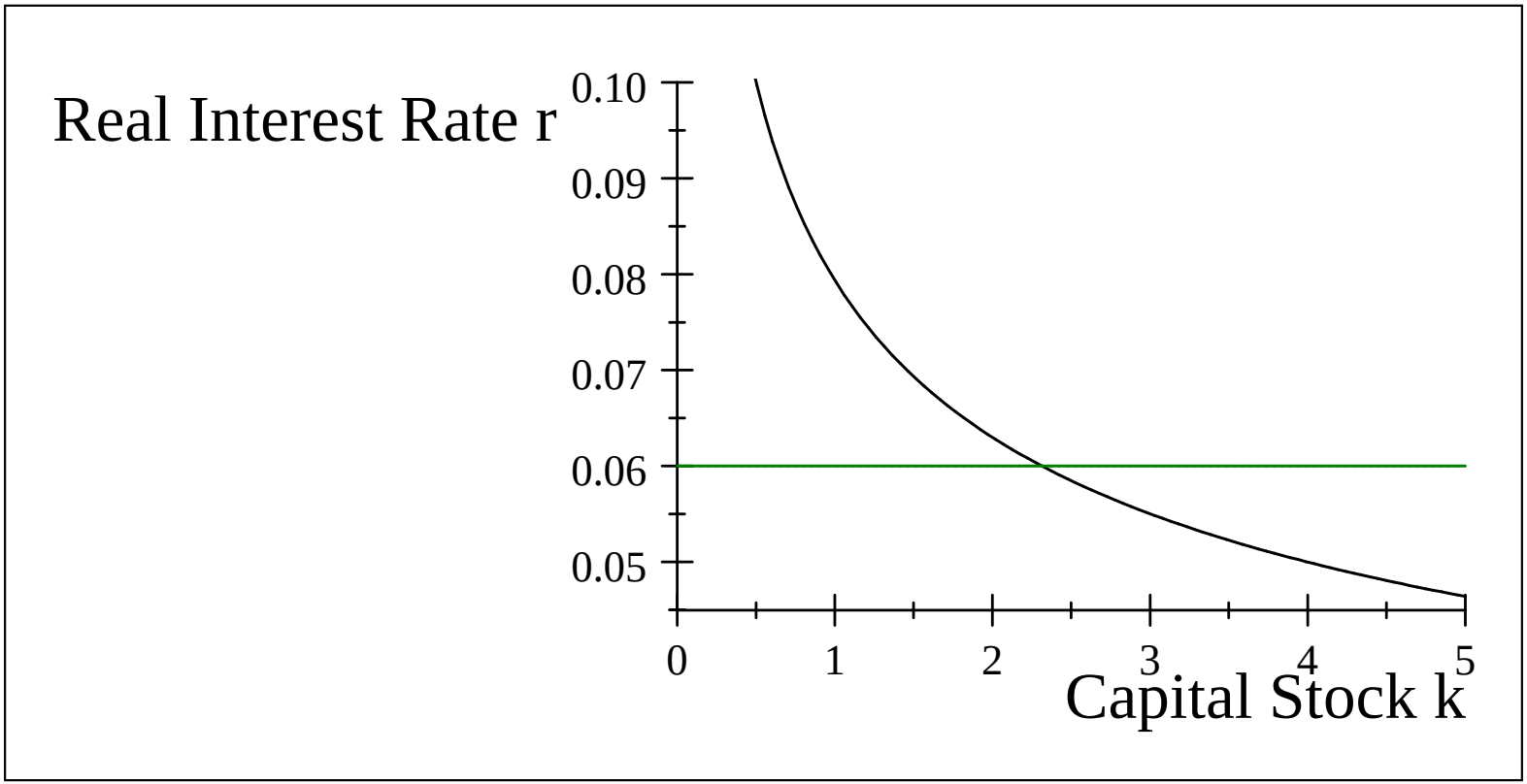


Figure: Capital Market with Downward Sloping Demand for Capital that equals the Marginal Product of Capital, Holding Labor Constant, Plus Fixed Interest Rate.

Indifference Curve & Production Function

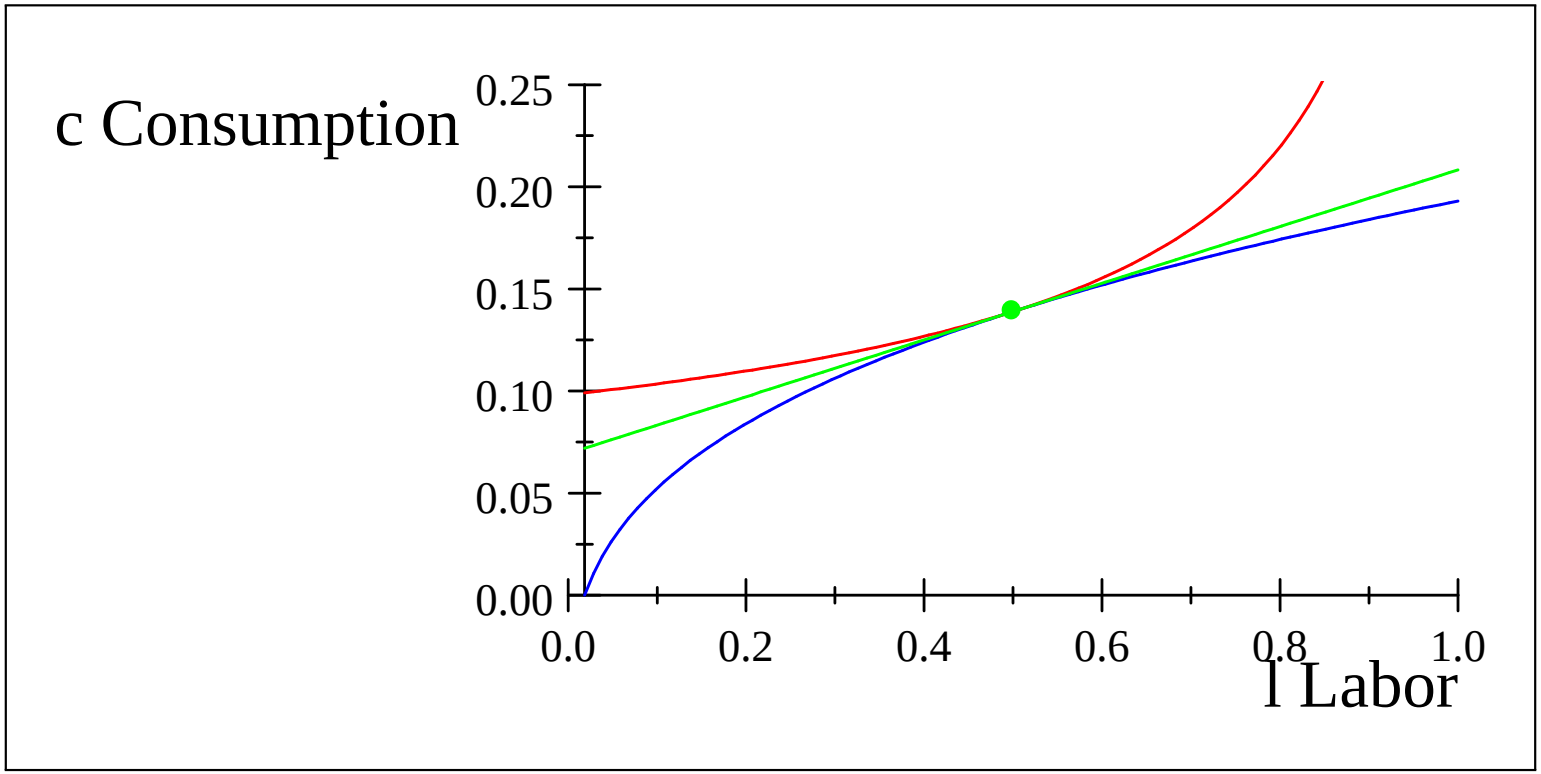


Figure: General Equilibrium Consumption and Utility Levels in Example Ramsey Economy.

Isoquant & Isocost & Input Ratio

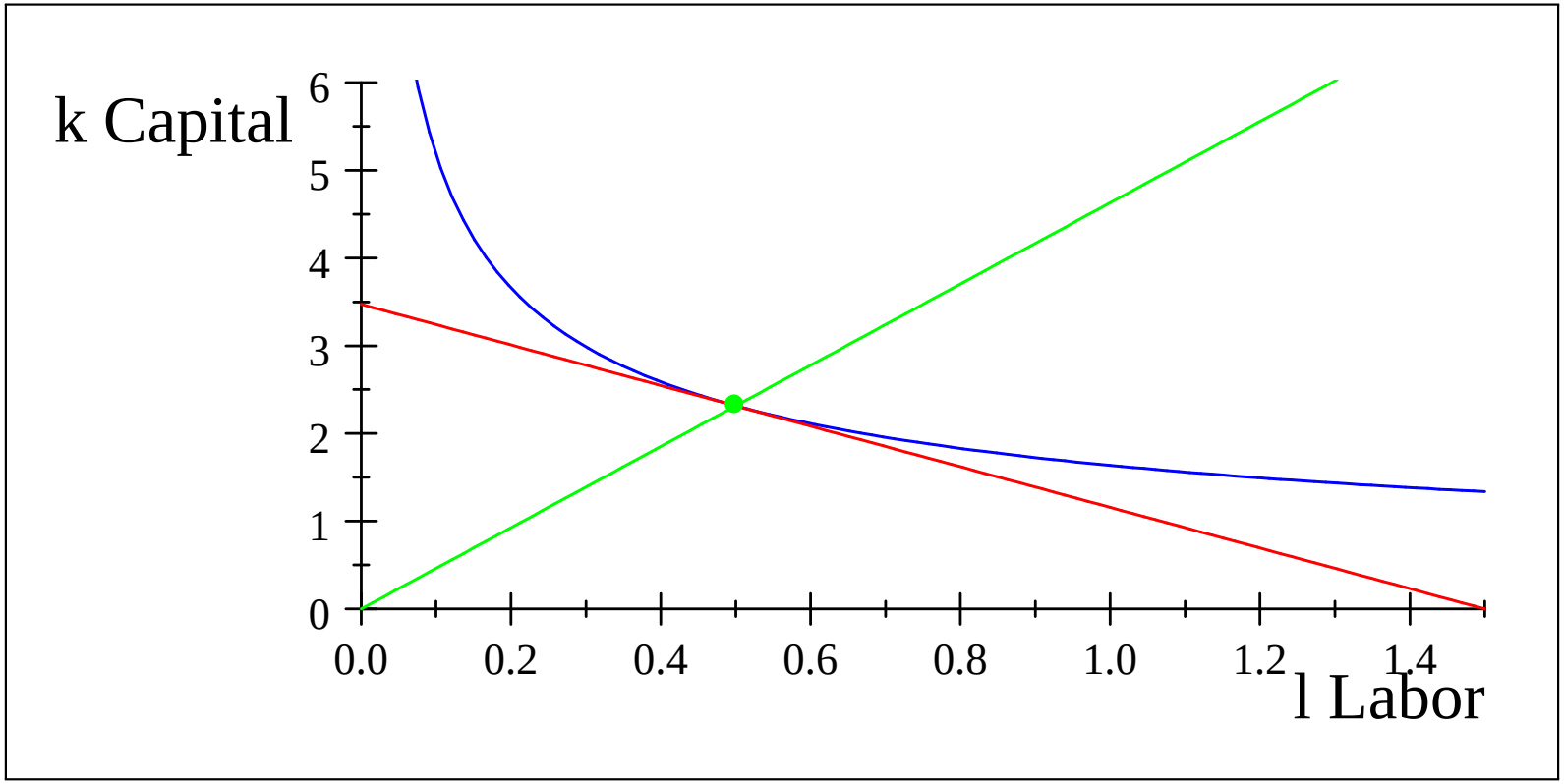


Figure: Factor Market Equilibrium in Ramsey Example Economy.

"Supply Side Economics"

- Increase in goods productivity through
- increase in productivity parameter A
- causes relative price of aggregate output to fall
- because AS shifts out more than AD curve.
- Sometimes called "*supply-side economics*".
- Used to describe *RBC* theory to emphasize
  - *RBC* theory works by productivity rising in expansions
  - & net increase in aggregate supply AS .
  - with corresponding increase in aggregate output y.
- Fall in relative price, $1/w$, not emphasized as much.
  - but important part of analysis:
  - relative price of goods to labor falls.

Explaining RBC Facts: Both Goods & Time Endowment Increase

- Using only goods output productivity increase:
  - time spent working does not change.
  - Comparable to employment rate not changing.
- We think of employment rate rising in expansion
  - & falling in contraction.
- Unemployment rate highly correlated with employment rate,
  - so unemployment falls in expansions & rises in contractions.
- Productivity change alone does not affect employment rate.
- Solution to problem: add another change plus productivity change:
- Time endowment increase in expansion.

Add Change in Time Endowment

- When productivity increases, get more output from given inputs.
  - results in increase in *endowment of goods*,
  - given production function & input levels.
- Increasing our good endowment combined
  - with increasing time endowment.
  - To explain RBC facts.
- Time fixed at some amount called T, for work & leisure.
- In expansion, more time taken from education & household sector
  - & spent in work & leisure.
  - Increase time endowment causes "*external margin" of time use*
  - for work and leisure to increase.
- Time endowment increase acts to shift
  - out supply of labor by more than demand.
  - Employment time goes up.
  - Plus with A increase, real wage rises.

Business Cycle Expansion

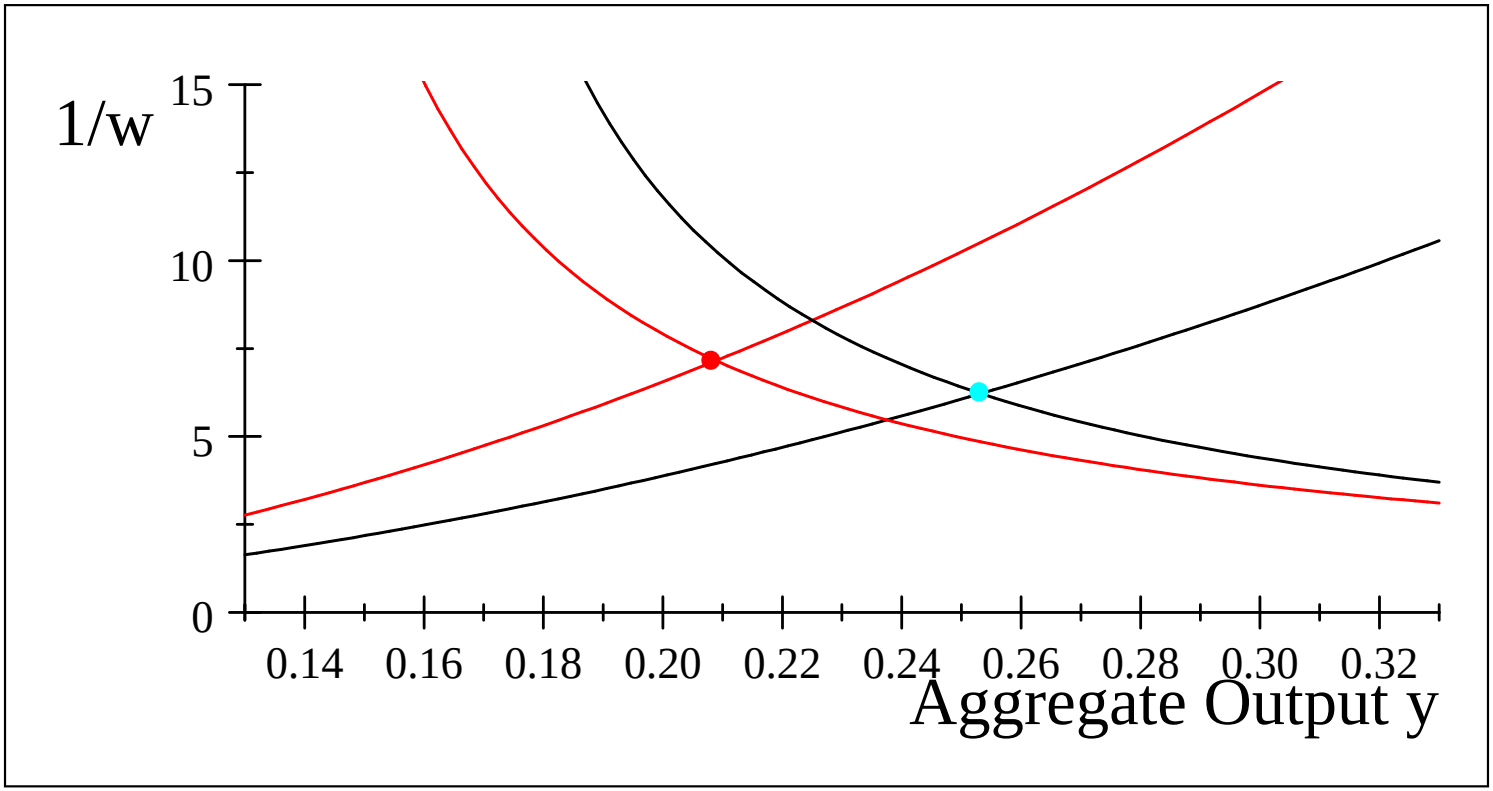


Figure: Business Cycle Expansion in Goods Market: $AS - AD$ Equilibrium with 5% Increase (in Black) in Both Productivity A and Time T as Compared to the Original (in Red).

Labor Market in Expansion

- Shift out in labor demand & slight pivoting of labor supply curve.
- Both goods & time endowment increases cause labor demand to shift out,
- as capital stock k rises & A itself rises.
- Labor supply shift out caused by higher time T
- offset by higher productivity A that shifts back labor supply.
- Leaves labor supply in roughly the same place.
- Employment rate & wage rate both rise.
- In example economy, labor supply rises 5%,
- wage rate rises by 16%.

Labor Demand Shifts out more than Labor Supply

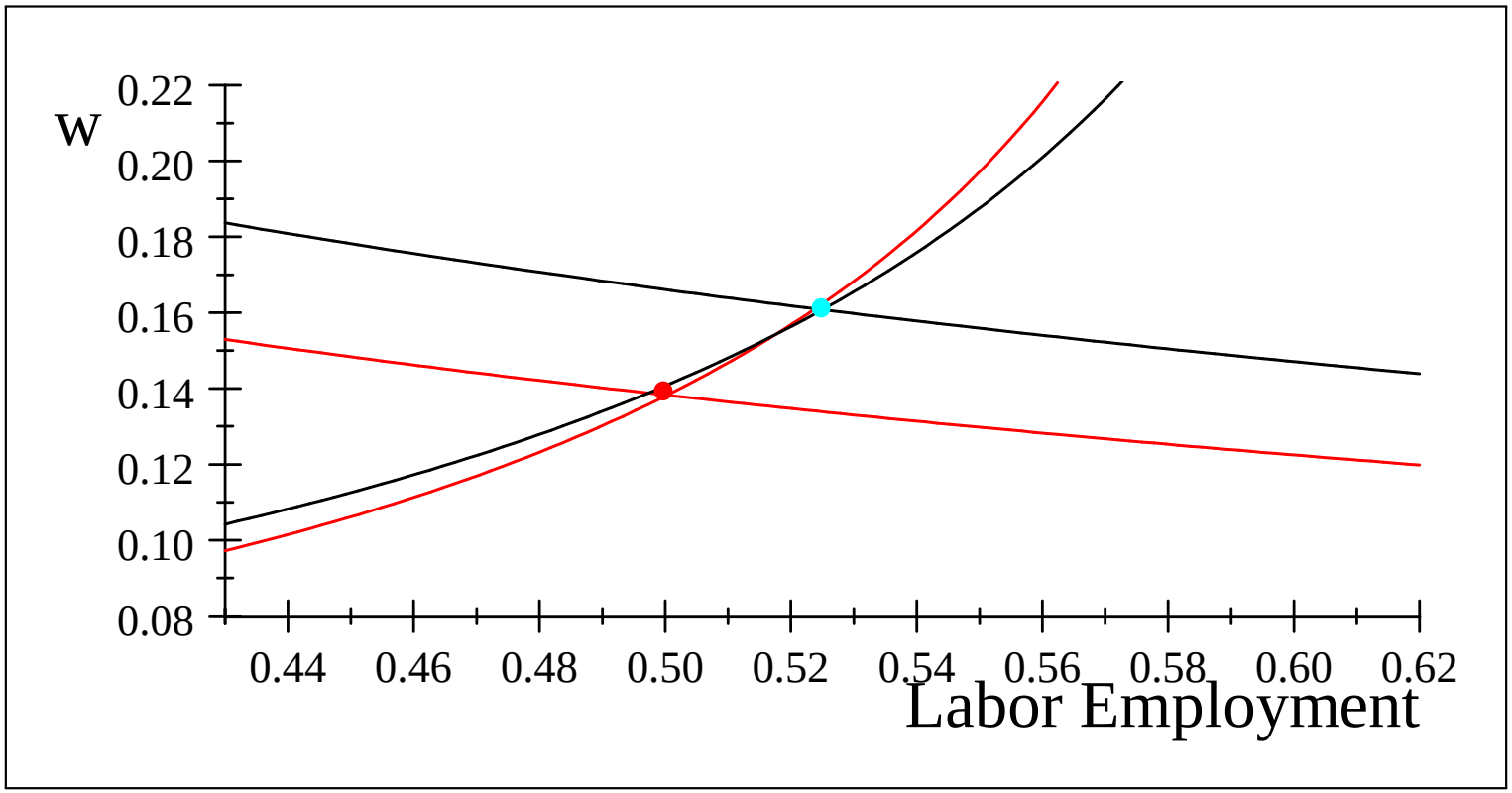


Figure: Business Cycle Expansion: Labor Market has a Shift out in Demand (Black) and Pivoting of Supply (Black) as Compared to Original (Red).

Capital Market: Demand Shifts Out, Supply Horizontal

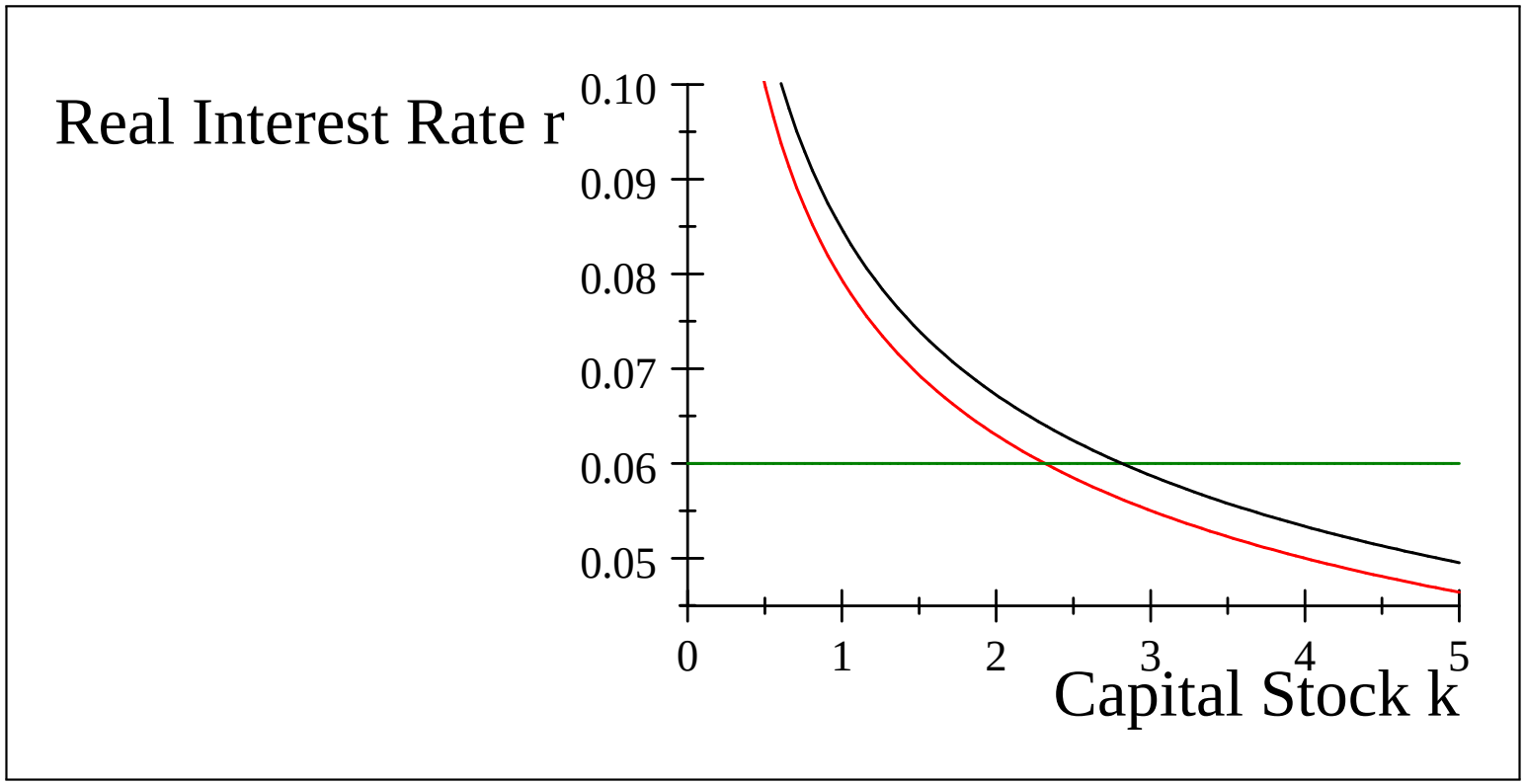


Figure: Capital Market Shows Shift Out of Demand for Capital (Black Curve) When both Factor Productivity A and Time Endowments T Increase by 5% relative to the Original Example Equilibrium (Red Curve).

Expansion Facts Explained

- Increase in real wage rate w, capital k, labor l,
  - consumption c & output y.
  - Used 5% increase in both goods & time endowments.
- k rose by more than wage w : saw in Fred Graphs.
- And $1/w$ falls as real wage w is procyclic
- although evidence mixed.
- Here c/y ratio constant at 0.67, but falls in NIPA data.
- Extensions of Ramsey World with Human capital makes progress
- on c/y and procyclic r, real interest rate.

Application: Wage Rigidity Explanation of Crisis

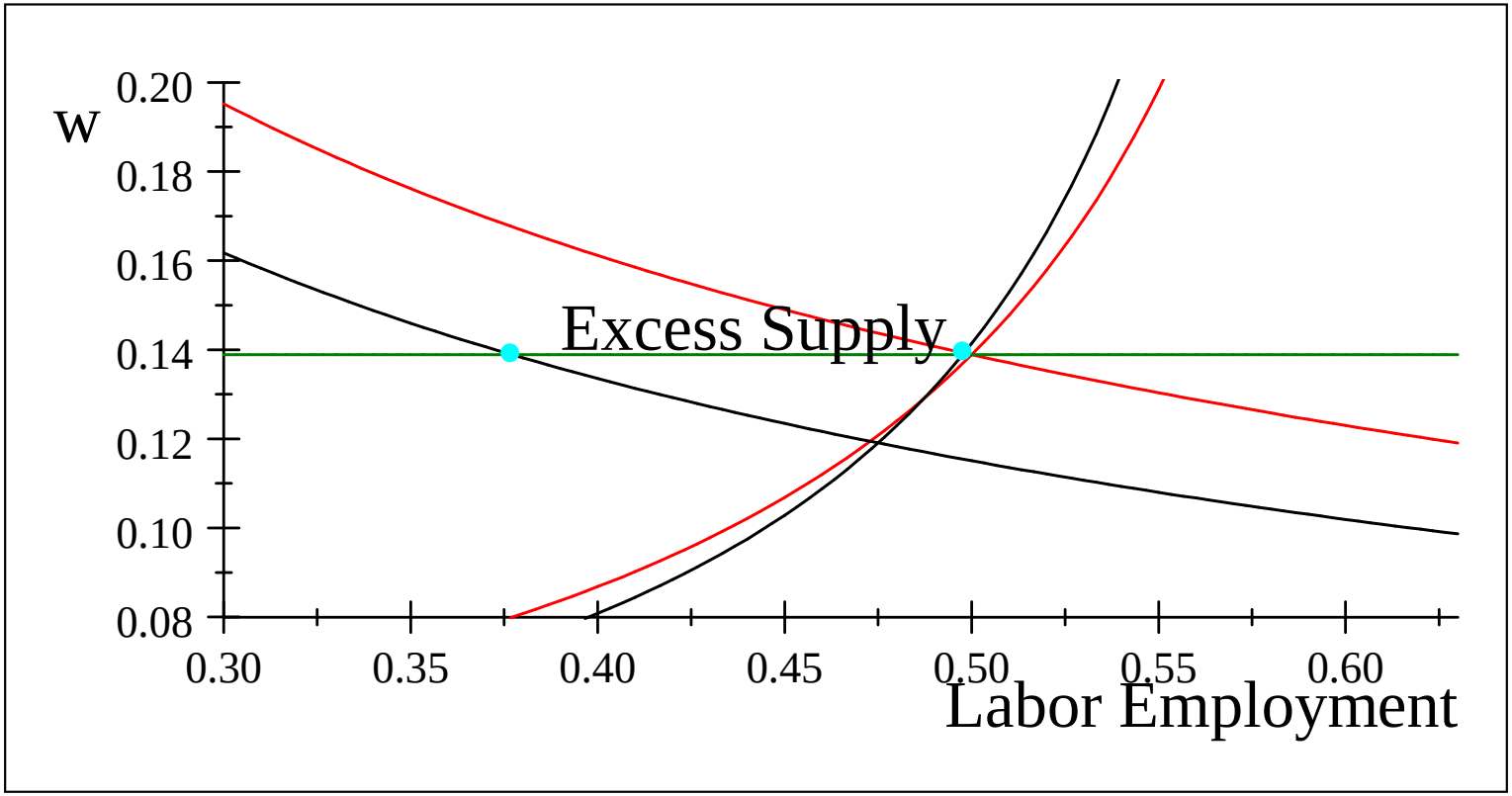


Figure: Excess Labor Supply with a Fixed Wage During Contraction (in Black) relative to the original example equilibrium (in Red).

Appendix: Crises from Bank Productivity Decline

- Model bank crisis by bank sector production of intermediary
- collecting savings of consumer, lending investment to firm,
- and let bank productivity factor fall by 26%.
- Data from FRED: Chicago Federal Reserve Bank
- computation of National Financial Condition Sub-Index.
- Measure of aggregate consumer and firm leverage,
- Index falls dramatically at start of Great Recession & stays down.

FRED Leverage Index

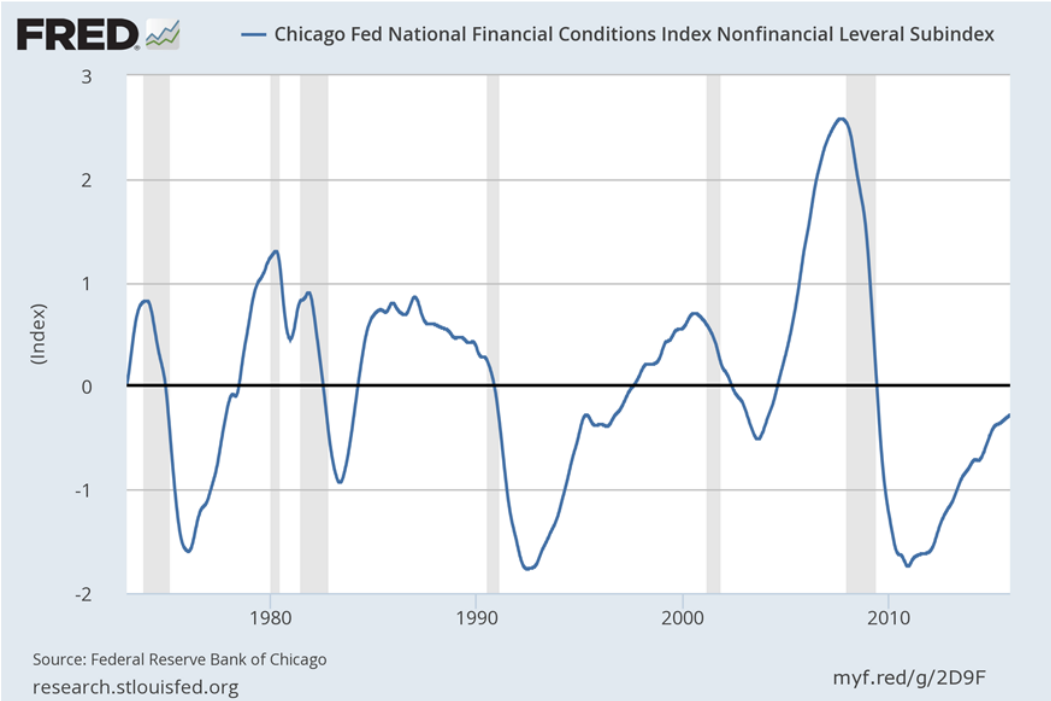
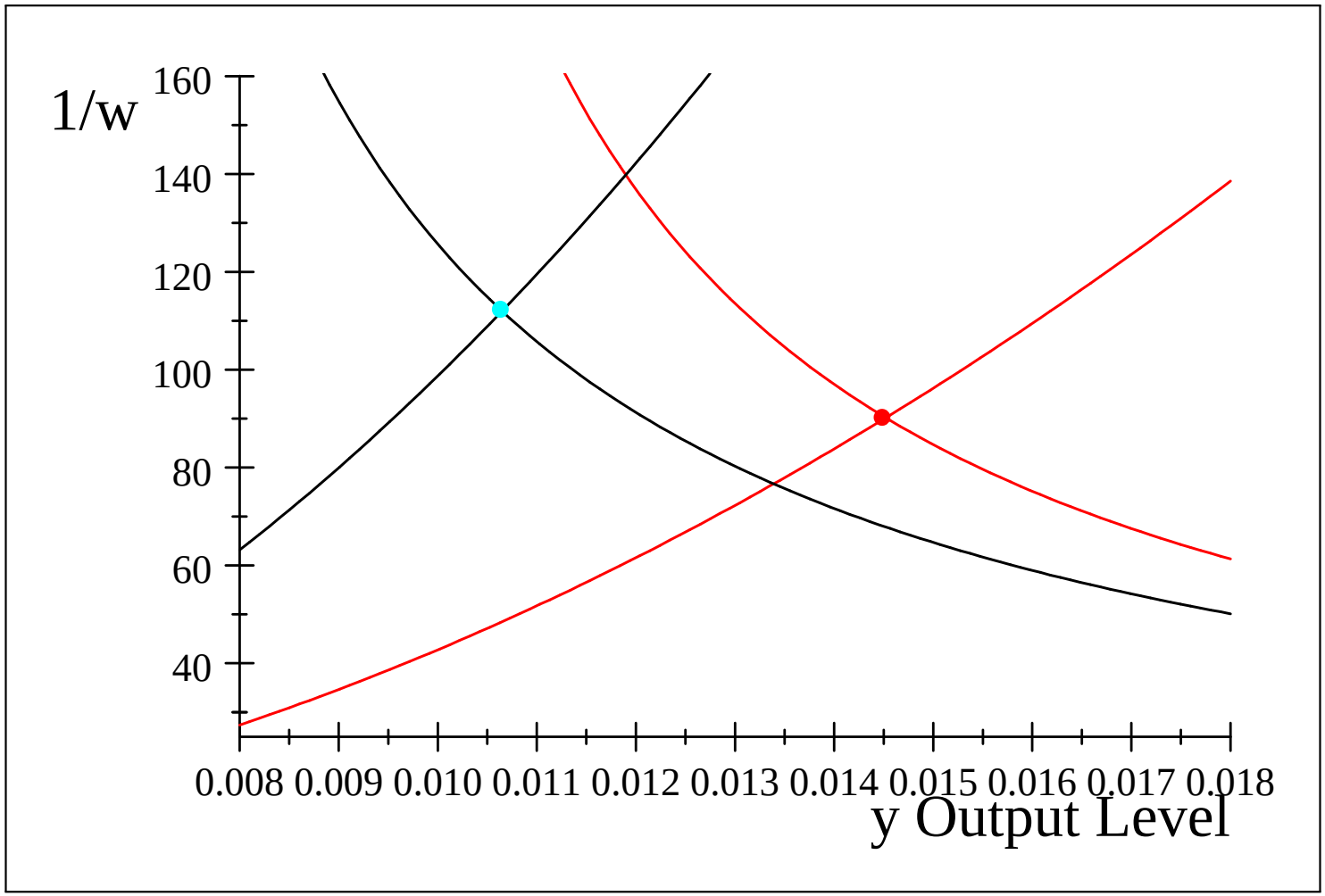


Figure: Chicago Fed National Financial Conditions Sub-Index for Leverage.

Ramsey World Bank Crisis

- 26% bank productivity decline in Ramsey World
- simulates crisis-type decrease in bank's ability
- to intermediate savings into investment.
- Causes capital stock down by 34%, as in DJIA 2008 fall.
- Capital stock k amount in Ramsey world is value of equity capital.
- 34% drop in equity stocks happened from May 2, 2008, to January 9, 2009
- when DJIA dropped from $13,058$ to 8599 : a 34% drop.
- Occurred during banking crisis of Great Recession
- which included insolvency of Lehman Brothers investment bank
- in September 15, 2008, when Lehmans filed for Chapter 11 bankruptcy.
- $AS - AD$: net AS shift back, capital stock down 34%; $\frac{1}{w}$ rises.

AS-AD Bank Crisis from Bank Productivity Decline



$AS - AD$ Shift Bank after Bank Crisis Type Fall in Bank Producitivity.

Labor Market Decrease with Bank Productivity Crash

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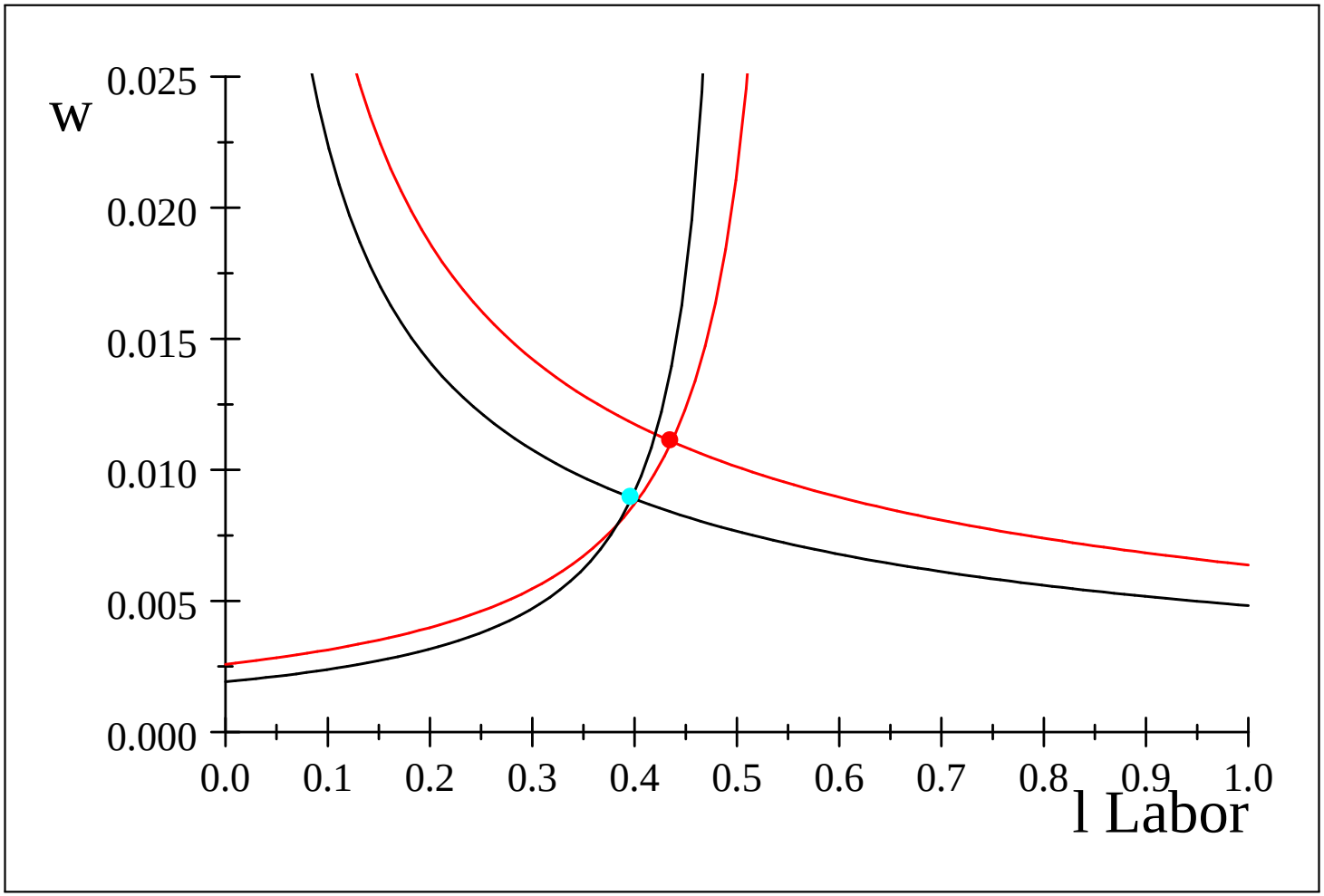
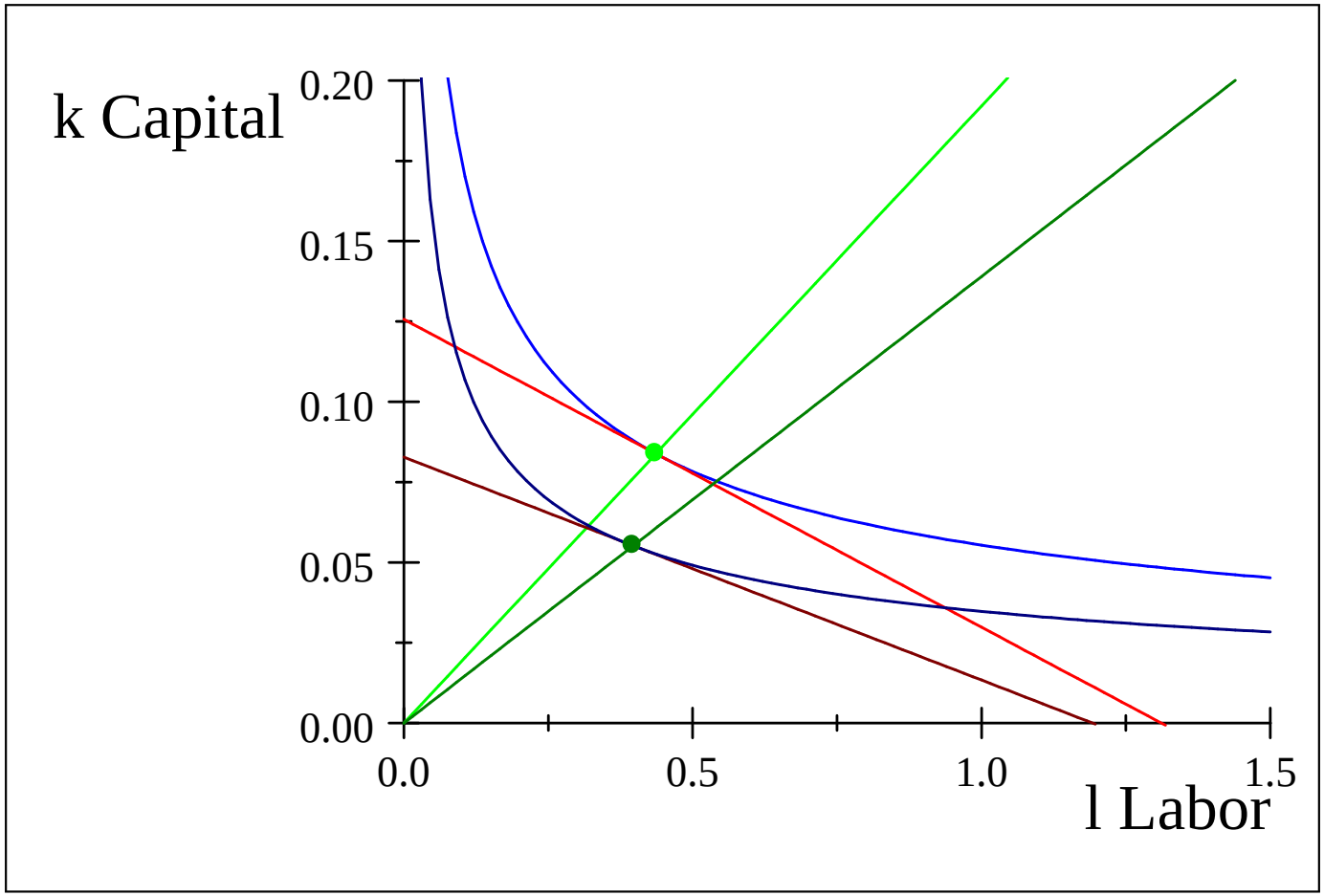
9%



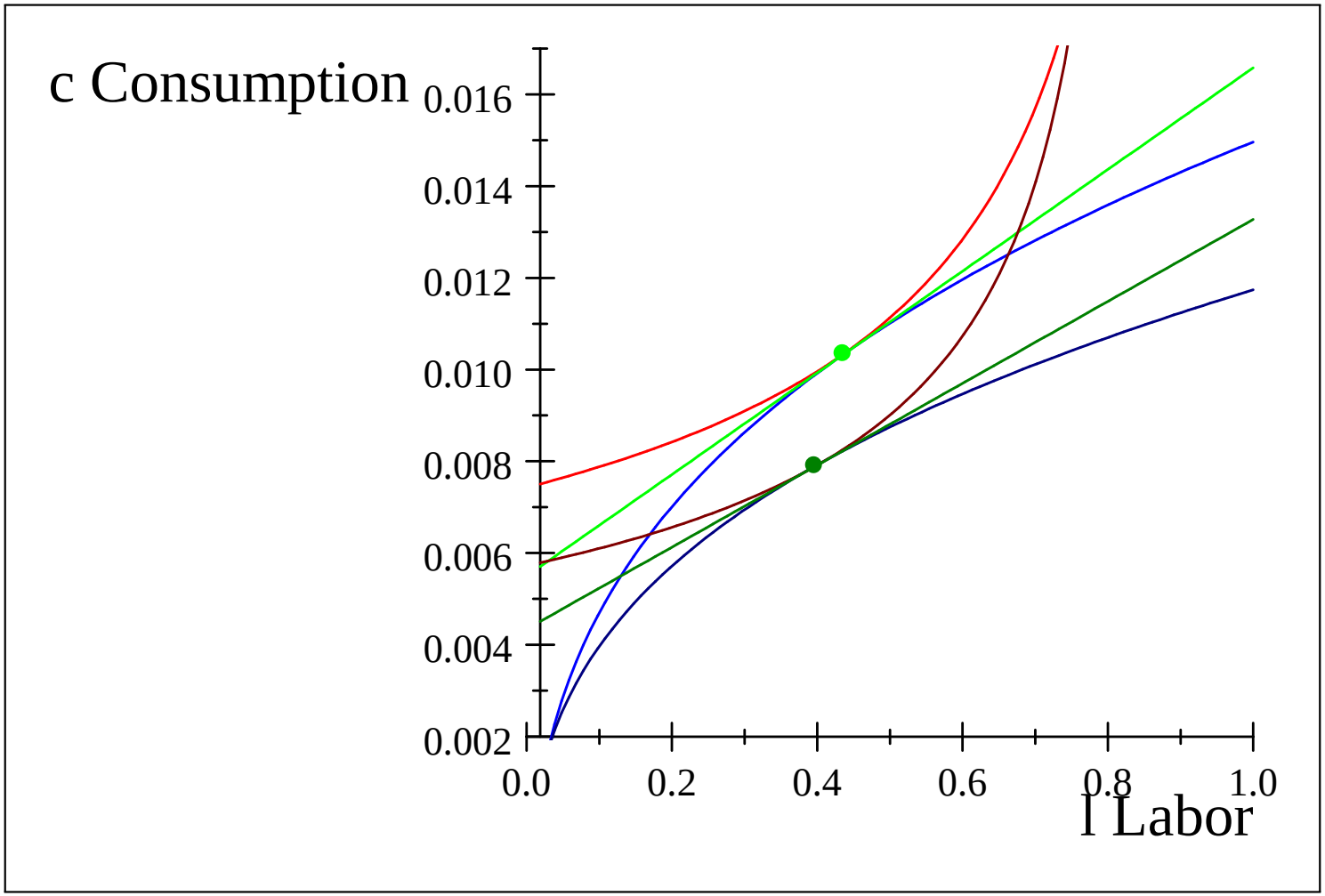
Labor Market: Lower Employment and Lower Wage Rate during Bank Crisis

Capital/Labor Decrease with Bank Productivity Crash



Factor Market Equilibrium in During Bank Crisis (Darker Colors).

Consumption/Labor Decrease with Bank Productivity Crash



Consumption and Utility Levels Fall during Bank Crisis Decrease in Bank Productivity.

Questions

1. Describe a statistical definition of the relative price of goods to labor.
2. Characterize the variation over the business cycle and trend over time in the empirical measure of the real price of goods relative to labor.
3. Describe how the real wage rate changes relative to the changes in real output growth.
4. Identify a measure of the value of equity capital and describe how this has changed over time.
5. Describe a sense in which the value of equity correlates with the inflation rate in recent US history, and how this relates to the debt-deflation explanation of crises.
6. How has the labor participation rate changed over time both cyclically and in terms of its long run trend.
7. What is the relative price of goods to labor the aggregate demand and aggregate supply analysis, or $AS - AD$, of Ramsey's World?

1. How does the equilibrium capital stock affect the aggregate demand and aggregate supply analysis of Ramsey's World?
2. What is the relative price of labor in the labor market's supply and demand for time spent working in Ramsey's World?
3. Explain a business cycle expansion in Ramsey's World using graphs and a description of the graphs. What variables change in way that is consistent with the evidence presented in the Chapter?
4. How do aggregate supply and demand shift during a contraction, or recession, in Ramsey's World?
5. How does the labor market change when there is a recession in Ramsey's World?
6. Describe how an excess supply of labor can exist and can potentially be consistent with certain aspects of a depression.
7. Explain how a banking crisis can be modeled in the Ramsey World using goods and labor markets.