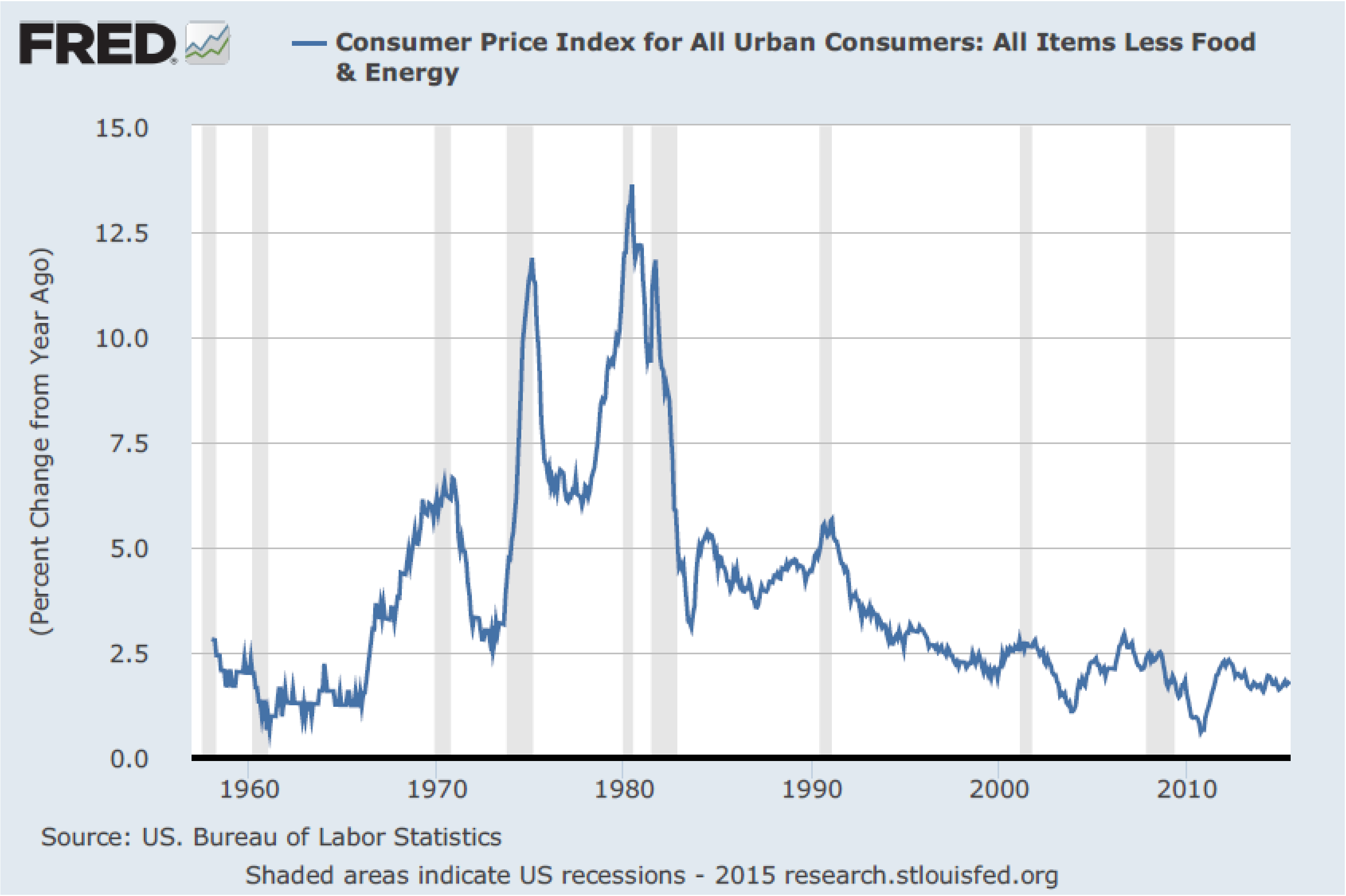
Modelo de Ciclos Reales

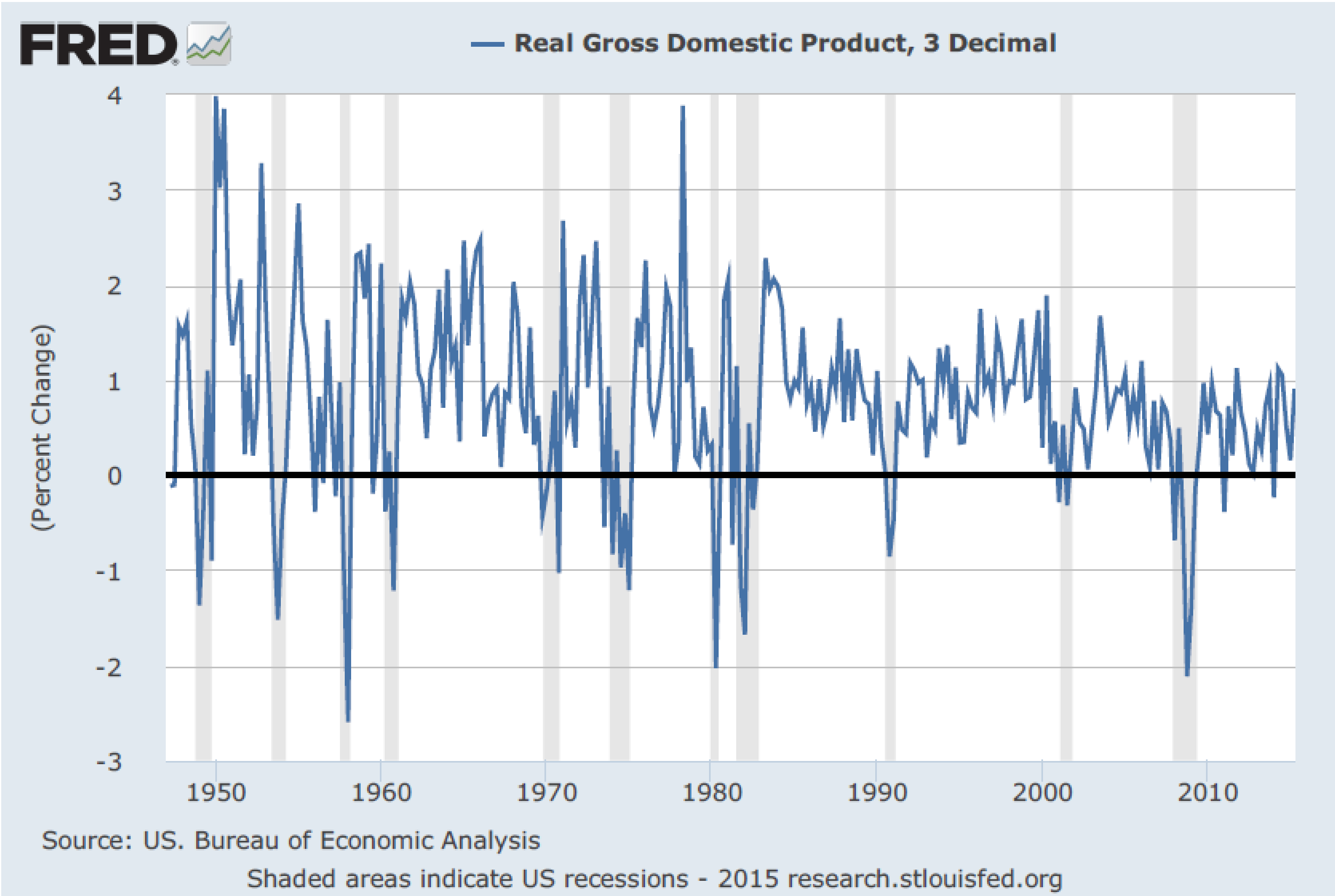
Introducción

- Los modelos RBC se desarrollaron en respuesta a la falla de los grandes modelos macroeconómicos durante los 60s y a principios de los 70s.

- El objetivo fue crear un modelo de fluctuaciones basado en primeros principios, donde las restricciones externas involucran preferencias y tecnología.

- Modelo elegido: modelo neoclásico de crecimiento estocástico.


FRED
Consumer Price Index for All Urban Consumers: All Items Less Food & Energy
15.0
12.5
10.0
7.5
5.0
2.5
0.0
(Percent Change from Year Ago)
1960
1970
1980
1990
2000
2010
Source: US. Bureau of Labor Statistics
Shaded areas indicate US recessions - 2015 research.stlouisfed.org



FRED
Real Gross Domestic Product, 3 Decimal
(Percent Change)
4
3
2
1
0
-1
-2
-3
1950
1960
1970
1980
1990
2000
2010
Source: US. Bureau of Economic Analysis
Shaded areas indicate US recessions - 2015 research.stlouisfed.org

Introducción

- It is natural to begin our study of aggregate fluctuations by asking whether they can be understood using a competitive model without any externalities, asymmetric information, missing markets, or other imperfections.

- The Ramsey model is the natural Walrasian baseline model of the aggregate economy: the model excludes not only market imperfections, but also all issues raised by heterogeneity among households.

- We modify the Ramsey model in two ways.

Introducción

- First, there must be a source of disturbances: without shocks, a Ramsey economy converges to a balanced growth path and then grows smoothly.

- The initial extensions of the Ramsey model to include fluctuations emphasized technology shocks. Subsequent work in this area also emphasizes changes in government purchases.

- Both types of shocks represent real—as opposed to monetary, or nominal—disturbances: technology shocks change the amount that is produced from a given quantity of inputs, and government-purchases shocks change the quantity of goods available to the private economy for a given level of production.

- For this reason, the models are known as real-business-cycle (or RBC) models.

Introducción

- The second change that is needed to the Ramsey model is to allow for, variations in employment. In all the models we have seen, labor supply is exogenous and either constant or growing smoothly.

- Real-business-cycle theory focuses on the question of whether a Walrasian model provides a good description of the main features of observed fluctuations.

- Models in this literature therefore allow for changes in employment by making households' utility depend not just on their consumption but also on the amount they work; employment is then determined by the intersection of labor supply and labor demand.

Introducción

- Teoría unificada del ciclo y la tendencia.

- Producto secundario: "calibración" introducida como una forma de asignar valores a los parámetros.

- Los RBC fallan como un modelo para explicar las fluctuaciones económicas pero es un avance metodológico importante.

- Los modelos macroeconómicos más avanzados se construyen sobre el modelo RBC agregando fricciones necesarias para confrontar los datos.

Modelo RBC sin capital: Hogares

- Preferencias

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t)$$

- Donde

$$\beta \equiv \frac{1}{1+\rho} \in [0,1], U_c > 0, U_n < 0, U_{cc} \leq 0, \text{ and } U_{nn} \leq 0$$

- Restricción presupuestaria:

$$C_t + B_t = W_t N_t + (1 + r_{t-1}) B_{t-1} + D_t$$

Modelo RBC sin capital: Hogares

- Condiciones de optimalidad:

$$W_t = -\frac{U_{n,t}}{U_{c,t}} \equiv MRS_t$$

intratemporal

$$U_{c,t} = \beta(1 + r_t)E_t\{U_{c,t+1}\}$$

intertemporal

Modelo RBC sin capital: Hogares

- Consideremos las siguientes formas funcionales para la función de utilidad:

$$
\begin{aligned}
U(C_t, N_t) &= \frac{C_t^{1-\sigma}-1}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \quad \text{if } \sigma \neq 1 \\
&= \log C_t - \frac{N_t^{1+\varphi}}{1+\varphi} \quad \text{if } \sigma = 1
\end{aligned}
$$

Modelo RBC sin capital: Hogares

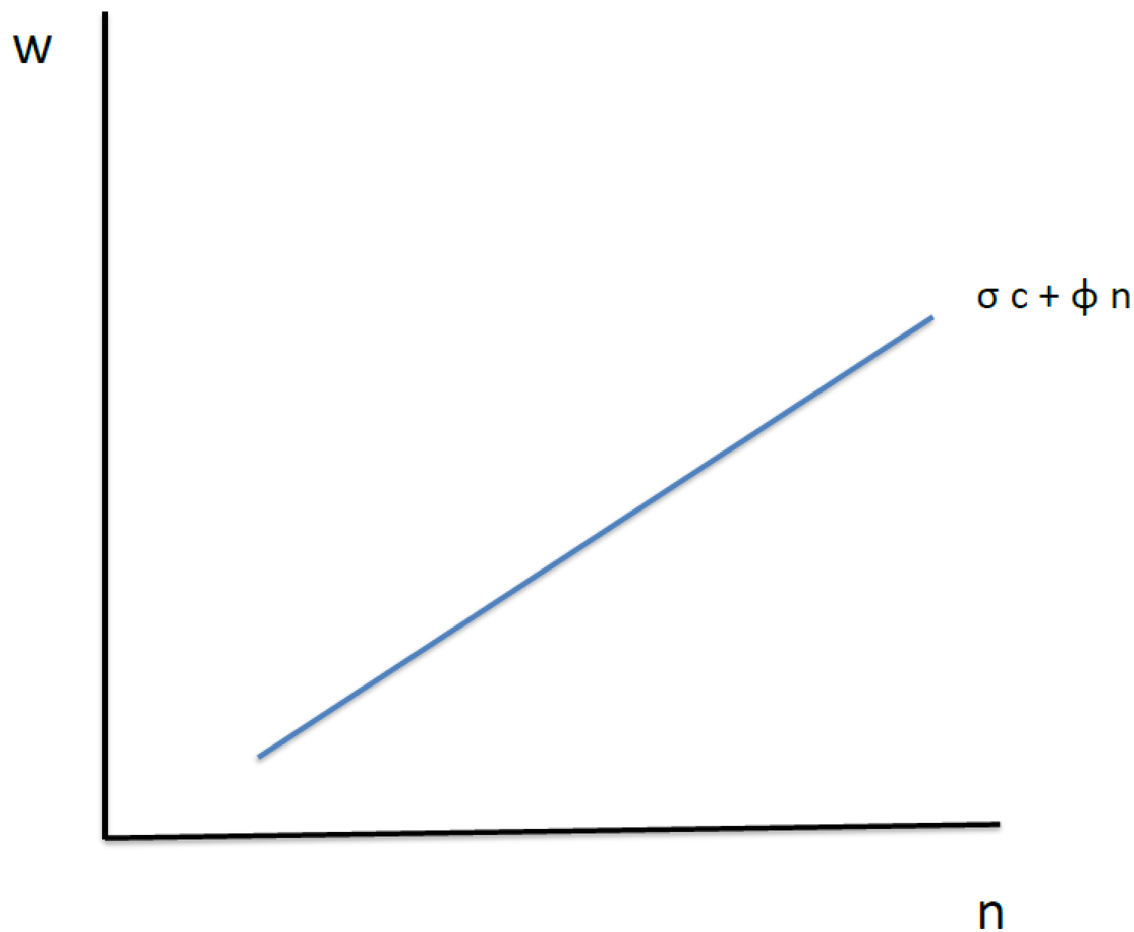
- En este caso, las condiciones de optimalidad pasan a ser:

$$W_t = C_t^{\sigma} N_t^{\varphi}$$
$$1 = \beta(1 + r_t) E_t \left\{ (C_{t+1}/C_t)^{-\sigma} \right\}$$

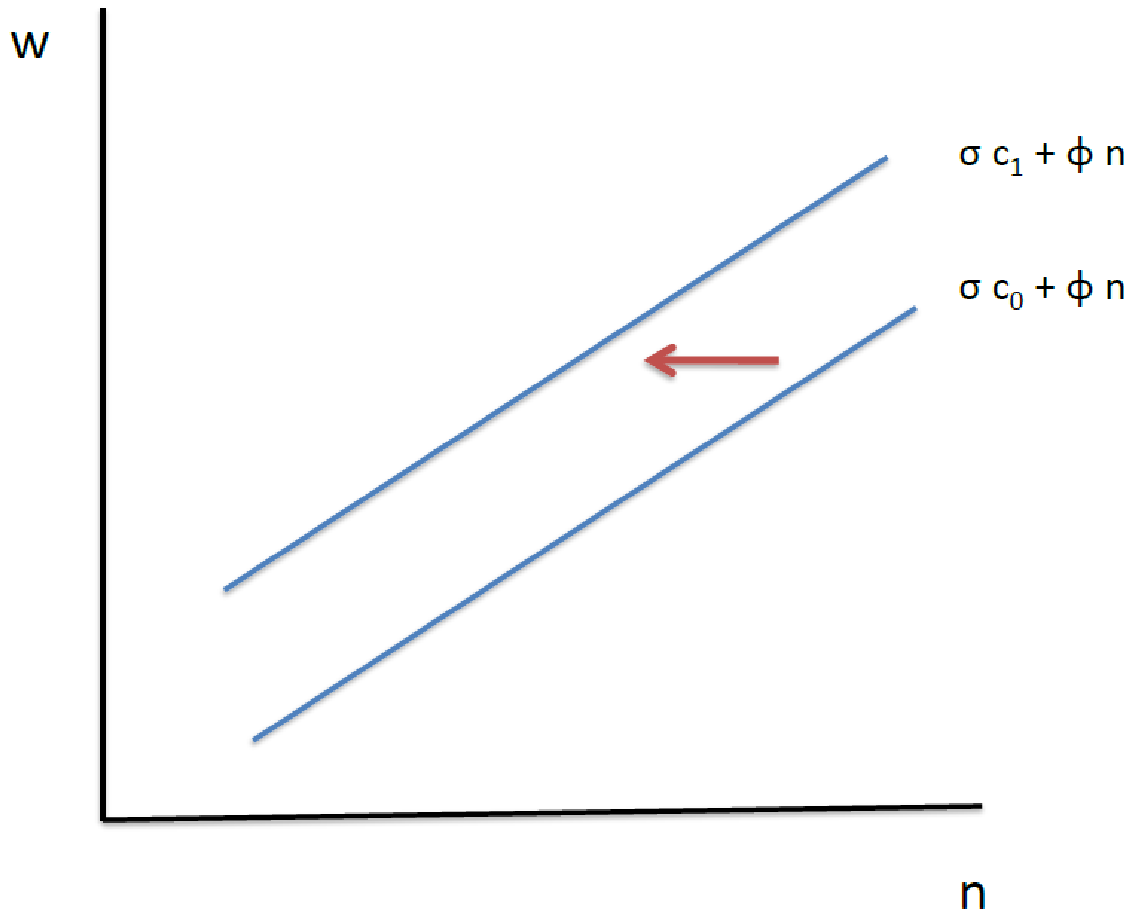
- Y sus versiones log-linearizadas:

$$w_t = \sigma c_t + \varphi n_t$$
$$c_t = E_t\{c_{t+1}\} - \frac{1}{\sigma}(r_t - \rho)$$

Oferta de trabajo



Oferta de trabajo



Modelo RBC sin capital: Firmas

- Tecnología

$$Y_t = A_t F(N_t)$$

- Donde:

$$F_n > 0,\ F_{nn} \leq 0$$

- Y donde $A_t \equiv \exp\{a_t\}$ es un parámetro tecnológico que evoluciona de acuerdo al proceso AR(1):

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a$$

Modelo RBC sin capital: Firmas

- Problema de la firma:

$$\max Y_t - W_t N_t$$

- Sujeto a la restricción tecnológica.

- Condición de optimalidad:

$$W_t = A_t F_{n,t} \equiv MPN_t$$

Modelo RBC sin capital: Firmas

- Consideremos la siguiente función de producción:

$$Y_t = A_t N_t^{1-\alpha}$$

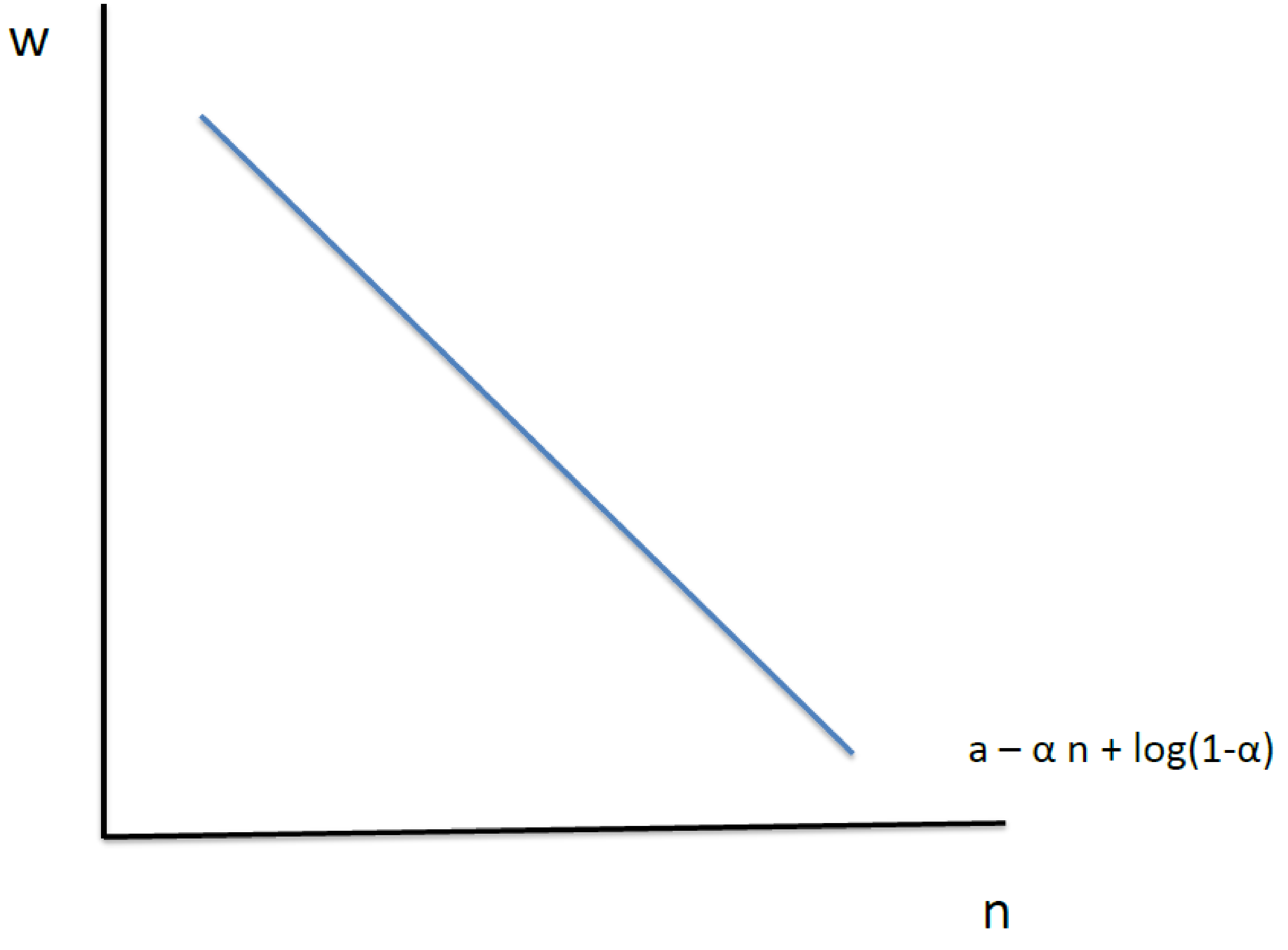
- Las condiciones de optimalidad:

$$\begin{aligned} W_t &= (1-\alpha) A_t N_t^{-\alpha} \\ &= (1-\alpha)(Y_t / N_t) \end{aligned}$$

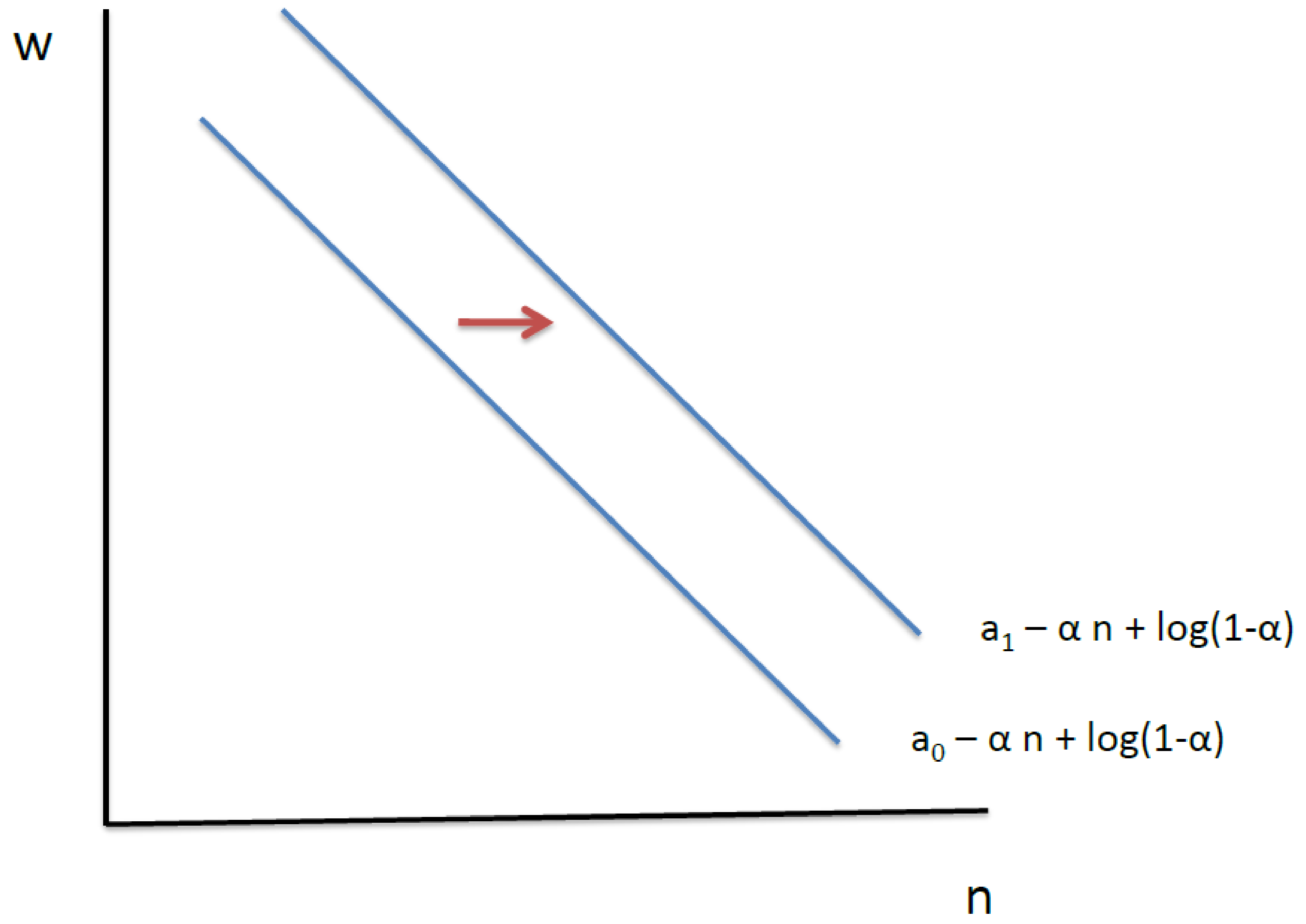
- Y sus versiones log-linearizadas:

$$w_t = a_t - \alpha n_t + \log(1-\alpha)$$

Demanda por trabajo



Demanda por trabajo



Condiciones de equilibrio

- Mercado de bienes:

$$Y_t = C_t$$

- Mercado del trabajo:

$$C_t^{\sigma} N_t^{\varphi} = W_t = (1-\alpha) A_t N_t^{-\alpha}$$

- Mercado de activos:

$$B_t = 0$$

$$1 = \beta(1 + r_t) E_t \left\{ \left(C_{t+1}/C_t \right)^{-\sigma} \right\}$$

Condiciones de equilibrio

- Considere un shock de productividad positivo:

- Efecto en consumo: suavizamiento y respuesta a tasa de interés.

- Trabajo/ocio. Efecto sustitución: Un mayor salario lleva a los trabajadores a trabajar más. Un efecto ingreso/riqueza: un aumento en el consumo hace que la los hogares quieran consumir más ocio.

- El efecto final dependerá de la fuerza de los dos efectos. Sustitución (elasticidad) y riqueza (persistencia). Mientras más transitorio, el aumento de C es menor y por lo tanto el efecto sustitución domina. Pero mientras más permanente el shock, el efecto ingreso domina, empleo puede caer.

Condiciones de equilibrio

- Los valores del equilibrio (en logaritmo e ignorando las constantes):

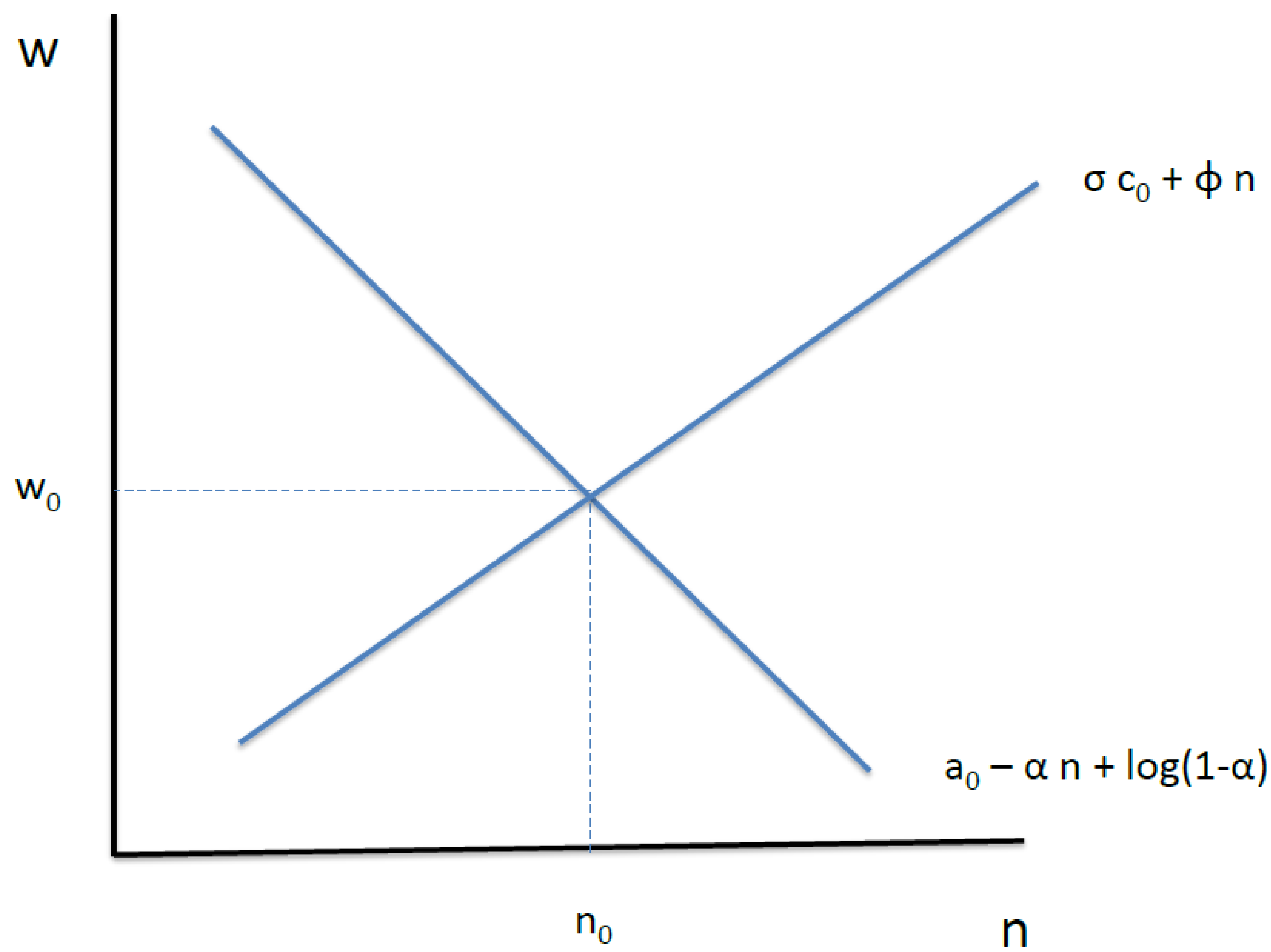
$$n_t = \frac{1-\sigma}{\sigma(1-\alpha)+\varphi+\alpha}\, a_t$$

$$y_t = \frac{1+\varphi}{\sigma(1-\alpha)+\varphi+\alpha}\, a_t$$

$$w_t = \frac{\sigma+\varphi}{\sigma(1-\alpha)+\varphi+\alpha}\, a_t$$

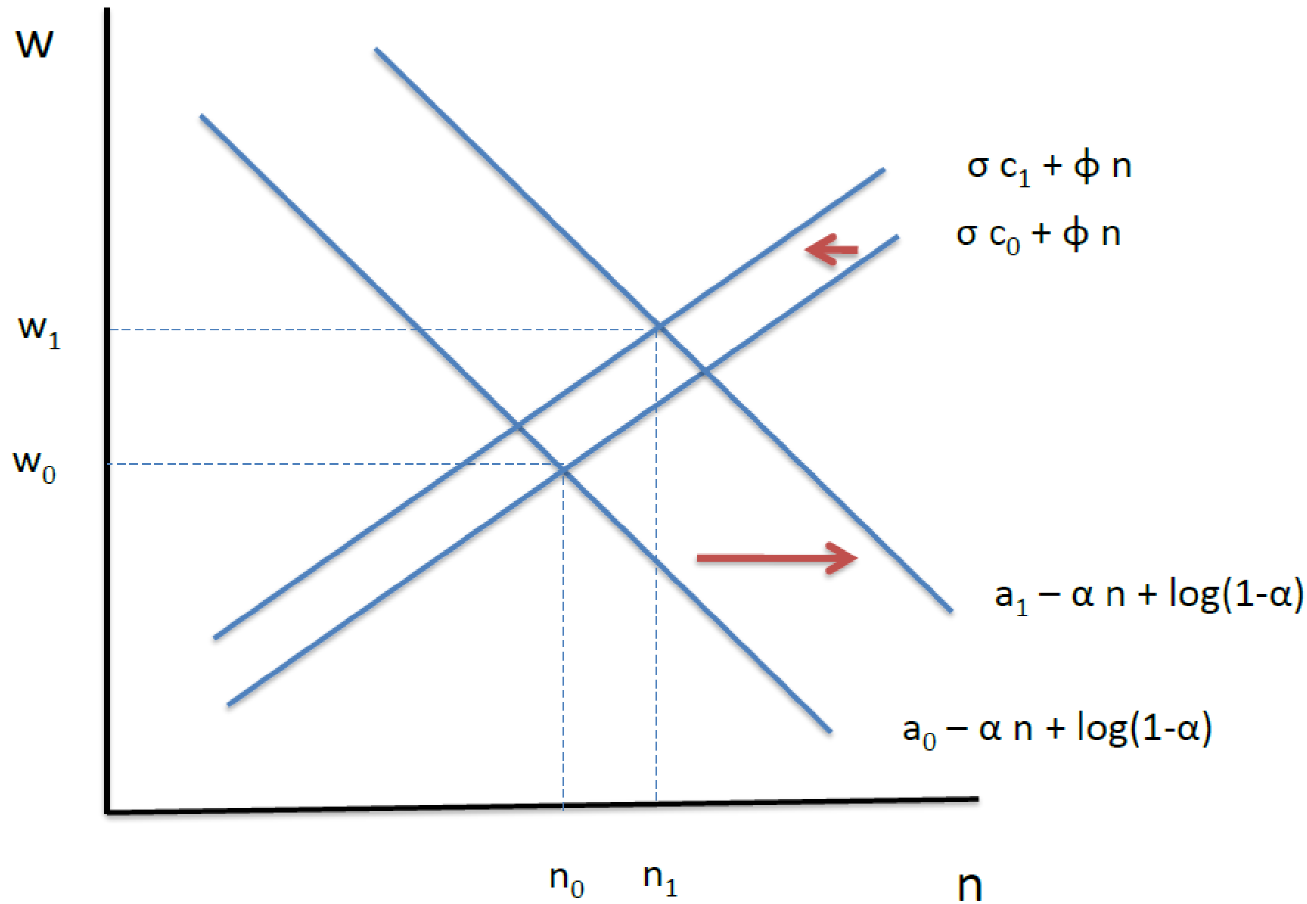
$$r_t = \rho - \frac{\sigma(1+\varphi)(1-\rho_a)}{\sigma(1-\alpha)+\varphi+\alpha}\, a_t$$

Equilibrio mercado laboral



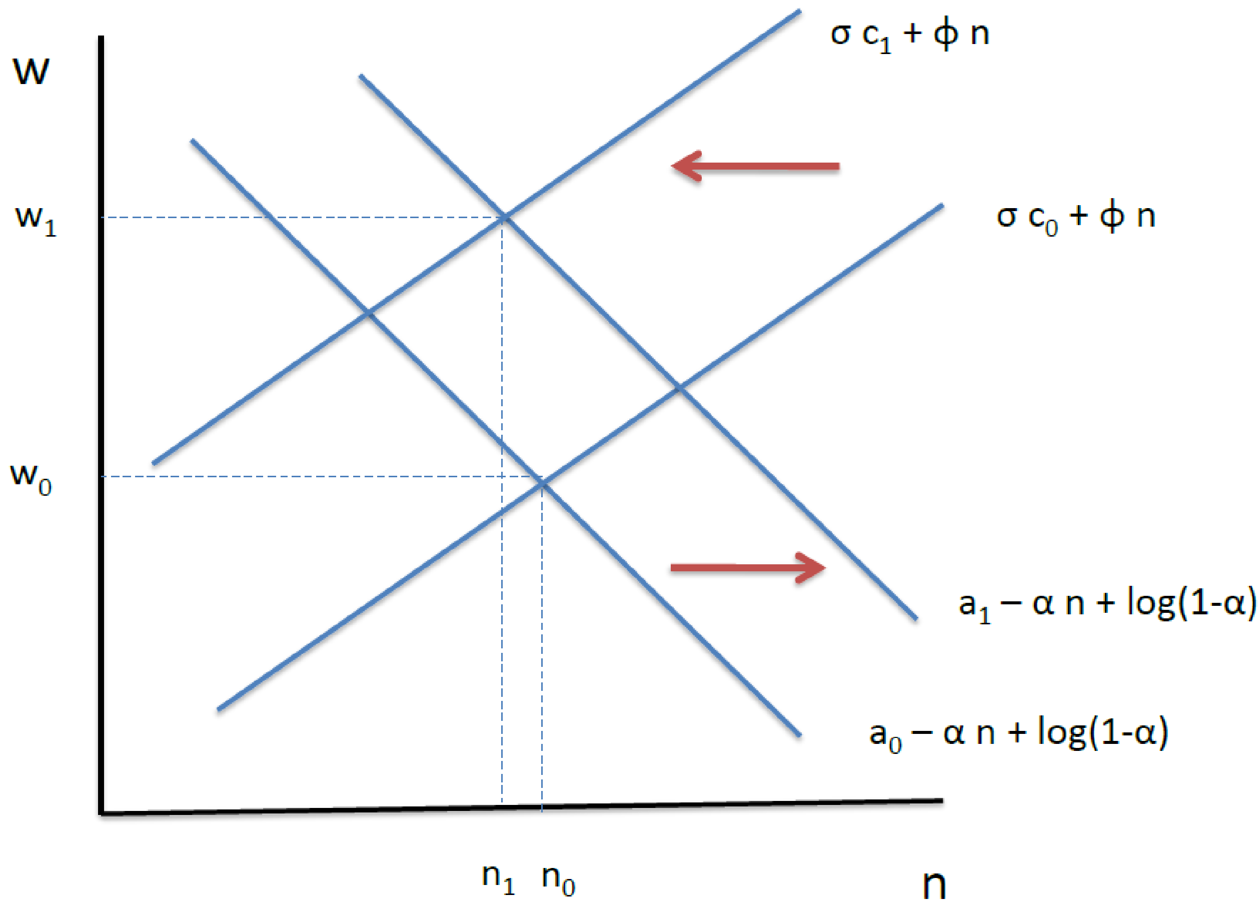
Equilibrio mercado laboral

- Efecto de un shock tecnológico ($\sigma < 1$)



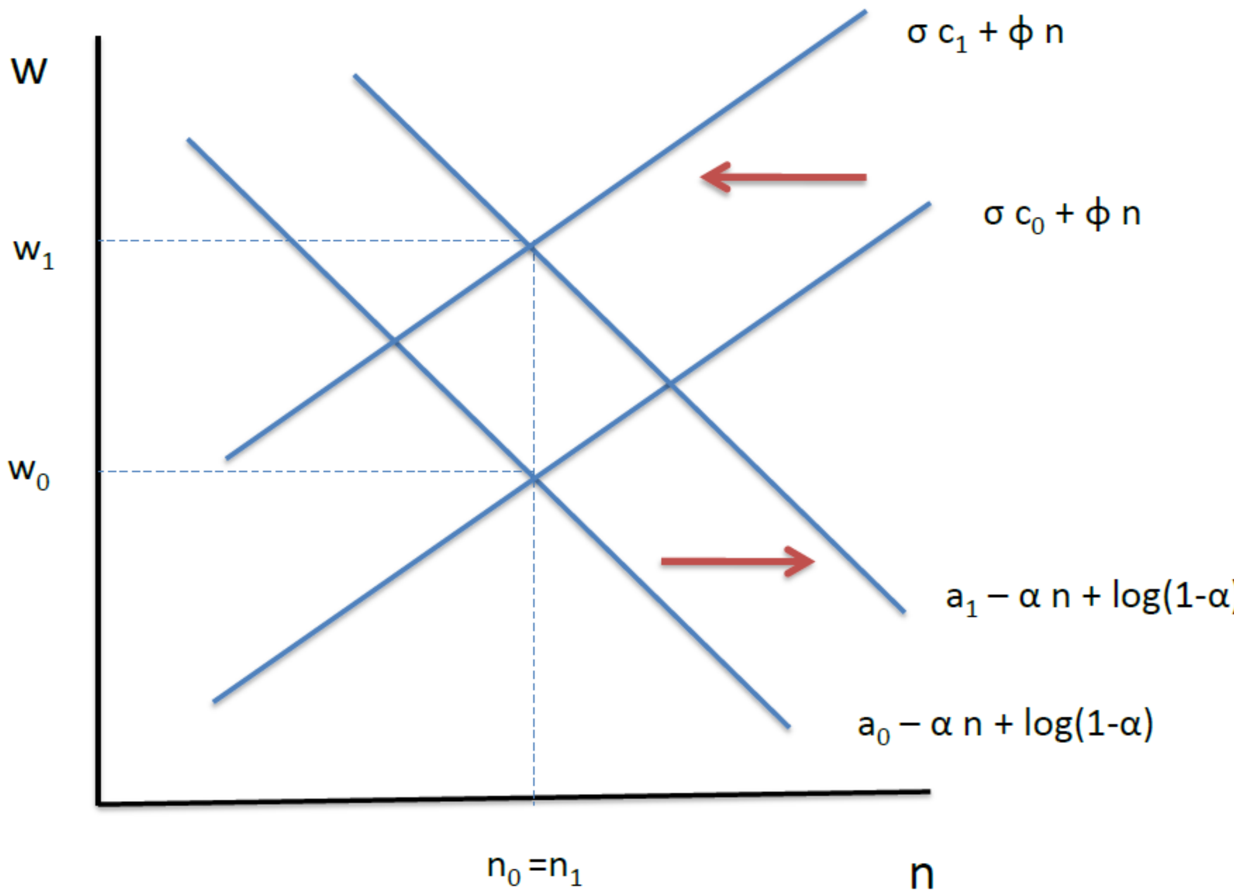
Equilibrio mercado laboral

- Efecto de un shock tecnológico ($\sigma > 1$)



Equilibrio mercado laboral

- Efecto de un shock tecnológico ($\sigma = 1$)



Asignación eficiente: problema del planificador social

- Maximiza:

$$U(C_t, N_t)$$

- Sujeto a:

$$C_t = A_t F(N_t)$$

- Condición de optimalidad:

$$-\frac{U_{n,t}}{U_{c,t}} = A_t F_{n,t}$$

- Equivalencia con la asignación de la solución de mercado.
- Las fluctuaciones observadas son óptimas.
- Políticas de estabilización no se justifican.

Calibración

- How should we judge how well a real-business-cycle model fits the data?

- One common approach is calibration (Kydland and Prescott, 1982). The basic idea of calibration is to choose parameter values on the basis of microeconomic evidence and then to compare the model's predictions concerning the variances and covariances of various series with those in the data.

- Calibration has two potential advantages over estimating models econometrically. First, because parameter values are selected on the basis of microeconomic evidence, a large body of information beyond that usually employed can be brought to bear, and the models can therefore be held to a higher standard. Second, the economic importance of a statistical rejection, or lack of rejection, of a model is often hard to interpret.

Midiendo shocks tecnológicos

- One way to measure technological progress was suggested by Solow (Solow residual).

- Suppose the production function is of the form:

$$Y = F(K, N, A)$$

- A is the index of technological level, and enters the production function without restrictions. We want to measure the contribution of A to Y . Differentiate and rearrange to get:

Midiendo shocks tecnológicos

$$\frac{dY}{Y} = \frac{F_K K}{Y}\frac{dK}{K} + \frac{F_N N}{Y}\frac{dN}{N} + \frac{F_A A}{Y}\frac{dA}{A}$$

- Suppose now that ¯rms price according to marginal cost. Then,

$$\frac{dY}{Y} = \frac{RK}{PY}\frac{dK}{K} + \frac{WN}{PY}\frac{dN}{N} + \frac{F_A A}{Y}\frac{dA}{A}$$

- Define the Solow residual as $S \equiv (F_A A/Y)(dA/A)$. Let α_K be the share of capital costs in output, and α_N be the share of labor costs in output.

Midiendo shocks tecnológicos

- Then,

$$S = \frac{dY}{Y} - \frac{dX}{X}$$

where

$$\frac{dX}{X} \equiv \alpha_K \frac{dK}{K} + \alpha_N \frac{dN}{N}$$

Midiendo el ciclo económico

- Lo que buscamos es descomponer una serie de tiempo $\{x_t\}_{t=0}^{\infty}$ en su componente tendencia $\{\tau_t^x\}_{t=0}^{\infty}$ y su componente ciclo $\{v_t\}_{t=0}^{\infty}$, con $x_t = \tau_t^x + v_t^x$.

- x_t es expresada en logaritmo natural: $x_t = \ln X_t$.

- Recuerde que $\ln(1+y) \approx y$ cuando y es pequeño.

Midiendo el ciclo económico

- De lo anterior tenemos que si el ciclo económico no es muy grande:

$$v_t^x = x_t - \tau_t^x = \ln X_t - \ln T_t^X = \ln\left(1 + \left(\frac{X_t}{T_t^X} - 1\right)\right)$$
$$\approx \frac{X_t - T_t^X}{T_t^X}$$

- Que es la desviación proporcional con respecto a la tendencia de la serie.

- El ciclo es medido como la desviación porcentual de la variable de interés (PIB por ejemplo) de su valor de tendencia y por lo tanto es comparable a través de distintas series.

Midiendo el ciclo económico: filtro Hodrick-Prescott

- Sobre una muestra $[0, N]$, la tendencia HP $\{\tau_t^X\}_{t=0}^N$ es la solución al siguiente problema:

$$\min_{\{\tau_t^X\}_{t=0}^N} \sum_{t=0}^{N} (x_t - \tau_t^X)^2$$

Sujeto a

$$\sum_{t=1}^{N-1} [(\tau_{t+1}^X - \tau_t^X) - (\tau_t^X - \tau_{t-1}^X)]^2 \leq \mu$$

- Donde mientras más pequeño sea μ, más suave es la tendencia. Para las series de tiempo, μ es elegido de forma tal que el multiplicador de Lagrange (λ) de la restricción sea 1600 en datos trimestrales y 100 en datos anuales.

Midiendo el ciclo económico: filtro Hodrick-Prescott

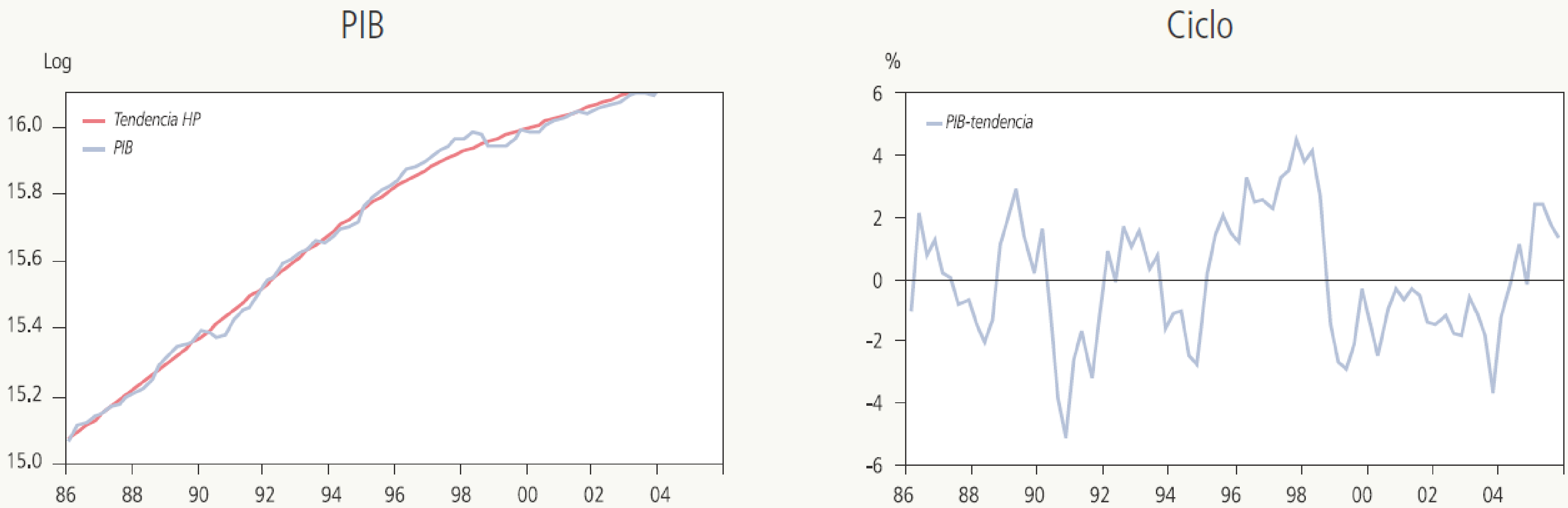
- Es importante notar que esta función penaliza torceduras en la serie τ_t^X y penaliza su distancia con la serie x_t.

- La importancia relativa de ambas penalizaciones es regulada por λ.

- Si $\lambda = 0$, $\tau_t^X = x_t$. Mientras que si $\lambda = \infty$, tenemos una tendencia lineal $(\tau_{t+1}^X - \tau_t^X) = (\tau_t^X - \tau_{t-1}^X)$.

GRÁFICO 5

Ciclo Económico de Chile, 1986-2005



Fuente: Elaboración propia en base a cifras del Banco Central de Chile.

Midiendo el ciclo económico: filtro Hodrick-Prescott

- Las principales críticas al filtro HP son que:
  - la tendencia encontrada es sensible a los puntos del comienzo y el fin de la muestra.
  - que el filtro tiende a amplificar los ciclos de períodos típicos y a suavizar fluctuaciones tanto de largo como de muy corto plazo.
  - que la elección del coeficiente λ es arbitraria.

Regularidades empíricas ciclo económico

TABLE 5.4 A calibrated real-business-cycle model versus actual data

	U.S. data	Baseline real-business-cycle model
σ_Y	1.92	1.30
σ_C/σ_Y	0.45	0.31
σ_I/σ_Y	2.78	3.15
σ_L/σ_Y	0.96	0.49
Corr$(L,Y/L)$	−0.14	0.93

Source: Hansen and Wright (1992).

RBC: Predicción versus evidencia empírica

- The model produces output fluctuations that are only moderately smaller than those observed in practice. This finding is the basis for Prescott’s (1986) famous conclusion that aggregate fluctuations are not just consistent with a competitive, neoclassical model, but are predicted by such a model.

- The second and third lines of the table show that both in the United States and in the model, consumption is considerably less volatile than output, and investment is considerably more volatile.

- The final two lines of the table show that the baseline model is less successful in its predictions about the contributions of variations in labor input and in output per unit of labor input to aggregate fluctuations.

- In the U.S. economy, labor input is nearly as volatile as output; in the model it is much less so. And in the United States, labor input and productivity are essentially uncorrelated; in the model they move together closely.

Table 1
Business Cycle Statistics for the U.S. Economy

	Standard Deviation	Relative Standard Deviation	First Order Auto-correlation	Contemporaneous Correlation with Output
Y	1.81	1.00	0.84	1.00
C	1.35	0.74	0.80	0.88
I	5.30	2.93	0.87	0.80
N	1.79	0.99	0.88	0.88
Y/N	1.02	0.56	0.74	0.55
w	0.68	0.38	0.66	0.12
r	0.30	0.16	0.60	-0.35
A	0.98	0.54	0.74	0.78

Source: King and Rebelo (1999)

Table 3
Business Cycle Statistics for Basic RBC Model[35]

	Standard Deviation	Relative Standard Deviation	First Order Auto-correlation	Contemporaneous Correlation with Output
Y	1.39	1.00	0.72	1.00
C	0.61	0.44	0.79	0.94
I	4.09	2.95	0.71	0.99
N	0.67	0.48	0.71	0.97
Y/N	0.75	0.54	0.76	0.98
w	0.75	0.54	0.76	0.98
r	0.05	0.04	0.71	0.95
A	0.94	0.68	0.72	1.00

Note: All variables have been logged (with the exception of the real interest rate)and detrended with the HP filter.

Source: King and Rebelo (1999)

RBC: Predicción versus evidencia empírica

- Volatilidad
  - El modelo explica cerca de un 70% de la volatilidad observada del producto.
  - Puede explicar la volatilidad relativa de consumo e inversión.
  - El consumo y las horas exhiben poca volatilidad respecto del producto.
- Persistencia
  - Explica la alta autocorrelación positiva.
- Patrones cíclicos
  - Explica la pro-ciclicidad del consumo, la inversión y las horas.
  - Limitación: predice una pro-ciclicidad alta de tasas de interés y salarios.
- Simulaciones
  - Bajo co-movimiento de las variables del mercado laboral.

Evaluación modelos RBC: dificultades

- There is strong evidence that monetary shocks have important real effects. This finding means more than just that baseline real-business-cycle models omit one source of output movements.

- A second difficulty concerns the technology shocks. The model posits technology shocks with a standard deviation of about 1 percent each quarter. It seems likely that such large technological innovations would often be readily apparent. Yet it is usually difficult to identify specific innovations associated with the large quarter-to-quarter swings in the Solow residual.

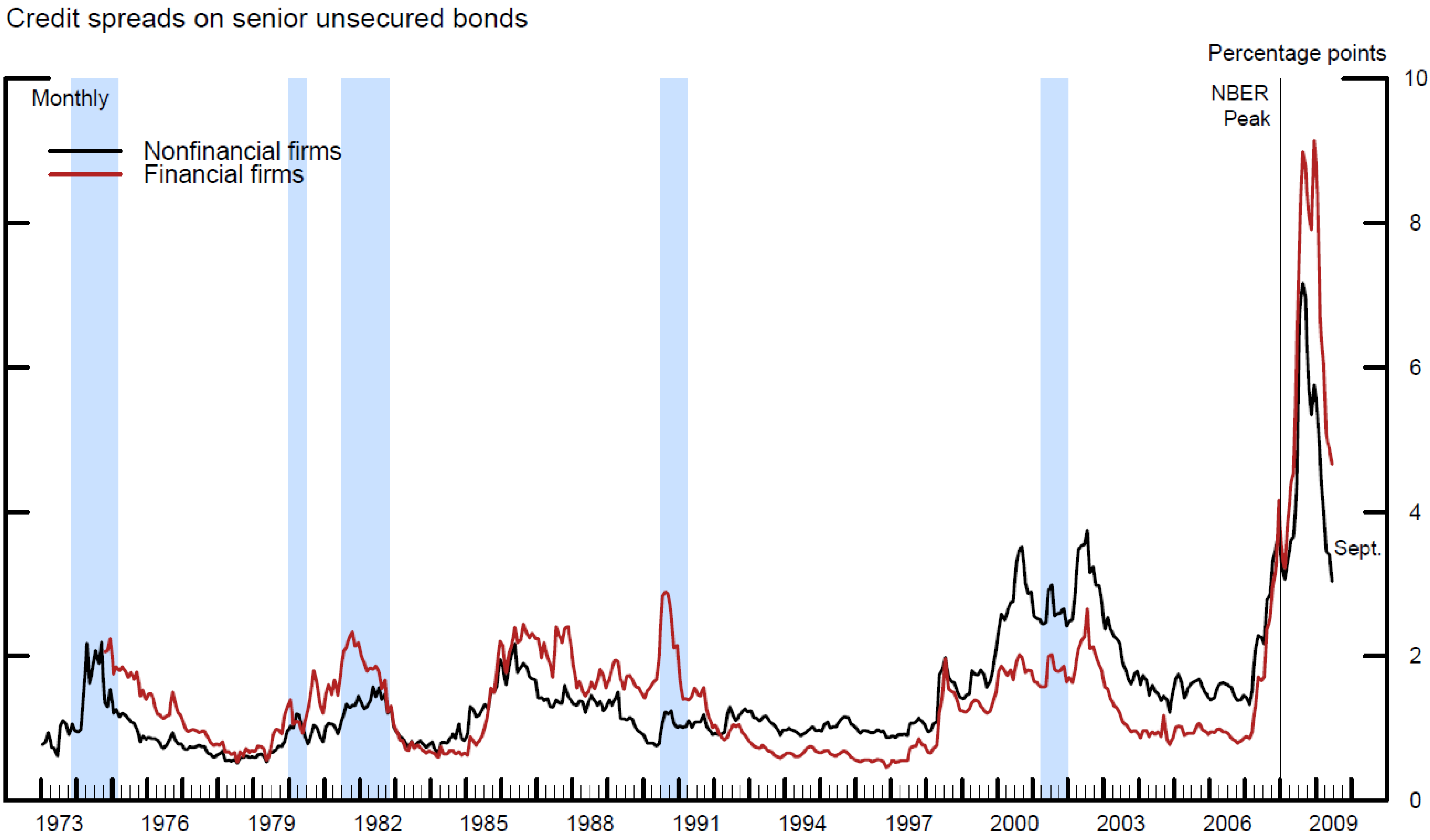
- Also, there is significant evidence that short-run variations in the Solow residual reflect more than changes in the pace of technological innovation. Great Depression.

Evaluación modelos RBC: dificultades

- These findings suggest that variations in the Solow residual may be a poor measure of technology shocks. Solow residual: increasing returns, increases in the intensity of capital and labor utilization, and the reallocation of inputs toward more productive firms.

- A third problem with the model concerns the effects of properly identified technology shocks. The general finding is that following a positive technology shock, labor input falls rather than rises (see Galí and Rabanal, 2004).

- A fourth difficulty concerns the microeconomic foundations of the model. There is strong direct evidence from the markets for goods, labor, and credit that those markets depart from the assumptions underlying the models of this chapter in ways that are potentially very relevant to aggregate fluctuations.


Credit spreads on senior unsecured bonds
Percentage points
Monthly
Nonfinancial firms
Financial firms
NBER
Peak
Sept.
10
8
6
4
2
0
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009