Potential Costs of Pollution Control and Energy Conservation in American State Economies

ABSTRACT

This study analyzes a model of American State economies with specifications for pollution control and energy conservation. The findings provide estimates of the fundamental conditions of state economic performance and technical requirements for development and growth in state economies. The factors posit basic relationships for explaining variation in state energy costs, energy consumption, and carbon emissions during the 2000 to 2014-period. In the model summary, the results demonstrate the importance of incentives and costs to any manipulation of basic conditions to attain greater energy conservation and reductions in pollution. The findings suggest any regulatory imposition or continuing stable evolution of strategies to plan for decreasing energy consumption and carbon emissions are likely to produce fewer jobs and higher unemployment rates of longer duration in The States. As a result, this state level analysis implies decentralization may generate some improvements and provide for more cost effective solutions in conservation and pollution control. Even so, the costs may be substantial and require more from labor markets, in terms of maintaining employment levels, jobs creation, and rates of adjustment for reducing unemployment.

STUDY FINDINGS

- The model estimates are consistent with Cobb-Douglas coefficients indicating a 2/3-1/3 division of labor and capital input to the valuation of Gross State Product.
- Income or wealth development is estimated as a one-to-one relationship with the valuation of State production, with the negative intercept implying some gap between potential and actual valuation in Gross State Product.
- State energy costs are estimated as a one-to-one relationship with development in state economies as measured by the valuation of Gross State Product. The positive intercept estimated implies some minimal levels of development autonomous from energy cost expenditures.
- Any reduction in state energy costs implies increases in long-run valuation of GSP.
- Any reductions in state energy cost expenditures imply strong declines in the short-run valuation of GSP.
- Changes in state energy cost expenditures are consistent with 2/3-1/3 effects on labor and capital market conditions.
- The valuation of Gross State Product is strongly and positively related to State Energy Consumption.
- The negative intercept estimated, in the State Energy Consumption model, indicated less developed and lower income areas have both a lower *and* differential rate of energy consumption.
- State Energy Consumption is strongly and positively related to State Personal Income.
- State Energy Consumption is a one-to-one relationship with Wealth Development controlling for the marginally significant negative effects of Savings in Bank Deposits and a cost index of the valuation of Housing—in real estate inflation. Greater investment savings and increasing costs of housing marginally decrease energy consumption.
- State Energy Consumption is strongly and positive related to State Energy Cost-Expenditures: increasing rates of energy consumption produce increasing energy costs.
- Minimization of state energy expenditures generates potential savings in energy conservation by reduction in rates of consumption.
- State rates of Carbon Emissions are strongly and positively related to State Energy Consumption.
- Carbon Emissions from energy use are estimated to have a one-to-one relationship with levels of State Energy Consumption.
- Any reduction in State Energy Consumption, through conservation, indicates significant potential for reductions in levels of State Carbon Emissions, for the 2000-2013 data.
- Any changes in energy consumption imply significant changes in carbon emissions based on rates of energy use.
- Direct reductions in carbon emission levels imply significant potential for cleaner use of energy.
- State Carbon Emissions are strongly and positively related to valuation of Gross State Production.
- Any impositions of pollution control on state economies are likely to generate significant costs in valuation of Gross State Product.
- For each one percentage increase in GSP (state development) there is 3/4% increase estimated in State Carbon Emissions.
- Measurable state carbon emission levels are strongly and positive related to the number of jobs in state economies and marginally negatively related to the value of State Banking Deposits.
- Any imposition of costs to reduce emissions levels is likely to generate declining numbers of employed and therefore rates of job creation.
- State savings rates, measurable by the proportion of value of State Banking Deposits available for investment, indicate future consumption and therefore are not related to increasing rates of carbon emissions.
- State rates of Energy Consumption are estimated to have a one-to-one relationship with the Number Employed in State economies.
- Any changes in energy consumption or the employment base in state economies determine both changes in labor markets, such as rates of unemployment and job creation, and any potential for savings from declining rates of energy consumption.

- State Banking Deposits are marginally and negatively related to State Energy Consumption suggesting banking deposits provide for savings and future investment in state economies that are unrelated to current rates' of energy consumption.
- State Energy Costs are significantly and positively determined by the Number Employed in State economies, State Banking Deposits, and a House cost index that controls for either the effects of inflation or the cost of living in different States.
- Minimization of Energy Costs or Cost-Expenditures is therefore likely to produce reductions in the number of employment or number of jobs in state economies, decreases in savings and decisions to pay for increasing costs of energy, and increases in costs of living and therefore inflation for investment in housing and real estate development.
- Inflationary effects are consistent with the estimation of a State Phillips Curve (coefficient = -.430).
- GSP growth rate effects are consistent with the estimation of Okun's Law (coefficient = -.254).
- GSP share effects are consistent with an Interstate Competition Hypothesis, with any change in the relative size of a State's economy exhibiting increasing returns (coefficient = .140).
- Disequilibrium effects from adjustments in State Unemployment Rates reveal stability in the rates of adjustment by the State Phillips Curve and Okun's Law relationships, and interstate competition to attain increasing returns.
- Disequilibrium effects in State Unemployment Rates also indicate stability in the rates of adjustment, and significant positive effects from any changes in rates of jobs creation, savings, and energy cost-minimization.

THE MODEL

- EQ1 Cobb-Douglas Production Model:
  Gross State Product by Number Employed & State Banking Deposits
  Valuation of Gross State Product, Jobs Report, Savings

- EQ2 Equilibrium Condition: State Personal Income and Gross State Product

- EQ3 Cost Function: Gross State Product by Energy Cost-Expenditures

- EQ4 Consumption Function: State Energy Consumption Function by Gross State Product

- EQ5 Consumption Function, Income, Savings, Real Estate Value:
  State Energy Consumption by Personal Income, Banking Deposits, & House Prices
  - 5A Energy Consumption by Income
  - 5B Energy Consumption by Income, Deposits, & House Prices

- EQ6 Consumption-Cost Function = Expenditure Function:
  State Energy Consumption by Energy Cost-Expenditures

- EQ7 Pollution Control Model:
  State Energy-based Carbon Emissions by State Energy Consumption

- EQ8 Joint Product Model:
  State Energy-based Carbon Emissions by Gross State Product
  Production Function, Pollution Control Model

- EQ9 Joint Product Model:
  State Energy-based Carbon Emissions by Number Employed & State Banking Deposits
  Production Function, Pollution Control Model

- EQ10 Equilibrium Condition:
  State Energy Consumption by Number Employed & State Banking Deposits
  Energy Conservation Model

- EQ11 State Energy Cost-Expenditures by Number Employed, State Banking Deposits, & a House Price Value Index
  Energy Costs by Jobs, Savings, & House Prices
  Cost of Living Index = Expenditure Function, Energy Conservation Model

- EQ12 State Phillips Curve: State Unemployment Rate by Regional Inflation Rate

- EQ13 Okun's Law: State Unemployment Rate by Gross State Product Growth Rate

- EQ14 Interstate Competition: Unemployment Rate by State Share of Gross Domestic Product
  GSP Share = relative size of the State economy

- EQ15 Disequilibrium Adjustment Model of State Unemployment Rates:
  Change in Unemployment Rate by Inflation Rate, Unemployment Rate, Growth, & Share

- EQ16 Disequilibrium Adjustment in Unemployment Rates with Energy Costs:
  Change in Unemployment Rate by Unemployment Rate, Job Creation, Savings, & Energy Costs

RESEARCH DESIGN

Sources

Bureau of Economic Analysis (BEA).

Bureau of Labor Statistics (BLS).

Department of Energy (DOE).

United States Energy Information Administration (October 2015) Report: Energy-Related Carbon Emissions at the State Level, 2000-2013.

Federal Deposit Insurance Corporation (FDIC).

Bob Hall and Mary Lee Kerr. 1991-1992. The Green Index: A State-by-State Guide to the Nation's Environmental Health, 1991. Island Press.

Renew America. 1988. Reducing the Rate of Global Warming: The States' Role.

Time Series Data

House Prices, 2000-2012.
Gross State Product, 1994-2012.
Personal Income, 1994-2012.
Bank Deposits, 1994-2015.
State Energy Consumption, 2000, 2005, 2010.
Carbon Emissions, 2000-2013.
Regional CPI, 1994-2013.
State Unemployment Rate, 1994-2013.

Variable Definitions

Jobs = number of employees or size of state workforce = Labor supply
Deposits = Banking Deposits by States = Capital supply
GSP = Gross State Product
Y = Personal Income
Ecost = State Energy Cost
Econs = State Energy Consumption
Hprice = Housing Prices
Carbon = Carbon Emissions
Irate = Inflation rate change = change in Regional Consumer Price Index
Urate = State Unemployment Rate
Growth = change in Gross State Product
Share = State Share of Total Gross State Product

MODEL SUMMARY

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ1	.972	.945	.945	.2455

Predictors: (Constant), LN(DEPOSIT), LN(JOBS)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ2	.996	.993	.993	.0924

Predictors: (Constant), LN(GSP)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ3	.945	.893	.893	.3441

Predictors: (Constant), LN(ECOST)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ4	.909	.826	.825	.3988

Predictors: (Constant), LN(GSP)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ5A	.903	.815	.814	.4111
EQ5B	.913	.834	.831	.3919

a Predictors: (Constant), LN(Y)
b Predictors: (Constant), LN(Y), HPRICE, LN(DEPOSIT)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ6	.929	.864	.863	.3635

Predictors: (Constant), LN(ECOST)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ7	.948	.899	.898	.3331

Predictors: (Constant), LN(ECONS)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ8	.812	.660	.659	.5609

Predictors: (Constant), LN(GSP)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ9	.812	.659	.655	.6143

Predictors: (Constant), LN(DEPOSIT), LN(JOBS)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ10	.927	.860	.858	.3698

Predictors: (Constant), LN(DEPOSIT), LN(JOBS)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ11	.923	.852	.849	.3922

Predictors: (Constant), HPRICE, LN(DEPOSIT), LN(JOBS)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ12	.208	.043	.042	1.9278

Predictors: (Constant), INFLATION RATE

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
EQ13	.413	.170	.169	1.7269
EQ14	.448	.201	.199	1.6962
EQ12-14	.472	.223	.221	1.6729

a Predictors: (Constant), GROWTH
b Predictors: (Constant), GROWTH, SHARE
c Predictors: (Constant), GROWTH, SHARE, INFLATION RATE

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.186	.034	.033	1.0653
2	.230	.053	.051	1.0557
3	.292	.085	.082	1.0382
EQ15	.299	.090	.085	1.0362

a Predictors: (Constant), URATE
b Predictors: (Constant), URATE, IRATE
c Predictors: (Constant), URATE, IRATE, GROWTH
d Predictors: (Constant), URATE, IRATE, GROWTH, SHARE

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.653	.426	.423	.6336
2	.702	.492	.482	.6003
EQ16	.733	.537	.524	.5753

a Predictors: (Constant), URATE
b Predictors: (Constant), URATE, LN(JOBS), LN(DEPOSIT)
c Predictors: (Constant), URATE, LN(JOBS), LN(DEPOSIT), LN(ECOST)

MODEL ESTIMATION

EQUATION 1	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	10.309	.179		57.613	.000	9.956	10.662
LN(JOBS)	.717	.033	.681	21.489	.000	.652	.783
LN(DEPOSITS)	.303	.030	.324	10.234	.000	.244	.361

a Dependent Variable: LN(GSP)

EQUATION 2	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	-.408	.053		-7.745	.000	-.511	-.305
LN(GSP)	1.013	.003	.996	359.635	.000	1.007	1.018

a Dependent Variable: LN(Y)

EQUATION 3	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	9.313	.270		34.441	.000	8.779	9.847
LN(ECOST)	1.007	.029	.945	35.192	.000	.950	1.063

a Dependent Variable: LN(GSP)

EQUATION 4	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	-8.336	.585		-14.241	.000	-9.493	-7.179
LN(GSP)	.825	.031	.909	26.512	.000	.764	.887

a Dependent Variable: LN(ECONS)

EQUATION 5	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	-7.884	.590		-13.369	.000	-9.050	-6.719
LN(Y)	.809	.032	.903	25.549	.000	.746	.871
(Constant)	-9.007	.743		-12.115	.000	-10.476	-7.538
LN(Y)	1.017	.072	1.135	14.052	.000	.874	1.160
LN(DEPOSITS)	-.219	.069	-.255	-3.154	.002	-.355	-.082
HPRICE	-.00177	.001	-.080	-2.376	.019	-.003	.000

a Dependent Variable: LN(ECONS)

EQUATION 6	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	-1.345	.275		-4.885	.000	-1.890	-.801
LN(ECOST)	.904	.029	.929	30.915	.000	.846	.962

a Dependent Variable: LN(ECONS)

EQUATION 7	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	-2.905	.198		-14.671	.000	-3.296	-2.514
LN(ECONS)	1.010	.028	.948	36.645	.000	.955	1.064

a Dependent Variable: LN(CARBON)

EQUATION 8	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	-9.756	.398		-24.521	.000	-10.538	-8.975
LN(GSP)	.749	.021	.812	35.458	.000	.707	.790

a Dependent Variable: LN(CARBON)

EQUATION 9	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	-1.224	.443		-2.765	.006	-2.096	-.351
LN(JOBS)	.988	.083	.938	11.868	.000	.823	1.152
LN(DEPOSITS)	-.143	.074	-.153	-1.934	.055	-.288	.003

a Dependent Variable: LN(CARBON)

EQUATION 10	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	1.344	.317		4.243	.000	.718	1.970
LN(JOBS)	1.053	.063	1.085	16.625	.000	.928	1.178
LN(DEPOSITS)	-.161	.057	-.183	-2.804	.006	-.274	-.048

a Dependent Variable: LN(ECONS)

EQUATION 11	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	1.844	.351		5.257	.000	1.151	2.537
LN(JOBS)	.799	.070	.800	11.475	.000	.661	.936
LN(DEPOSITS)	.127	.063	.140	2.024	.045	.003	.251
HPRICE	.02067	.001	.094	2.872	.005	.001	.003

a Dependent Variable: LN(ECOST)

EQUATION 12	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	6.639	.162		40.875	.000	6.320	6.957
IRATE	-.430	.064	-.208	-6.717	.000	-.555	-.304

a Dependent Variable: URATE

EQUATION 13 & 14	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	6.653	.114		58.538	.000	6.430	6.876
GROWTH	-.254	.019	-.413	-13.196	.000	-.292	-.216
(Constant)	6.367	.123		51.962	.000	6.126	6.607
GROWTH	-.253	.019	-.411	-13.363	.000	-.290	-.215
SHARE	.139	.025	.174	5.654	.000	.091	.188
(Constant)	6.980	.173		40.445	.000	6.641	7.319
GROWTH	-.233	.019	-.379	-12.231	.000	-.270	-.196
SHARE	.141	.024	.175	5.779	.000	.093	.188
IRATE	-.297	.060	-.154	-4.974	.000	-.413	-.180

a Dependent Variable: URATE

EQUATION 15	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	.692	.110		6.299	.000	.477	.908
URATE	-.106	.019	-.186	-5.504	.000	-.144	-.068
(Constant)	1.162	.159		7.319	.000	.850	1.473
URATE	-.125	.020	-.218	-6.343	.000	-.163	-.086
IRATE	-.154	.038	-.140	-4.065	.000	-.228	-.080
(Constant)	1.687	.183		9.196	.000	1.327	2.047
URATE	-.168	.021	-.294	-8.047	.000	-.209	-.127
IRATE	-.128	.037	-.116	-3.419	.001	-.202	-.055
GROWTH	-.070	.013	-.198	-5.451	.000	-.095	-.045
(Constant)	1.686	.183		9.206	.000	1.326	2.045
URATE	-.177	.021	-.309	-8.310	.000	-.219	-.135
IRATE	-.131	.037	-.119	-3.509	.000	-.205	-.058
GROWTH	-.071	.013	-.203	-5.580	.000	-.097	-.046
SHARE	.032	.015	.069	2.063	.039	.002	.062

a Dependent Variable: URATEDIF = First Difference Annual Change in the Rate of Unemployment

EQUATION 16	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	1.053	.132		7.989	.000	.793	1.314
URATE	-.220	.021	-.653	-10.490	.000	-.262	-.179
(Constant)	1.338	.526		2.544	.012	.298	2.378
URATE	-.205	.021	-.607	-9.541	.000	-.247	-.163
LN(JOBS)	.449	.106	.543	4.222	.000	.239	.659
LN(DEPOSITS)	-.326	.100	-.435	-3.264	.001	-.523	-.129
(Constant)	2.711	.624		4.348	.000	1.479	3.944
URATE	-.160	.024	-.475	-6.725	.000	-.207	-.113
LN(JOBS)	.892	.156	1.078	5.711	.000	.583	1.200
LN(DEPOSITS)	-.313	.096	-.418	-3.271	.001	-.502	-.124
LN(ECOST)	-.527	.141	-.623	-3.741	.000	-.806	-.249

a Dependent Variable: URATEDIF = First Difference Annual Change in the Rate of Unemployment

Analysis of State Economic Relationships

State Phillips Curve

State Unemployment Rate = change in Regional Consumer Price Index

Irate = P(Urate)

$\Delta p = 8 - 2 \bullet U$

$U = 2$
$\Delta p = 8 - 2 \bullet 2$
$\Delta p = 4$

$U = 3$
$\Delta p = 8 - 2 \bullet 3$
$\Delta p = 2$

$U = 4$
$\Delta p = 8 - 2 \bullet 4$
$\Delta p = 0$

$U = 3$
$\Delta p = 2$
Misery Index = Unemployment Rate + Inflation Rate
$M = U + \Delta p$
$5 = 3 + 2$

$U = 4 - \frac{1}{2} \bullet \Delta p$

State Okun's Law

$\Delta U = .30 - .300 \cdot \Delta q$
$\Delta q = 1 - 3.333 \cdot \Delta U$
$\Delta q = .856 - 1.827 \cdot \Delta U$
-3
-2
$\Delta q = 1 - 3.000 \cdot \Delta U$
$\Delta q = 1 - 2.000 \cdot \Delta U$

Martin Prachowny estimated about a 3% decrease in output for every 1% increase in the unemployment rate.

According to Andrew Abel and Ben Bernanke, estimates based on data from more recent years give about a 2% decrease in output for every 1% increase in unemployment (Abel and Bernanke, 2005).

$(q - q_t) / q_t = - c \cdot (U - U_0)$.

q is actual output
q_t is potential GDP
U is actual unemployment rate
U_0 is the natural rate of unemployment

$\Delta q/q = k - c\Delta U$

Δq is the change in actual output from one year to the next
ΔU is the change in actual unemployment from one year to the next
k is the average annual growth rate of full employment output

$\Delta q/q = .03 - 2\Delta U$

$\Delta U = - 0.4 \cdot (\Delta q - 2.5)$
$\Delta q = 2.5 - (2.5 \cdot \Delta U)$
$\Delta U = 1 - (0.4 \cdot \Delta q)$

ΔU is the change in the unemployment rate in percentage points.
Δq is the percentage growth rate in real output, as measured by real GNP.

Pareto Distribution Model

$\Delta q = \alpha \bullet U^{-1}$

$dq = A \bullet \alpha \bullet U^{-\alpha + 1}\, dU$
$\alpha > 0$
$\alpha < 2 \Rightarrow$ no variance
$\alpha < 1 \Rightarrow$ no mean
tail of distribution $U \rightarrow \infty$

$\Delta q = \alpha \bullet U^{-\beta}$

$\Delta q = U^{\beta}$

$\log(\Delta q) = U_0 - 3 \bullet \log(U)$

$U = \Delta q^{1/\beta}$
$\beta < -1$
$\beta > 1$
$\Delta q > 0$

$u = \Delta q^{1/\beta}$
$\log(U) = (1/\beta) \bullet \log(\Delta q)$
$\log(U) = \alpha - .333 \bullet \log(\Delta q)$

$\Delta q = U^{\beta}$
$1/\beta < -1$
$1/\beta > 1$
$U > 0$
$\log(\Delta q) = \beta \bullet \log(U)$
$\log(\Delta q) = U_0 - 3 \bullet \log(U)$

$\beta = \log(\Delta q) / \log(U)$
$[-1 \bullet \log(U)] / \log(\Delta q) \neq 0$
$q > 0$
$q \neq 0$

Simulation Results

$\log(\Delta q) = \underline{\alpha} - \beta \bullet \log(U)$
$\log(\Delta q) = U_0 - 4 \bullet \log(U)$
$\log(\Delta q) = U_0 - 3 \bullet \log(U)$
$\log(\Delta q) = U_0 - 2 \bullet \log(U)$
$\log(\Delta q) = U_0 - 1 \bullet \log(U)$
$\log(U) = \underline{g} - (1/\beta) \bullet \log(\Delta q)$
$\log(U) = \underline{g} - (1/4) \bullet \log(\Delta q)$
$\log(U) = \underline{g} - (1/3) \bullet \log(\Delta q)$
$\log(U) = \underline{g} - (1/2) \bullet \log(\Delta q)$
$\log(U) = \underline{g} - 1 \bullet \log(\Delta q)$

State Phillips Curve and Okun's Law Relationship

Misery Index
$M = U + \Delta p$
$\Delta q = \alpha - (\beta \bullet \Delta q)$

State Unemployment Rate by changes in GSP and Regional CPI

$U = \alpha - (\beta \bullet \Delta q) - (\kappa \bullet \Delta p)$
$U = \alpha - (1/3 \bullet \Delta q) - (.5 \bullet \Delta p)$
$\Delta q = (3 \bullet \alpha) - (3 \bullet U) - (1.5 \bullet \Delta p)$
$\Delta p = (2 \bullet \alpha) - (2 \bullet U) - (.667 \bullet \Delta q)$
$\alpha = U + (1/3 \bullet \Delta q) + (½ \bullet \Delta p)$

$U = \alpha - (1/3 \bullet \Delta q) - (.15 \bullet \Delta p)$
$\Delta q = (3 \bullet \alpha) - (3 \bullet U) - (.45 \bullet \Delta p)$
$\Delta p = (6.667 \bullet \alpha) - (6.667 \bullet U) - (2.222 \bullet \Delta q)$
$\alpha = U + (.333 \bullet \Delta q) + (.150 \bullet \Delta p)$

A DIAGRAMMATIC EXPOSITION

FIGURE 1.0

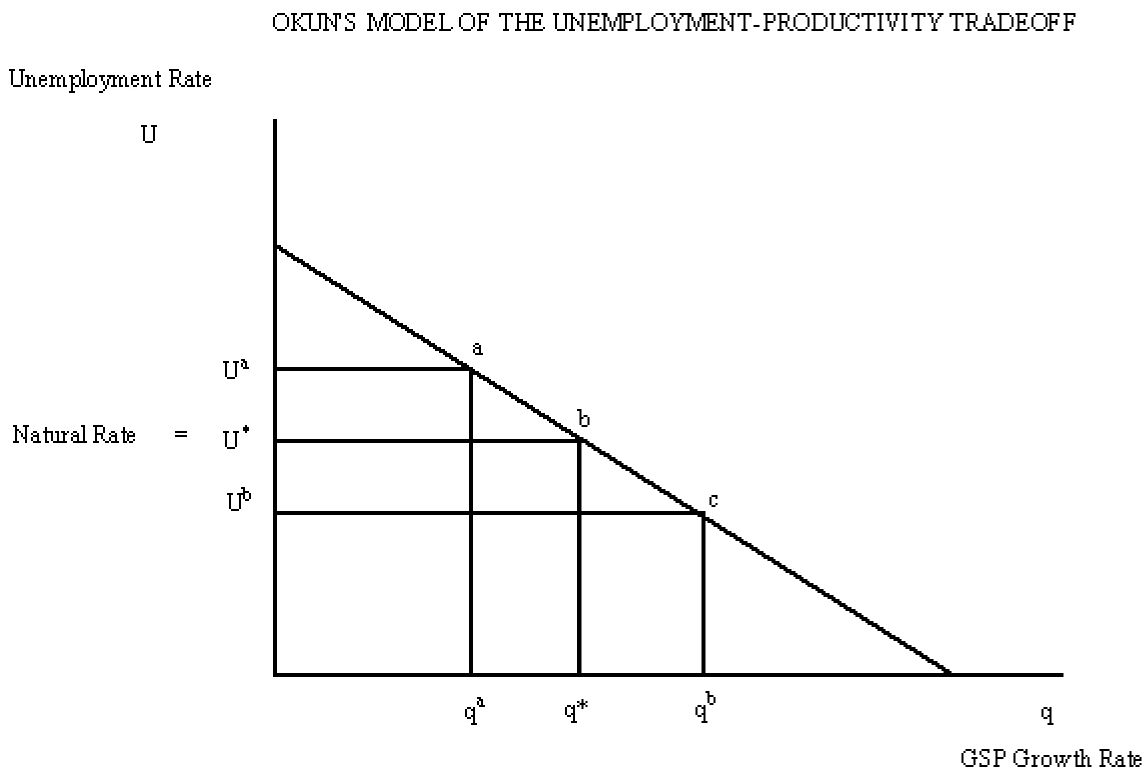
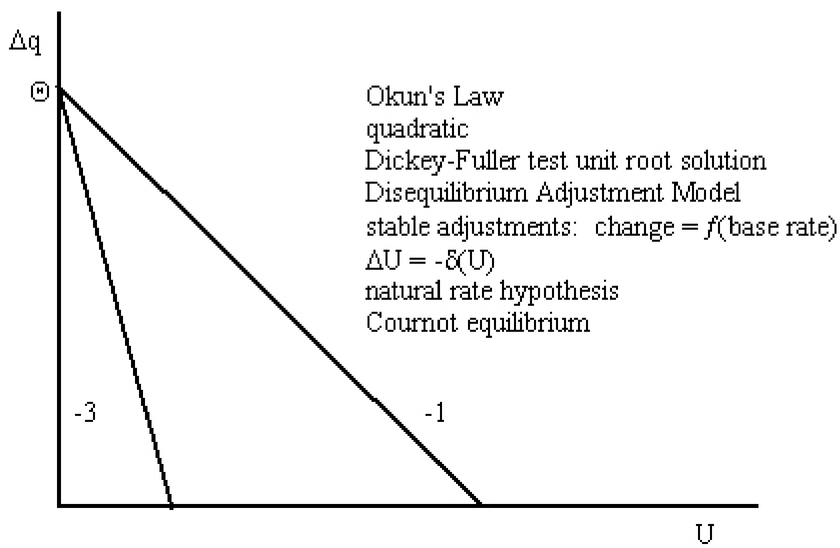


FIGURE 2.0



Δq
Θ
Okun's Law
quadratic
Dickey-Fuller test unit root solution
Disequilibrium Adjustment Model
stable adjustments: change = f(base rate)
ΔU = -δ(U)
natural rate hypothesis
Cournot equilibrium
-3
-1
U

FIGURE 3.0

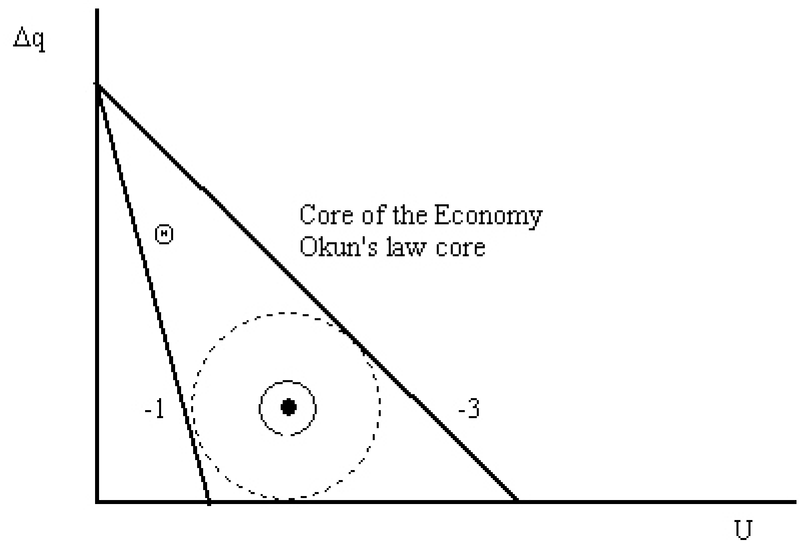
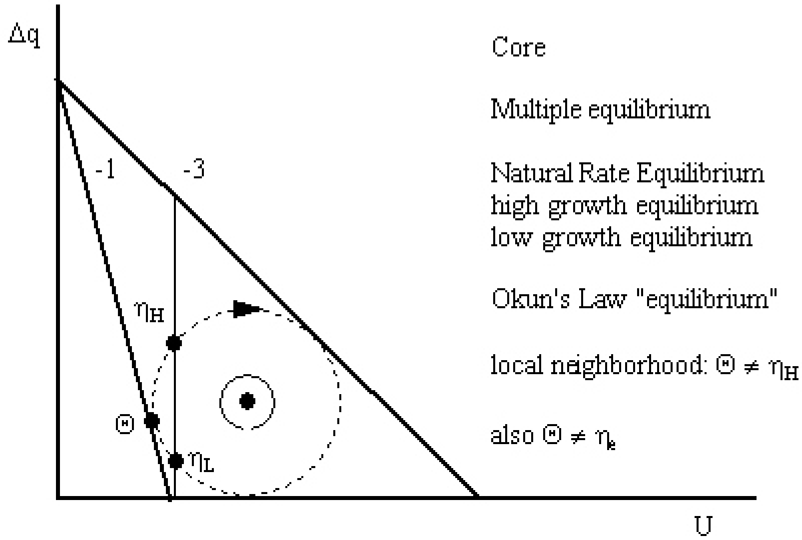
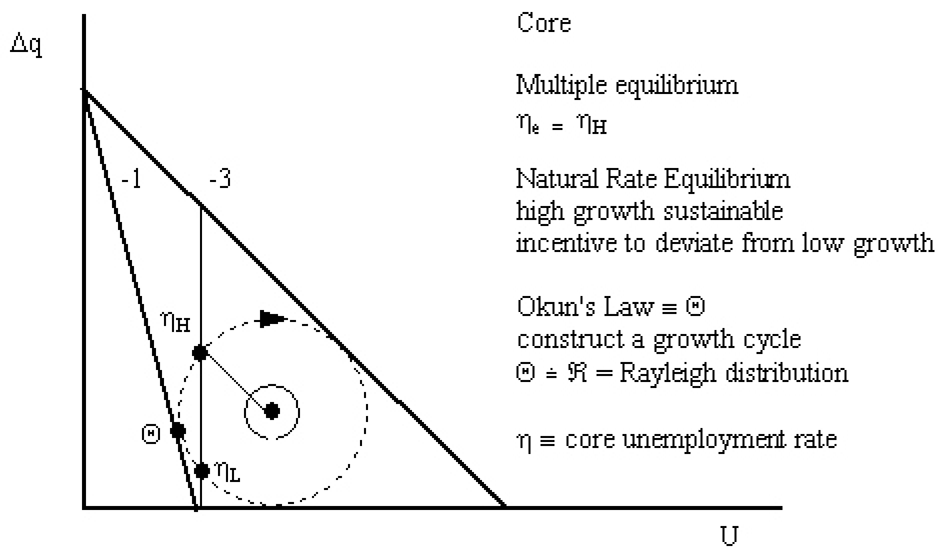


FIGURE 4.0



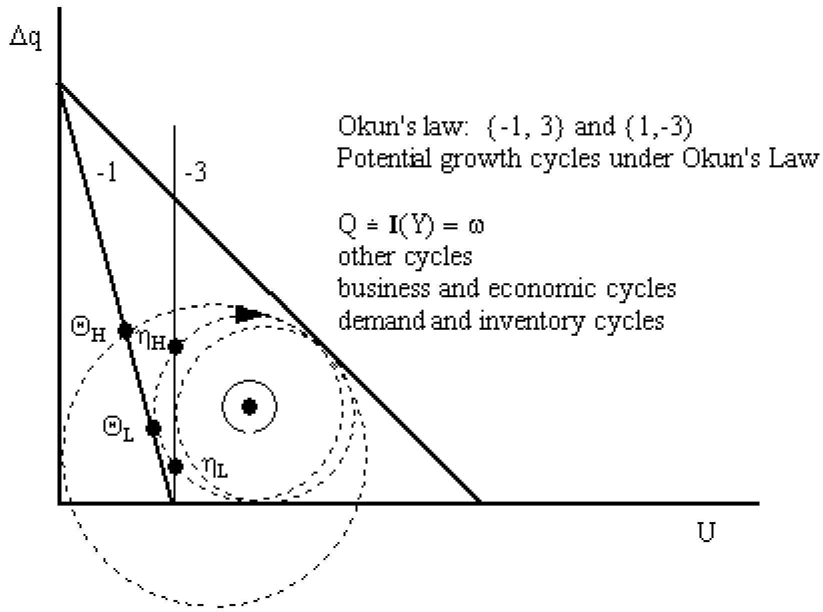
Δq
-1
-3
ηH
Θ
ηL
U
Core
Multiple equilibrium
Natural Rate Equilibrium
high growth equilibrium
low growth equilibrium
Okun's Law "equilibrium"
local neighborhood: Θ ≠ ηH
also Θ ≠ ηk

FIGURE 5.0



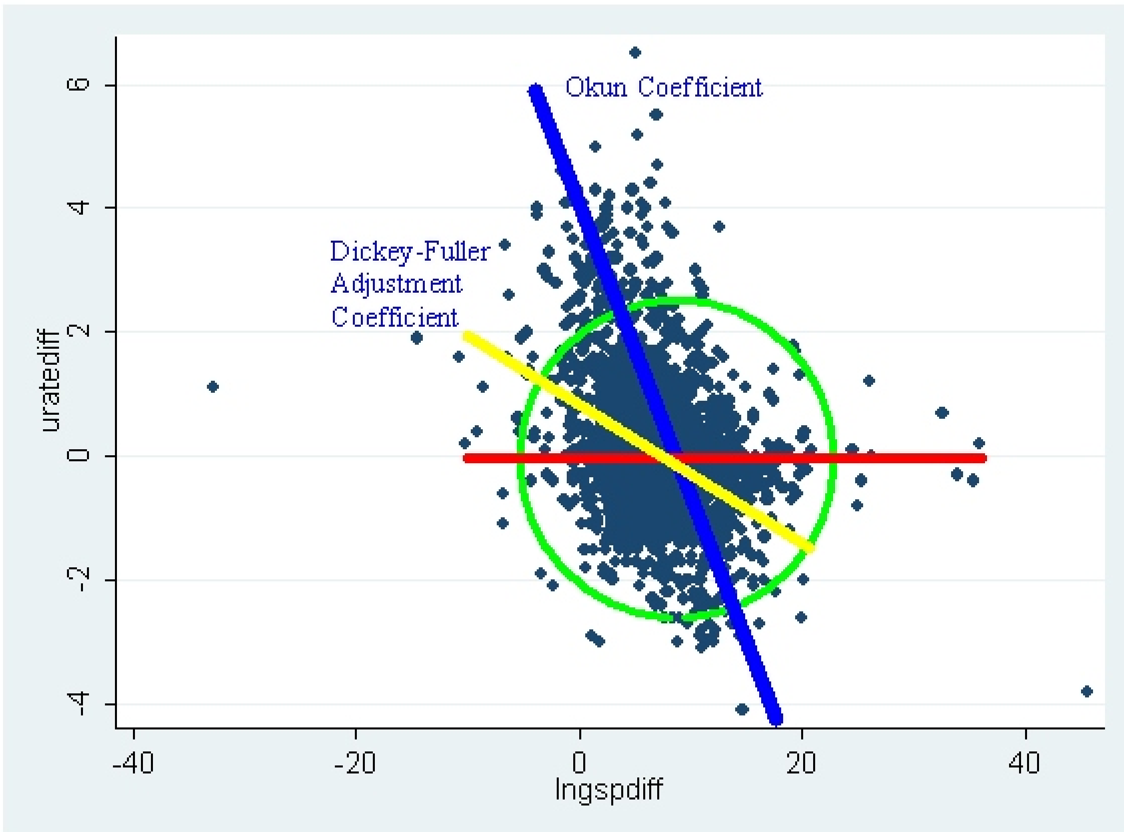
Δq
-1
-3
ηH
Θ
ηL
U
Core
Multiple equilibrium
ηe = ηH
Natural Rate Equilibrium
high growth sustainable
incentive to deviate from low growth
Okun's Law ≡ Θ
construct a growth cycle
Θ ≐ ℜ = Rayleigh distribution
η ≡ core unemployment rate

FIGURE 6.0



Δq
-1
-3
Okun's law: {-1, 3} and {1,-3}
Potential growth cycles under Okun's Law
Q ≐ I(Y) = ω
other cycles
business and economic cycles
demand and inventory cycles
ΘH
ηH
ΘL
ηL
U

FIGURE 7.0



Okun Coefficient
Dickey-Fuller
Adjustment
Coefficient
uratediff
lngspdiff
6
4
2
0
-2
-4
-40
-20
0
20
40

FIGURE 8.0

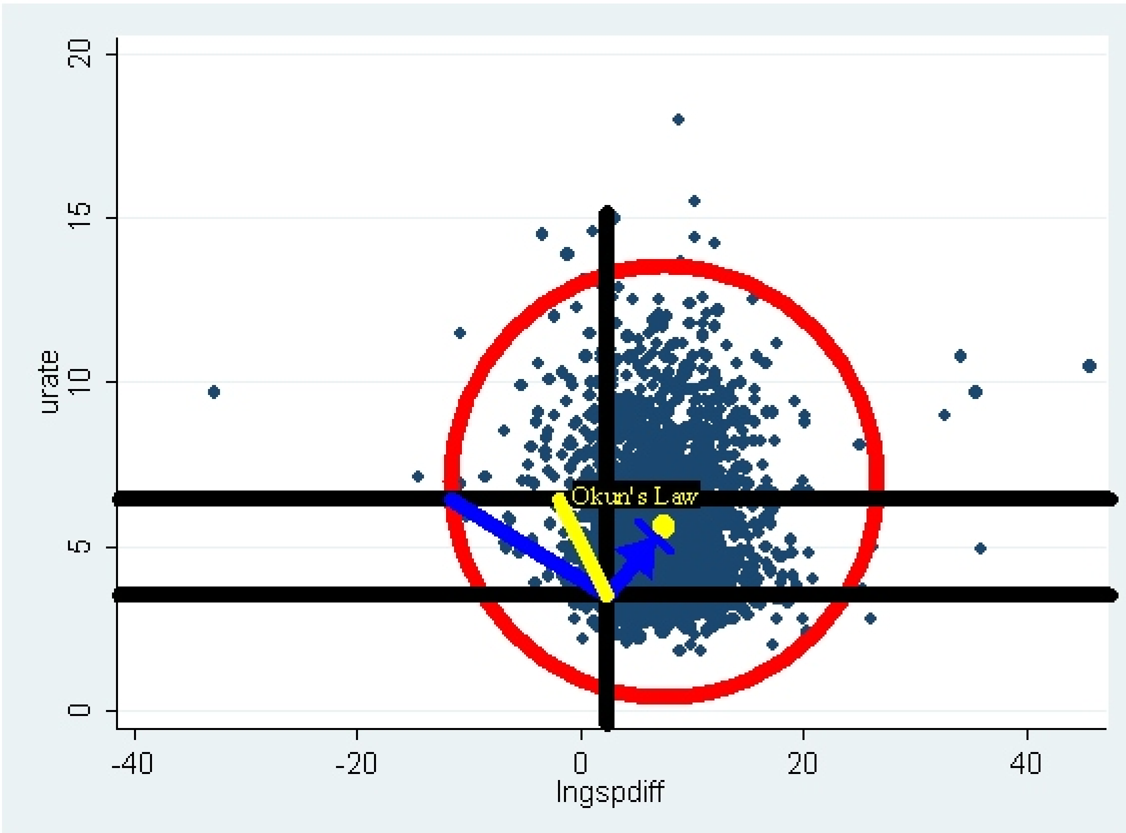
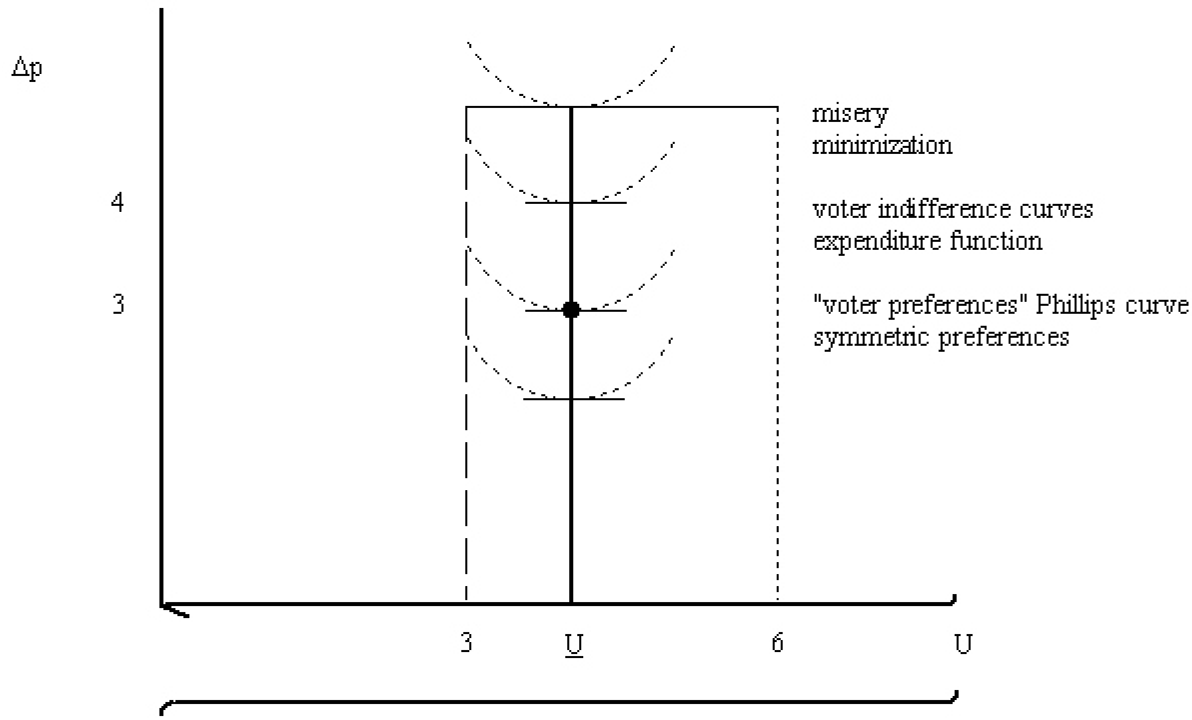


FIGURE 9.0



Δp
4
3
misery
minimization
voter indifference curves
expenditure function
"voter preferences" Phillips curve
symmetric preferences
3
U
6
U

FIGURE 10.0

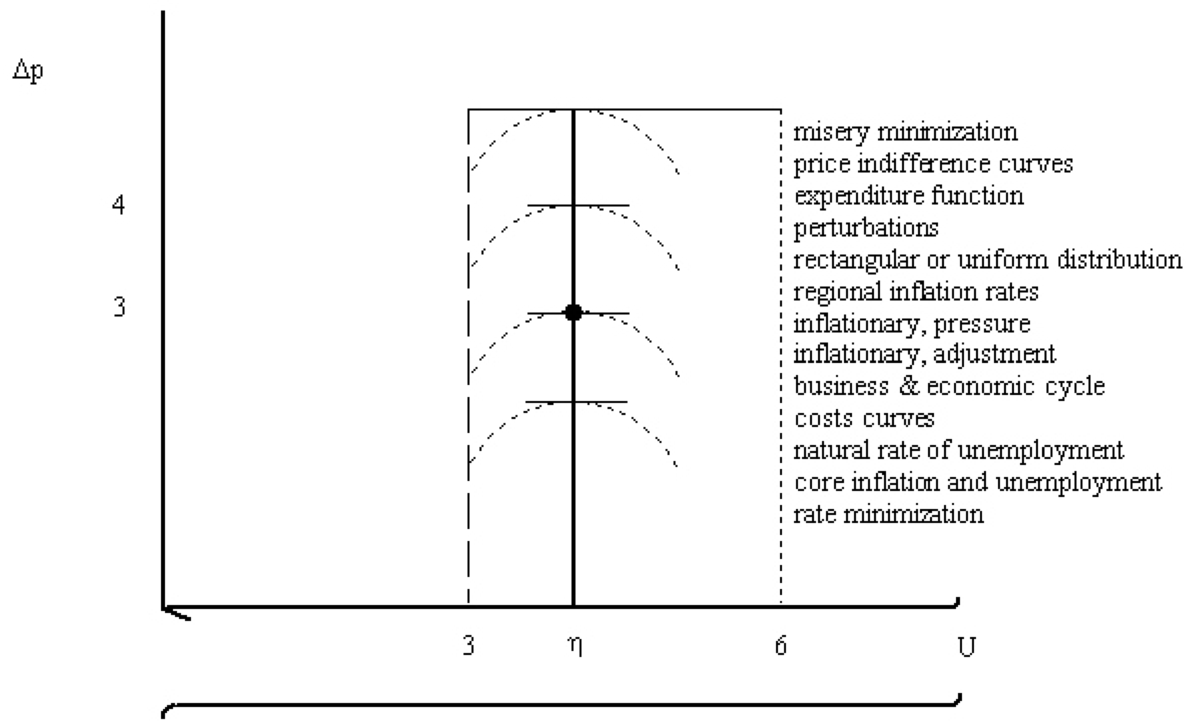
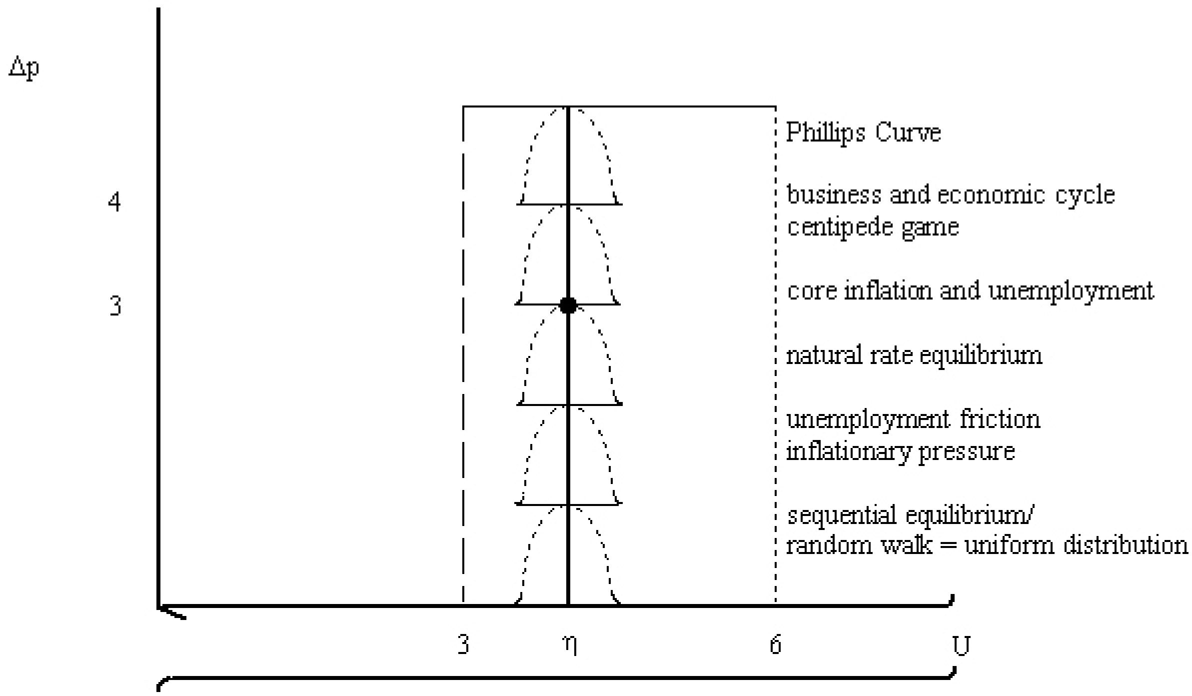

Δp
4
3
misery minimization
price indifference curves
expenditure function
perturbations
rectangular or uniform distribution
regional inflation rates
inflationary, pressure
inflationary, adjustment
business & economic cycle
costs curves
natural rate of unemployment
core inflation and unemployment
rate minimization
3
η
6
U

FIGURE 11.0



Δp
4
3
Phillips Curve
business and economic cycle
centipede game
core inflation and unemployment
natural rate equilibrium
unemployment friction
inflationary pressure
sequential equilibrium/
random walk = uniform distribution
3
η
6
U

FIGURE 12.0

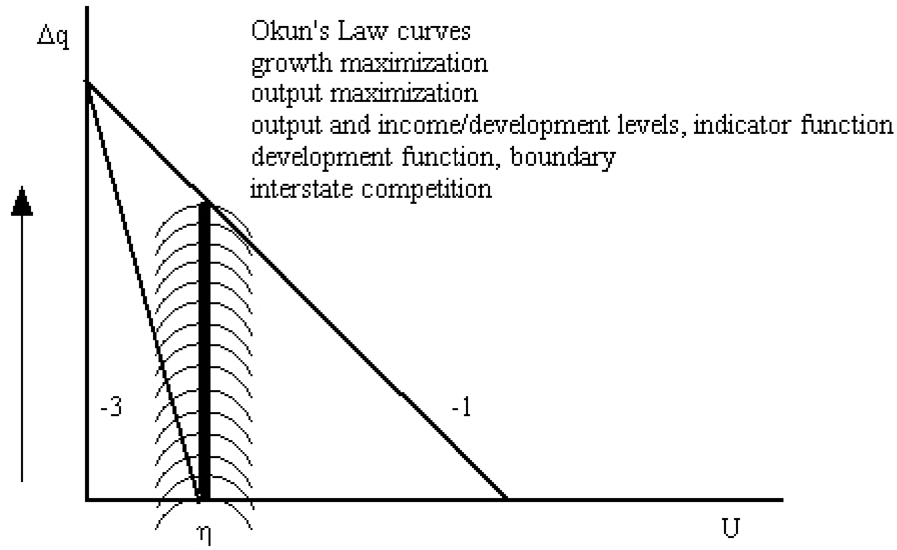

Δq
Okun's Law curves
growth maximization
output maximization
output and income/development levels, indicator function
development function, boundary
interstate competition
-3
-1
η
U

FIGURE 13.0

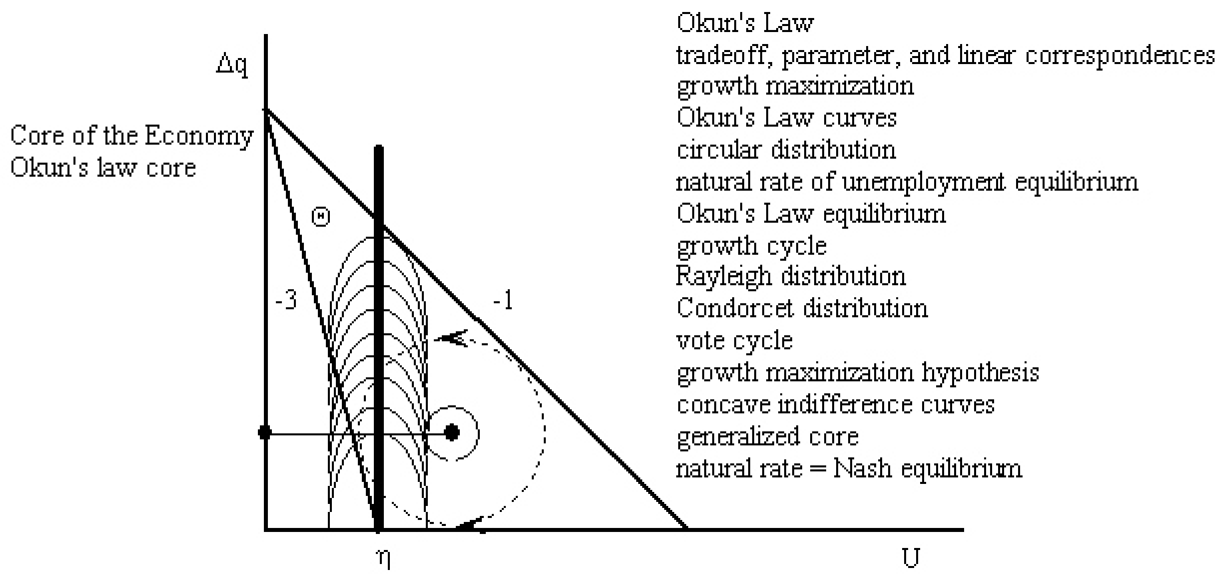

Okun's Law
tradeoff, parameter, and linear correspondences
growth maximization
Okun's Law curves
circular distribution
natural rate of unemployment equilibrium
Okun's Law equilibrium
growth cycle
Rayleigh distribution
Condorcet distribution
vote cycle
growth maximization hypothesis
concave indifference curves
generalized core
natural rate = Nash equilibrium
Δq
Core of the Economy
Okun's law core
Θ
-3
-1
η
U

FIGURE 14.0

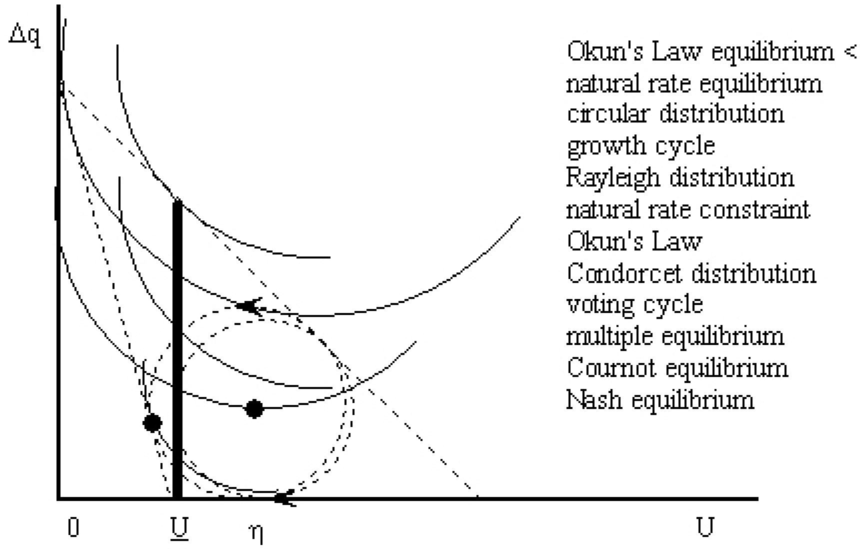
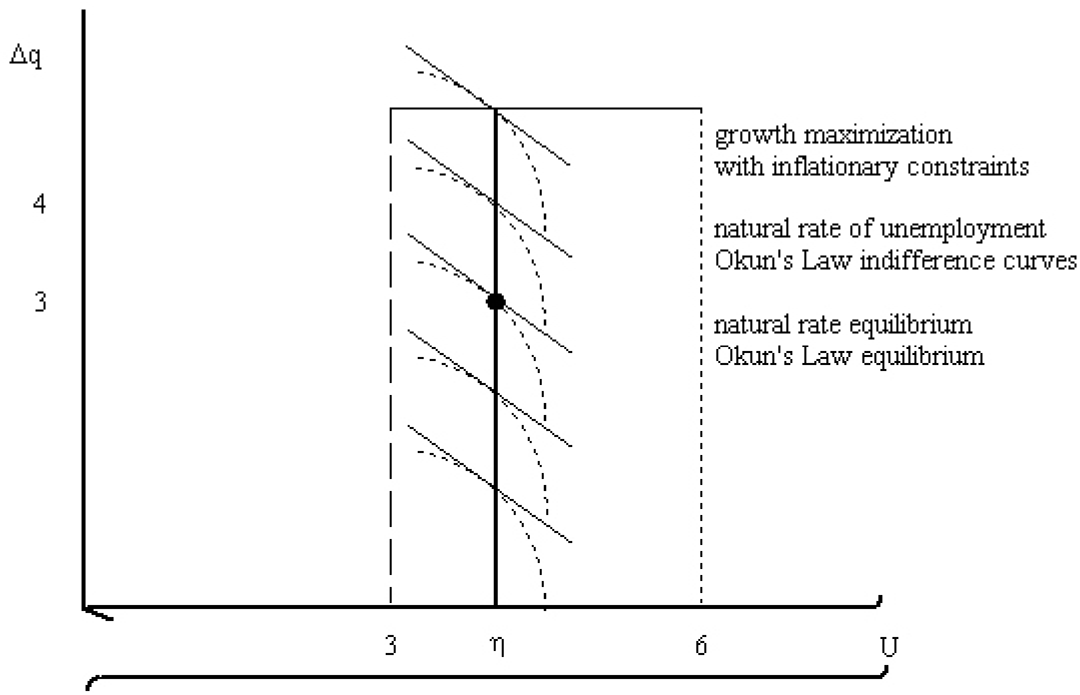

Δq
0
U
η
U
Okun's Law equilibrium <
natural rate equilibrium
circular distribution
growth cycle
Rayleigh distribution
natural rate constraint
Okun's Law
Condorcet distribution
voting cycle
multiple equilibrium
Cournot equilibrium
Nash equilibrium

FIGURE 15.0



Δq
4
3
growth maximization
with inflationary constraints
natural rate of unemployment
Okun's Law indifference curves
natural rate equilibrium
Okun's Law equilibrium
3
η
6
U

FIGURE 16.0

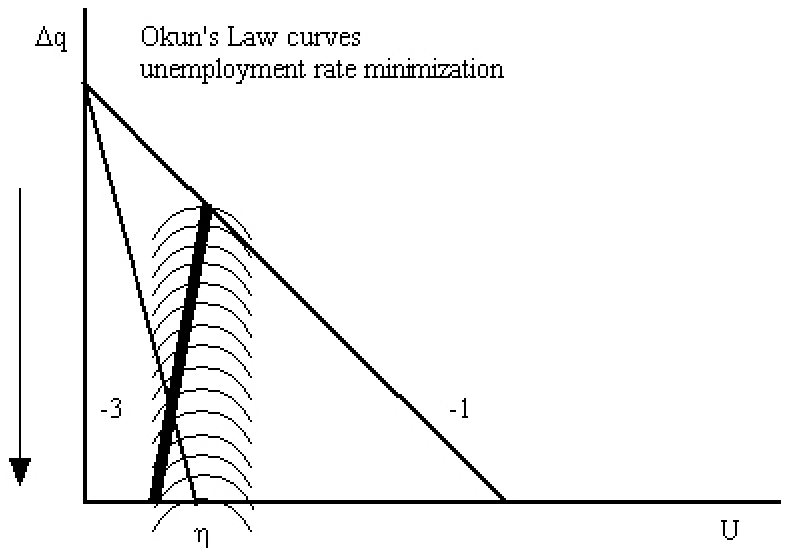
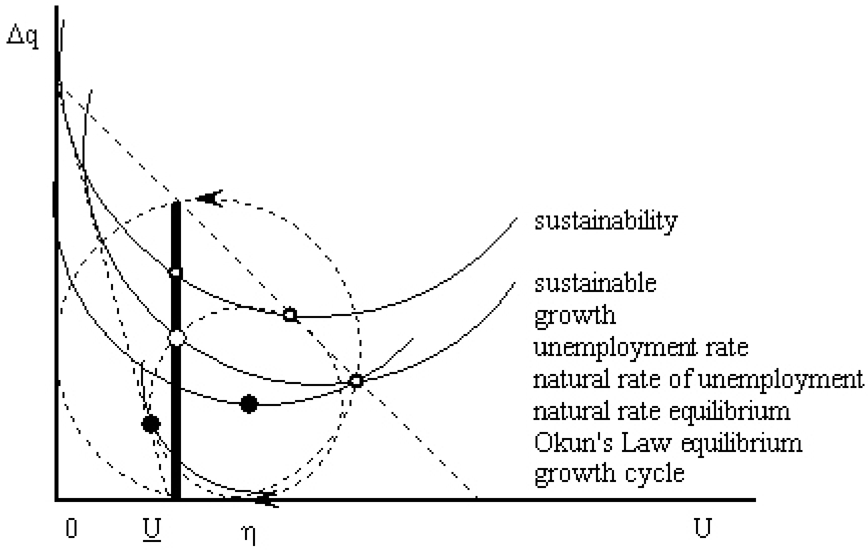
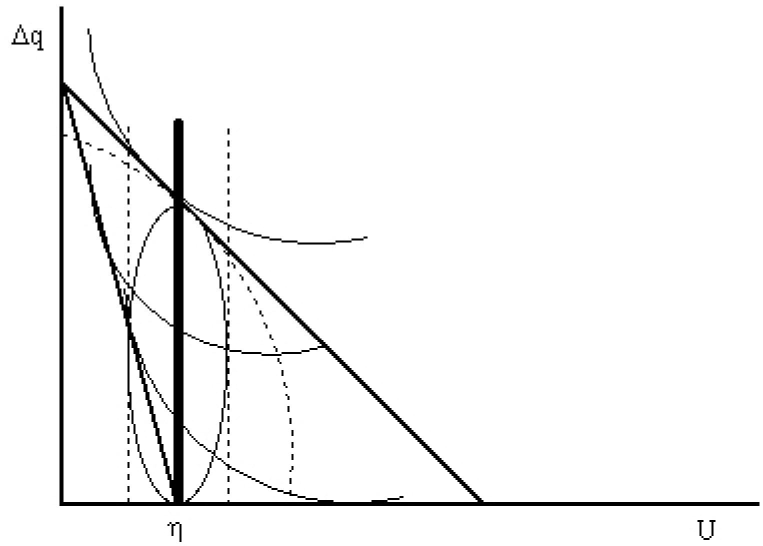


FIGURE 17.0



Δq
sustainability
sustainable
growth
unemployment rate
natural rate of unemployment
natural rate equilibrium
Okun's Law equilibrium
growth cycle
0
U
η
U

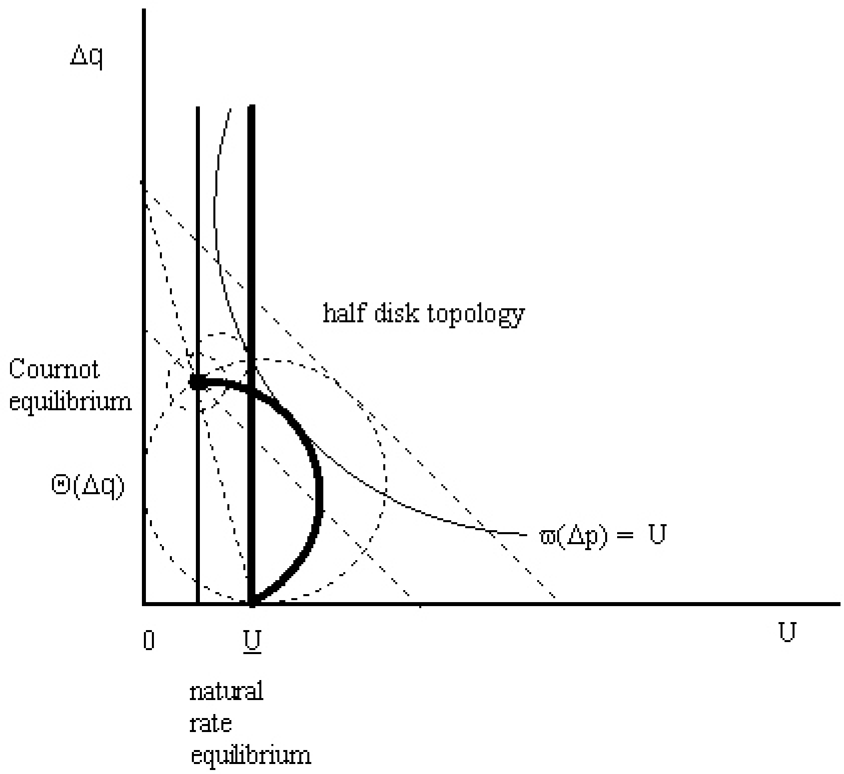
FIGURE 18.0



Okun's Law → natural rate hypothesis

sustainable growth

FIGURE 19.0



Δq
half disk topology
Cournot
equilibrium
Θ(Δq)
ϖ(Δp) = U
0
U
U
natural
rate
equilibrium