TABLE OF ALPHABETS

The transliterations shown are those used in the etymologies of this Dictionary. The names of the Hebrew and Greek letters are also entered and defined as English nouns. In some cases the English spelling is different from the transliterated spelling shown here, chiefly in the absence of diacritical marks. Thus the English word "omega" differs from the transliterated form *ōmega*. For individual histories of the English letters, see the opening page of each letter throughout the Dictionary.

HEBREW

Forms	Name	Sound
א	'aleph	'
ב	bēth	b (bh)
ג	gimel	g (gh)
ד	dāleth	d (dh)
ה	hē	h
ו	waw	w
ז	zayin	z
ח	ḥeth	ḥ
ט	ṭeth	ṭ
י	yodh	y
כ ך	kāph	k (kh)
ל	lāmedh	l
מ ם	mēm	m
נ ן	nūn	n
ס	samekh	s
ע	'ayin	'
פ ף	pē	p (ph)
צ ץ	ṣadhe	ṣ
ק	qōph	q
ר	rēsh	r
שׂ	sin	s
שׁ	shin	sh
ת	tāw	t (th)

Vowels are not represented in normal Hebrew writing, but for educational purposes they are indicated by a system of subscript and superscript dots. The transliterations shown in parentheses are used when the letter falls at the end of a word. The transliterations with subscript dots are pharyngeal consonants as in Arabic. The second forms shown are used when the letter falls at the end of a word.

ARABIC

Forms 1	2	3	4	Name	Sound
ا	ـا			'alif	'
ب	ـب	ـبـ	بـ	bā	b
ت	ـت	ـتـ	تـ	tā	t
ث	ـث	ـثـ	ثـ	thā	th
ج	ـج	ـجـ	جـ	jīm	j
ح	ـح	ـحـ	حـ	ḥā	ḥ
خ	ـخ	ـخـ	خـ	khā	kh
د	ـد			dāl	d
ذ	ـذ			dhāl	dh
ر	ـر			rā	r
ز	ـز			zāy	z
س	ـس	ـسـ	سـ	sīn	s
ش	ـش	ـشـ	شـ	shīn	sh
ص	ـص	ـصـ	صـ	ṣād	ṣ
ض	ـض	ـضـ	ضـ	ḍād	ḍ
ط	ـط	ـطـ	طـ	ṭā	ṭ
ظ	ـظ	ـظـ	ظـ	ẓā	ẓ
ع	ـع	ـعـ	عـ	'ayn	'
غ	ـغ	ـغـ	غـ	ghayn	gh
ف	ـف	ـفـ	فـ	fā	f
ق	ـق	ـقـ	قـ	qāf	q
ك	ـك	ـكـ	كـ	kāf	k
ل	ـل	ـلـ	لـ	lām	l
م	ـم	ـمـ	مـ	mīm	m
ن	ـن	ـنـ	نـ	nūn	n
ه	ـه	ـهـ	هـ	hā	h
و	ـو			wāw	w
ى	ـى	ـيـ	يـ	yā	y

The different forms in the four numbered columns are used when the letters are in: (1) isolation; (2) juncture with a previous letter; (3) juncture with the letters on both sides; (4) juncture with a following letter.

Long vowels are represented by the consonants *'alif* (for ā), *wāw* (for ū), and *yā* (for ī). Short vowels are not usually written; they can, however, be indicated by the following signs: ◌َ *fatha* (for a), ◌ِ *kasra* (for i), and ◌ُ *damma* (for u).

Transliterations with subscript dots represent "emphatic" or pharyngeal consonants, which are pronounced in the usual way except that the pharynx is tightly narrowed during articulation. When two dots are placed over the *hā*, the new letter thus formed is called *tā marbūta*, and is pronounced (t).

There are several other diacritical marks indicating such situations as the doubling of a consonant or the elision of a vowel.

GREEK

Forms	Name	Sound
Α α	alpha	a
Β β	beta	b
Γ γ	gamma	g (n)
Δ δ	delta	d
Ε ε	epsilon	e
Ζ ζ	zēta	z
Η η	ēta	ē
Θ θ	thēta	th
Ι ι	iota	i
Κ κ	kappa	k
Λ λ	lambda	l
Μ μ	mu	m
Ν ν	nu	n
Ξ ξ	xi	x
Ο ο	omicron	o
Π π	pi	p
Ρ ρ	rhō	r (rh)
Σ σ ς	sigma	s
Τ τ	tau	t
Υ υ	upsilon	u
Φ φ	phi	ph
Χ χ	khi	kh
Ψ ψ	psi	ps
Ω ω	ōmega	ō

The superscript ʽ on an initial vowel or *rhō*, called the rough breathing, represents an aspirate. Lack of aspiration on an initial vowel is indicated by the superscript ʼ, called the smooth breathing. When *gamma* precedes *kappa*, *xi*, *khi*, or another *gamma*, it has the value *n* and is so transliterated. The second lowercase form of *sigma* is used only in final position.

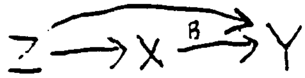
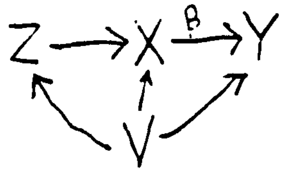
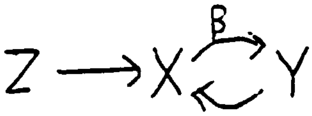
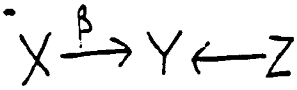
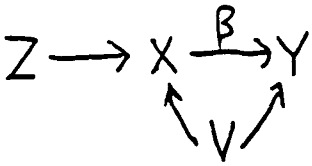
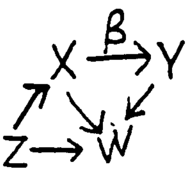
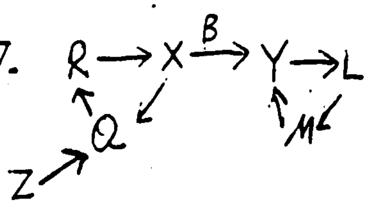
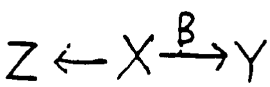
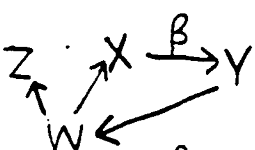
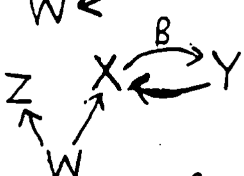
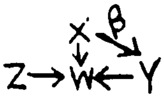
RUSSIAN

Forms	Sound
А а	a
Б б	b
В в	v
Г г	g
Д д	d
Е е	e
Ж ж	zh
З з	z
И и Й й	i, ĭ
К к	k
Л л	l
М м	m
Н н	n
О о	o
П п	p
Р р	r
С с	s
Т т	t
У у	u
Ф ф	f
Х х	kh
Ц ц	ts
Ч ч	ch
Ш ш	sh
Щ щ	shch
Ъ ъ	″[1]
Ы ы	y
Ь ь	′[2]
Э э	e
Ю ю	yu
Я я	ya

[1] This letter, called the "hard sign," is very rare in modern Russian. It indicates that the previous consonant remains hard even when followed by a front vowel.

[2] This letter, called the "soft sign," indicates that the previous consonant is palatalized even when a front vowel does not follow.

Arrow Diagram Exercise

	OLS OK?	IV OK?
1. 		
2. 		
3. 		
4. 		
5. 		
6. 		
7. 		
8. 		
9. 		
10. 		
11. 		

Answers on Reverse Side (Don't Look Until You Have Tried Yourself

This Side Up

ANSWERS

	OLS OK?	IV OK?	
1	N	N	
2	N	N	
3	N	Y	
4	Y	N	(Cov(Z,X) = 0)
5	N	Y	
6	Y	Y	(but OLS is more efficient)
7	Y	Y	(" " " " ")
8	Y	Y	(" " " " ")
9	N	N	
10	N	Y	
11	Y	N	(Cov(Z,X) = 0)

I. Is the real interest rate r constant?

A. Underlying Equation:

$$i_t = r + \pi_{t+1}^{e(t)} \quad \text{(Fisher Equation)}$$

B. Making the RX surprise ε_{t+1} explicit

$$i_t = r + \pi_{t+1} - \varepsilon_{t+1}$$

C. Possible regressions. Which one is unbiased?

1. $i_t = \alpha + \beta \pi_{t+1} + e_{t+1}$
2. $\pi_{t+1} = \alpha + \beta i_t + e_{t+1}$

D. What should β be if r is constant?

II. Is the term premium p constant?

A. Underlying Equation:

$$i_{t,t+2} = \frac{i_{t,t+1} + i_{t+1,t+2}^{e(t)}}{2} + p \quad \text{(Expectations theory of the Term structure of Interest Rates)}$$

B. Making the RX surprise ε_{t+1} explicit

$$i_{t,t+2} = \frac{i_{t,t+1} + i_{t+1,t+2} - \varepsilon_{t+1}}{2} + p$$

C. Possible regressions. Which are unbiased?

1. $i_{t,t+2} = \alpha + \beta(i_{t,t+1} + i_{t+1,t+2}) + e_{t+1}$
2. $i_{t,t+1} = \alpha + \beta(2i_{t,t+2} - i_{t+1,t+2}) + e_{t+1}$
3. $i_{t+1,t+2} = \alpha + \beta(2i_{t,t+2} - i_{t,t+1}) + e_{t+1}$
4. $\underbrace{i_{t+1,t+2} - i_{t,t+1}}_{\Delta i_{t,t+1}} = \alpha + \beta \underbrace{(i_{t,t+2} - i_{t,t+1})}_{\text{spread}} + e_{t+1}$

   $\Delta i_{t,t+1} = \alpha + \beta\, \text{spread} + e_{t+1}$

III. Is full-employment output y^f constant?

A. Underlying Equation:

$$y_{t+1} = y^f + b(\pi_{t+1} - \pi_{t+1}^{e(t)}) \quad \text{(Lucas Supply Curve)}$$

B. Making the RX surprise ε_{t+1} explicit:

$$y_{t+1} = y^f + b\,\varepsilon_{t+1}$$

C. Possible Regressions:

1. $y_{t+1} = \alpha + \beta y_t + e_{t+1}$
2. $y_{t+1} = \alpha + \beta p_{\text{stock mkt}\,t} + e_{t+1}$
3. $y_{t+1} = \alpha + \beta m_t + e_{t+1}$

D. If the underlying Lucas-Rapping Supply Curve is true and y^f is constant, then given RX, β in C.1,2,3 should be ____. In the data, β in C.1,2,3 is ____.

IV. What is the elasticity of Intertemporal Substitution s?

A. Underlying Equations

1. $\ln c_t = \ln c_{t+1}^{e(t)} + \delta - s r_t$

   (δ: impatience; $s r_t$: substitution effect)
2. $i_t = r_t + \pi_{t+1}^{e(t)}$

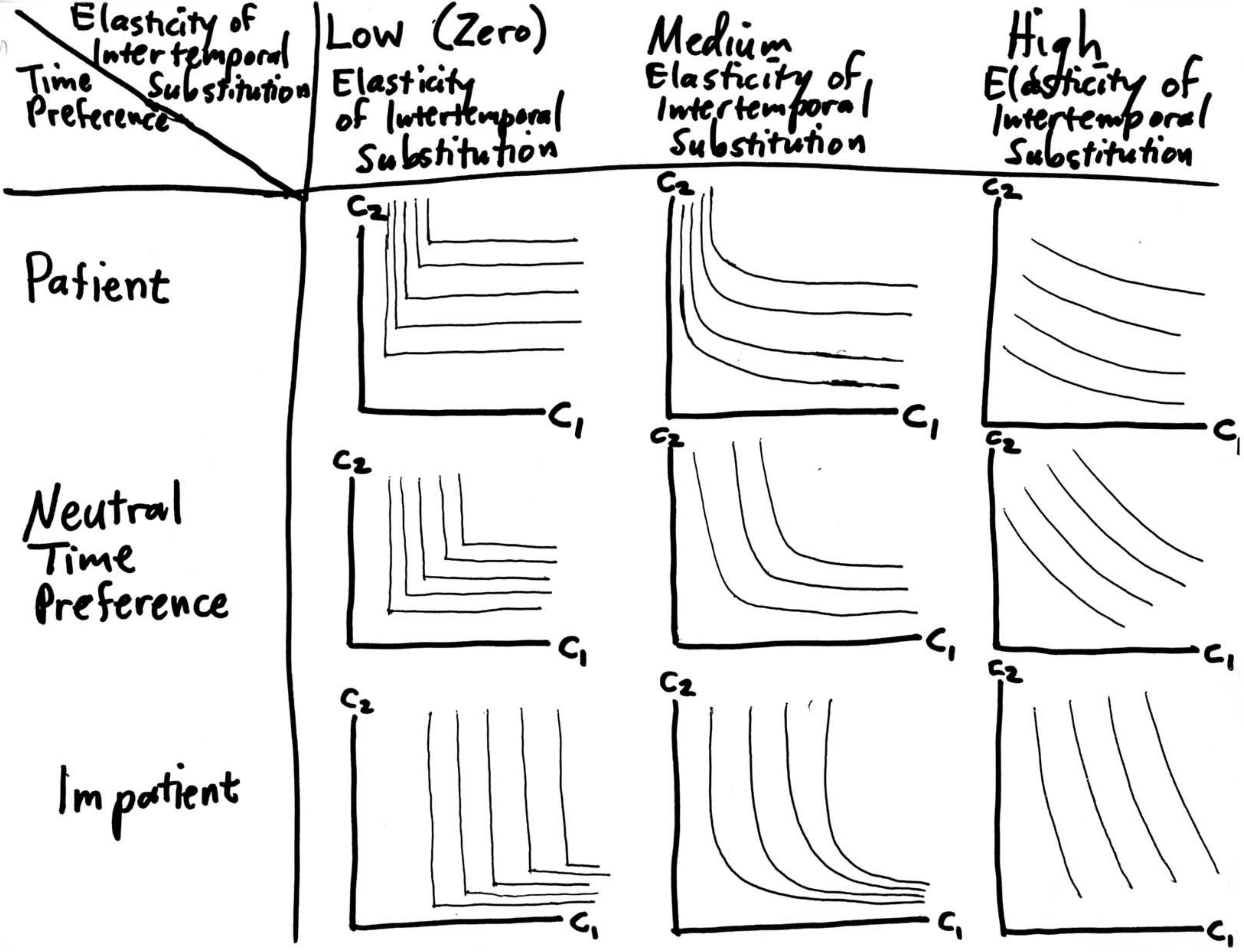
B. Making $\varepsilon_{t+1} = \ln c_{t+1} - \ln c_{t+1}^{e(t)}$ and $\nu_{t+1} = \pi_{t+1} - \pi_{t+1}^{e(t)}$ explicit:

$$\ln c_t = \ln c_{t+1} + \delta - s(i_t - \pi_{t+1}) - \varepsilon_{t+1} - s\nu_{t+1}$$

C. Possible Regressions. Which are (is) unbiased

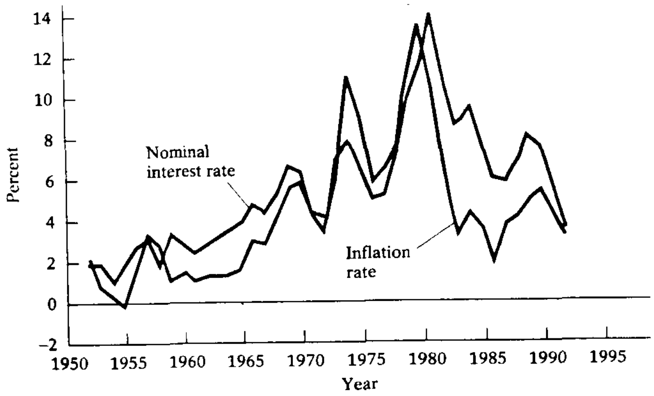
1. $(\ln c_{t+1} - \ln c_t) = \alpha + \beta(i_t - \pi_{t+1}) + e_{t+1}$ (OLS)
2. $(i_t - \pi_{t+1}) = \alpha + \beta(\ln c_{t+1} - \ln c_t) + e_{t+1}$ (OLS)
3. $\ln c_{t+1} - \ln c_t = \alpha + \beta(i_t - \pi_{t+1}) + e_{t+1}$
4. $(i_t - \pi_{t+1}) = \alpha + \beta(\ln c_{t+1} - \ln c_t) + e_{t+1}$

(3 and 4: IV using m_{t-1} as an instrument)


Elasticity of Intertemporal Substitution
Time Preference
Low (Zero) Elasticity of Intertemporal Substitution
Medium Elasticity of Intertemporal Substitution
High Elasticity of Intertemporal Substitution
Patient
Neutral Time Preference
Impatient
c_2
c_1

Fisher Equation: $i = r + \pi^e$.

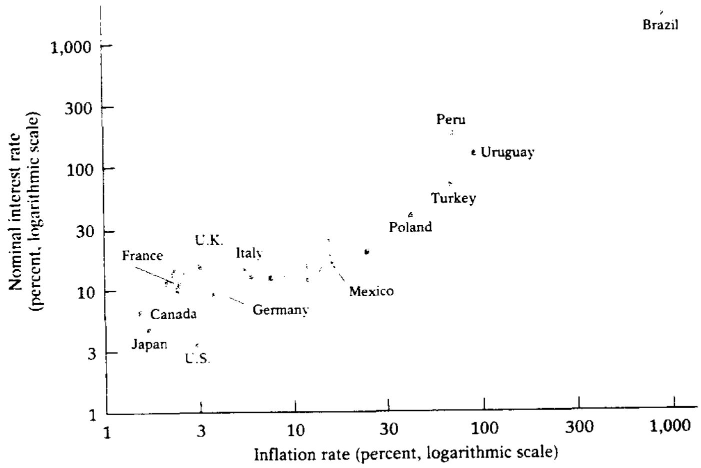
Figure 6-3



Inflation and Nominal Interest Rates Over Time This figure plots the nominal interest rate (on three-month Treasury bills) and the inflation rate (as measured by the CPI) in the United States since 1952. It shows the Fisher effect: higher inflation leads to a higher nominal interest rate.

Source: U.S. Department of Treasury and U.S. Department of Labor

Figure 6-4



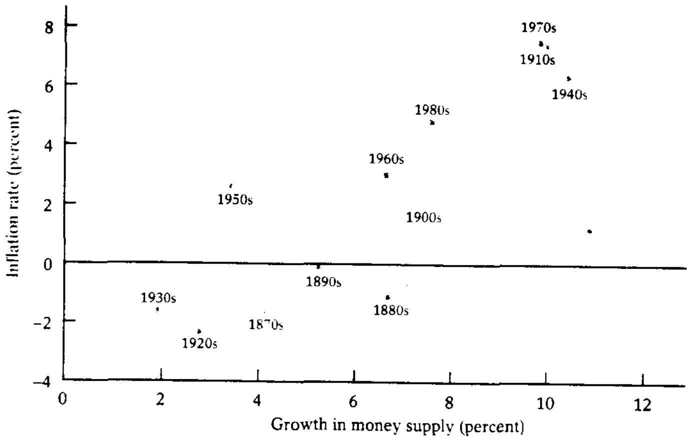
Inflation and Nominal Interest Rates Across Countries This scatterplot exhibits the three-month nominal interest rate and the inflation rate (during the previous year) in 28 countries in 1992. This figure also shows the positive correlation between the inflation rate and the nominal interest rate.

Source: International Financial Statistics.

$$\Delta \ln P = \Delta \ln M + \Delta \ln V - \Delta \ln Y$$

The link between inflation and interest rates is well known to Wall Street investment firms. Since bond prices move inversely with interest rates, one can get rich by predicting correctly the direction in which interest rates will move. Many Wall Street firms hire *Fed watchers* to monitor monetary policy and news about inflation in order to anticipate changes in interest rates.

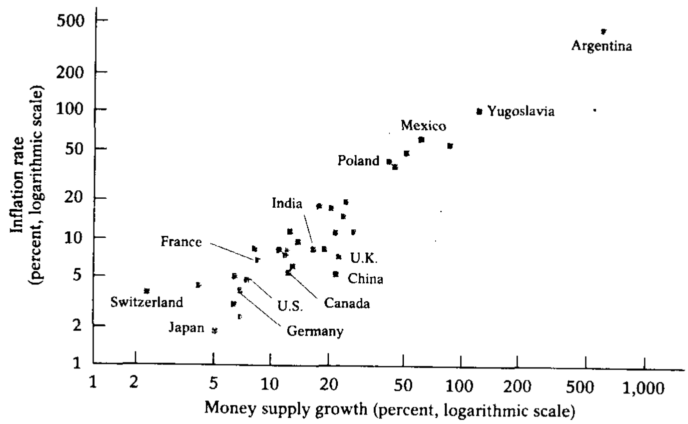
Figure 6-1



Historical Data on Inflation and Money Growth In this scatterplot of money growth and inflation, each point represents a decade. The horizontal axis shows the average growth in the money supply (as measured by $M2$) over the decade, and the vertical axis shows the average rate of inflation (as measured by the GDP deflator). The positive correlation between money growth and inflation is evidence for the quantity theory's prediction that high money growth leads to high inflation.

Source: For the data through the 1960s: Milton Friedman and Anna J. Schwartz, *Monetary Trends in the United States and the United Kingdom: Their Relation to Income, Prices, and Interest Rates 1867–1975* (Chicago: University of Chicago Press, 1982). For recent data: U.S. Department of Commerce, Federal Reserve Board.

Figure 6-2



International Data on Inflation and Money Growth In this scatterplot, each point represents a country. The horizontal axis shows the average growth in the money supply (as measured by currency plus demand deposits) during the 1980s, and the vertical axis shows the average rate of inflation (as measured by the GDP deflator). Once again, the positive correlation is evidence for the quantity theory's prediction that high money growth leads to high inflation.

Source: International Financial Statistics.

[3] Milton Friedman and Anna J. Schwartz, *A Monetary History of the United States, 1867–1960* (Princeton, N.J.: Princeton University Press, 1963); Milton Friedman and Anna J. Schwartz, *Monetary Trends in the United States and the United Kingdom: Their Relation to Income, Prices, and Interest Rates, 1867–1975* (Chicago: University of Chicago Press, 1982).

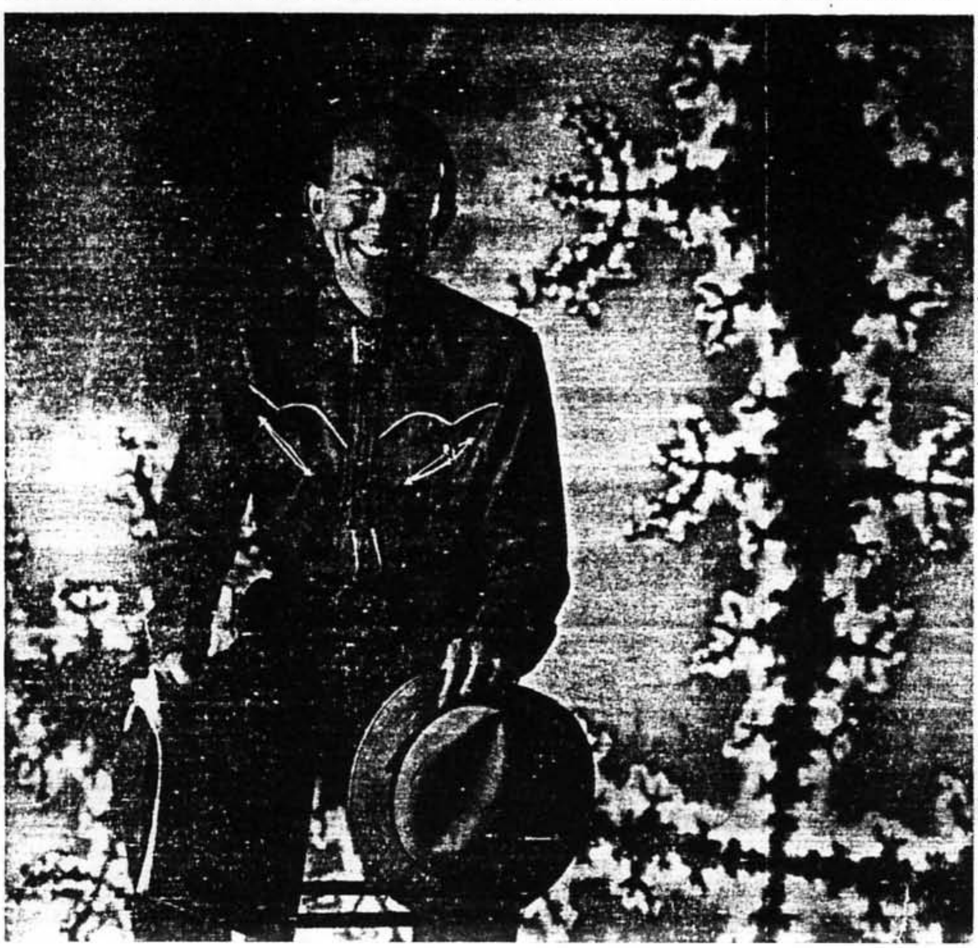
WHAT MAKES STOCK PRICES MOVE?

Academics have long argued that the market's swings, though unpredictable, are always rational and efficient. After the crash, a growing number say it ain't necessarily so. ■ *by Gary Hector*

BLACK MONDAY discomfited not only stockbrokers and portfolio managers, but also an influential set of academics whom they have long considered their archenemies—the efficient market crowd. These academics, you may recall, claim that buying high-priced investment advice is essentially a mug's game. Their bedrock belief, the efficient market hypothesis (EMH), holds that stock prices always reflect everything known about a company's prospects and the direction of the economy, so individuals cannot beat the market.

The notion that markets actually operate with such God-like omniscience and clockwork logic had been taking a licking even before October's crash. If the hypothesis were literally true, after all, Warren Buffett could not exist. The wizard of Omaha and a handful of other high-visibility investors, mostly disciples of the late Benjamin Graham, have outperformed the market averages with EMH-defying regularity. In recent years scholars have documented a host of other anomalies—persistent moneymaking opportunities that an unfailingly efficient market should long ago have arbitraged into oblivion. They have found that small-company stocks consistently yield higher returns than large ones, even after adjusting for risk. Year after year, share prices rise in early January. More often than not, they fall on Mondays.

Wisconsin's William Brock seeks patterns lurking within the market's chaotic convulsions.



ALAN D. LEVENSON (BACKGROUND: ART MATRIX, ITHACA, NY)

But these anomalies pale beside the mega-event that occurred on October 19. How could a rational, up-to-the-minute model of the market value it on Friday at $2.8 trillion and decide by Monday evening that it was worth $500 billion less?

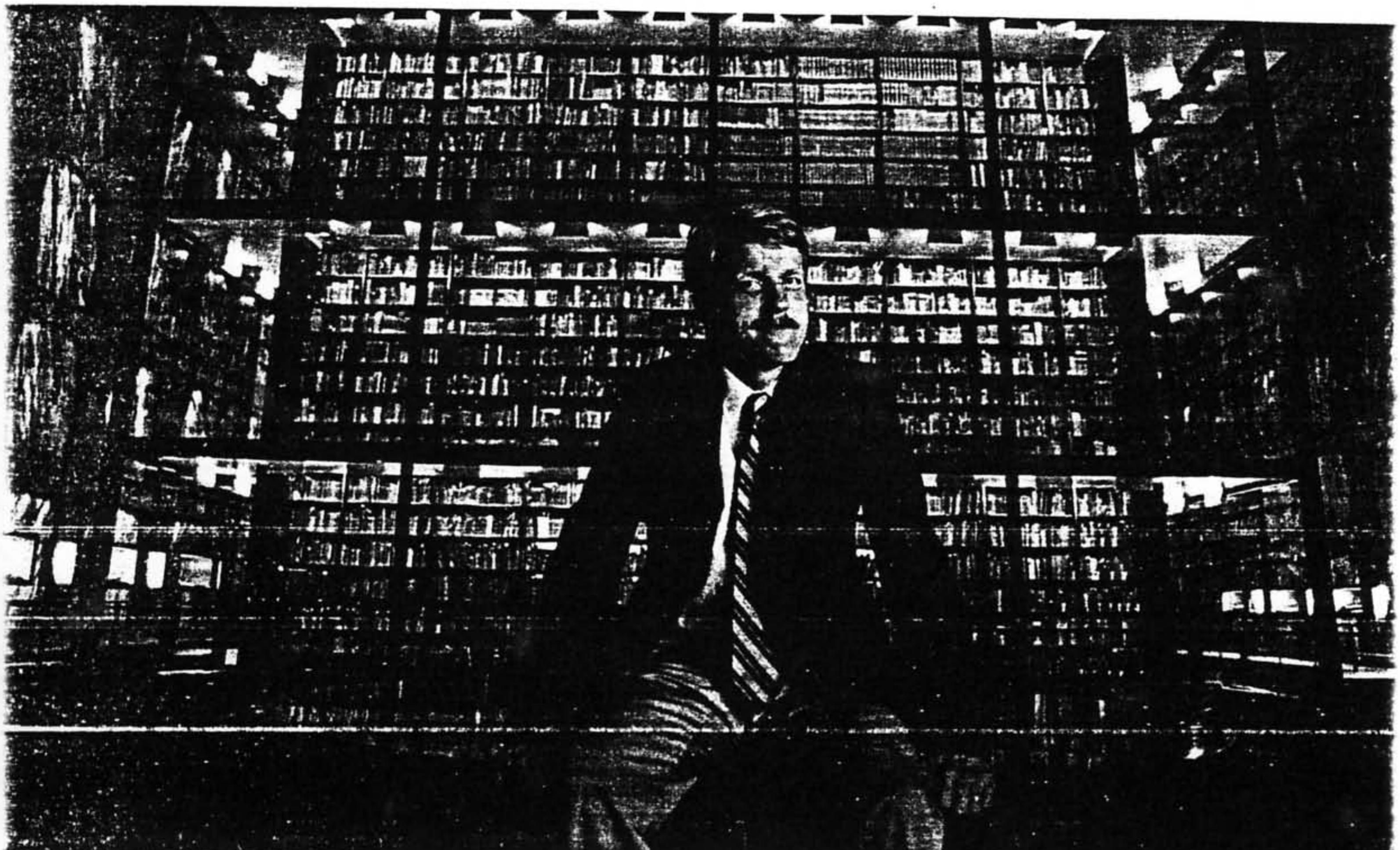
Some of the faithful see no contradiction. Says Eugene F. Fama, a finance professor at the University of Chicago and one of the original prophets of EMH: "The appropriate response to the October performance of the market is applause." Fama contends that investors had long been gleaning news that made them nervous. After digesting the details, they simply forced prices to a new, more efficient level—in record time. Neither Fama nor anyone else can identify precisely what new information sparked this rational stampede. But that only proves, he contends, that the market is wiser than mere mortals.

In general, however, the Dow's one-day, 508-point plunge has fostered a new uncertainty among finance professors. For two decades they have taught EMH as if it were as indisputable as the laws of gravity. Now, says James Van Horne, A. P. Giannini Professor of finance at Stanford University's graduate school of business, "the crash makes us realize that prices are not entirely efficient. You can get abrupt discontinuities. I think by and large all of us in finance are somewhat more humble."

Emboldened by October 19, critics of EMH are stepping up the hunt for new models that could more accurately describe the real world. Much of their work starts with the persuasive premise that a lot of investor behavior is less than rigorously rational. If that's so, then efficiency must suffer.

Cornell economist Richard Thaler, a leading advocate of this approach, draws upon psychological research that shows

REPORTER ASSOCIATE *Alan Deutschman*



Human emotion and irrationality play a much stronger role than the efficient market hypothesis allows, according to Yale's Robert J. Shiller

people tend to overemphasize recent events when making decisions. This propensity, he believes, could explain why stock prices tend to swing above and below rough estimates of their underlying value.

In a three-year-old study, Thaler and coauthor Werner DeBondt reviewed 50 years of stock-price data. They found that a portfolio of "losers"—companies that significantly underperformed the market for three years—turned around and outperformed it by almost 20% during the following three years. Over the same period, a portfolio of previously highflying stocks underperformed the market by about 5%. To Thaler, these regular cycles of undue optimism and pessimism are evidence of irrationality.

Lawrence Summers, a Harvard economist and top adviser to Michael Dukakis, strongly supports Thaler's thesis. Last winter, Summers and three co-authors published a paper arguing that a class of irrational investors known as "noise traders" move markets more successfully than EMH would allow. In financial parlance, noise is news with little bearing on a company's fundamental value. Noise traders are folks who tend to buy and sell on bad information, or who view the world, like Thaler's investors, wearing very short-term blinders.

IN A TRULY EFFICIENT market, noise traders should consistently lose out to smart investors and eventually be driven from the market. But in the world according to Summers, noise traders can be wrong and still make big bucks. When noise traders grow bullish on a stock, he reasons, rational investors, acutely aware that the noisy know-nothings could also drive the price down if they grow bearish, sell out. This leaves noise traders holding large quantities of shares whose price fluctuates more than less risky assets. Over time, Summers asserts, these riskier assets should tend to pay above average rates of return, so at least some noise traders will earn profits superior to those with sounder strategies.

Efficient marketers rightly complain that Summers is all theory and no evidence. H[e] admits that he has yet to find the data th[at] document how noise traders actually ga[r]ner their hypothetical gains. But Blac[k] Monday has only confirmed his belief th[at] the prices set in the stock market are some[times] bonkers. Says Summers: "The cras[h] proves that dramatic movements in stoc[k] prices occur on things other than new[s] about fundamental values."

Yale economist Robert J. Shiller, [a] longtime foe of EMH, sees human emo[]tion as the culprit. Shiller polled 1,000 in[]vestors before and immediately after Blac[k] Monday. Not surprisingly, he discovere[d] that shareowners don't focus overmuch o[n] fundamental values when the market i[s] crumbling around them. In the week be[]fore the crash, both buyers and sellers tol[d] Shiller the market was overvalued. Whe[n] the crash came, more than 60% describe[d] it as a clear case of a change in investo[r] psychology. Instead of displaying cool ra[]tionality on October 19, many institution[]al investors spent their time reacting t[o] other investors' jitters. That day, over 40% of those Shiller surveyed suffered symptoms of emotional stress—sweaty palms, tightness in the chest, irritability, or rapid pulse.

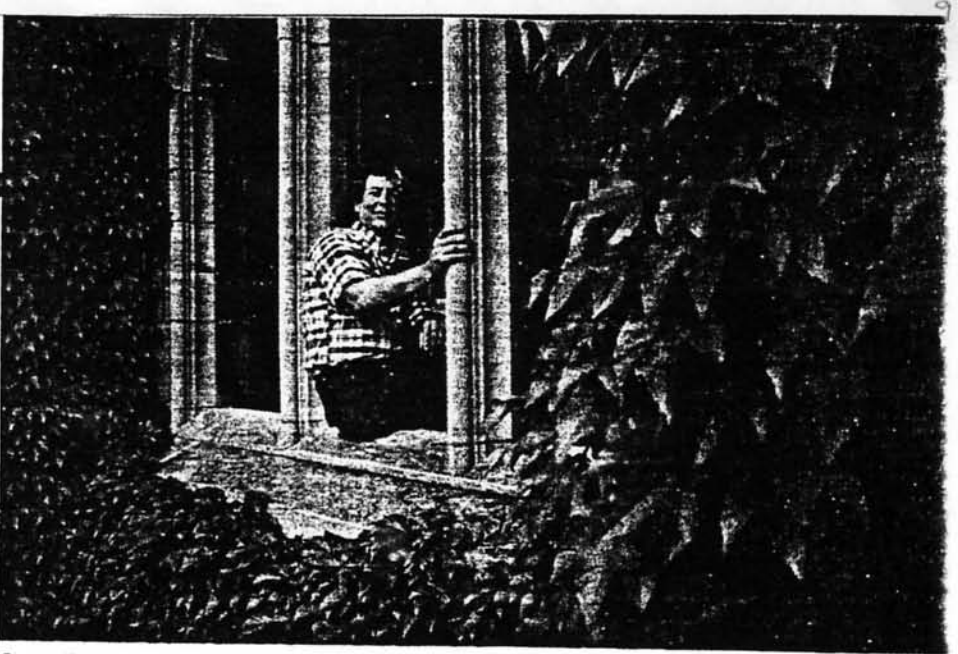
In search of an alternative stock market model that, unlike EMH, allows for the possibility of panic, Shiller has been exploring how epidemics and plagues spread. Two years ago he and co-author John Pound published a piece suggesting that individuals infect one another with enthusiasm for certain stocks. As a stock grows popular and its price rises, some investors are cured—that is, they sell out or at least buy fewer shares—and the progress of the disease slows.

While the notion of contagion holds tremendous metaphorical appeal, Shiller and Pound have so far failed to reduce their idea to a mathematical formula. After examining one year of trading data on ten stocks and polling the owners of those shares, they concluded that investors do infect one another with stock-purchasing ideas, but this contagion of interest is difficult to measure with any precision. Nor did the price movements they found conform to the hump-shaped pattern that an epidemic should produce.

Shiller's contagion model is typical of the fascinating, though fledgling, academic effort to develop far more complex mathematical models of the economy and markets than currently exist. Many of these models are being spawned by the arcane new field of chaos theory. Though in its infancy in the social sciences, chaos theory has been used in the physical sciences to provide insight into phenomena as diverse as the creation of weather patterns, the curling of cigarette smoke, and the stresses that cause spasmodic heart fibrillations.

In nature the apparently inexplicable onset of turbulence is a common and fundamental occurrence. A smooth flow of water suddenly bursts into thousands of droplets, or a waving flag shifts abruptly from gentle undulations to short, sharp snaps. What chaos theorists have discovered is that the origin of turbulence, though it appears a random event, follows patterns that can be predicted and reduced to a complex set of mathematical equations.

Might economists discover a set of equations that predict or at least closely resemble the gyrations of the stock market? Researchers claim their first excursions show promise. They are much more certain now than in the past that the ups and downs of stock prices follow patterns that are not random. Unfortunately, their ability to devise formulas that numerically capture this dimly perceived underlying order is still years away—and may never come. "Our main insight so far is that chaos theory helps explain stock behavior," says José Sheinkman, a professor of economics at the University of Chicago who did some pioneering work in the field. "But the theory gives no guidance on what departures from the random walk consist of." Agrees William Brock, an economist at the University of Wisconsin and another connoisseur of chaos: "As yet, chaos theory doesn't do anything for you formally. But it gives you inspiration for models and helps you think through ways to solve problems."



Cornell economist Richard Thaler says investors overreact to the latest news.

ONE INSIGHT Brock has already garnered from the physical sciences is the powerful effect of "positive feedback"—a term that describes the tendency of an existing trend to reinforce itself. Brock reasons that the events of October 19 were a classic example of how positive feedback can distort normal buying patterns. That day investors saw the heavy volume of trading, couldn't get information from their brokers, and so decided to mimic what other investors were doing and sell, thus pushing the market in the direction it was already headed.

The most intriguing insight chaos theory has to offer, however, is the notion that in a system as complex as the stock market, the quest for sweeping explanations of its more violent swings may be misguided. In the equations that have proved their ability to predict the onset of turbulence in nature, the dramatic transition from stability to chaos is often occasioned by a tiny shift in a single variable. Scientists call this the "butterfly effect"—a reference to the theoretical prospect that the beating of a butterfl wings over Mount Fuji could ultimate produce a hurricane in the Caribbean. similar fashion October's crash may w have been triggered by some event that the time either was imperceptible seemed insignificant.

For the denizens of Wall Street, this ne idea, like EMH, offers cold comfort. The business demands that they behave as they can outguess the market. But wh chaos theory suggests is that the marke movements may ultimately prove neith rational nor irrational, but inscrutable- and certainly not beatable. A butterfly ov Mount Fuji is not a scenario you can sell a pension fund.

On balance the current assault on EM is unlikely to have large policy cons quences. If markets are somewhat less ef cient and more irrational than EMH har liners hold, further tinkering—imposir trading halts on future Black Monday say—may be called for. No one is serious pushing a radical regulatory agenda.

The changes, if any, will come in th academy. Like Newtonian physics in th years before Einstein, the efficient mark hypothesis may be showing its theoretic shortcomings. But despite its recent batte ing, EMH should continue to hold swa for now. No one is close to devising a be ter model of how the financial worl works. "It's like the old saw, the whe may be crooked, but it's the only game i town," says Merton H. Miller, a Universit of Chicago business school professor an leading capital markets theorist. Still, wha finance professors appear more likely t acknowledge in the future—and Wa Streeters will chortle that they alread knew—is that, to paraphrase Hamlet, mor things move markets than were dreamt o in the professors' philosophy.