Chapter 2: Economic Theories, Data, and Graphs

This chapter provides an introduction to the methods that economists use in their research. We integrate a detailed discussion of graphing into our discussion of how economists present economic data and how they test economic theories.

In our experience, students typically do not learn enough about the connection between theory and evidence, and how both are central to understanding economic phenomena. We therefore recommend that considerable emphasis be placed on Figure 2-1, illustrating the process of going from model building to generating hypotheses to confronting data and testing hypotheses, and then returning to model building (or rebuilding). There is no real beginning or end to this process, so it is difficult to call economics an entirely "theory driven" or "data driven" discipline. Without the theory and models, we don't know what to look for in the data; but without experiencing the world around us, we can't build models of human behaviour and interaction through markets. The scientific approach in economics, as in the "hard" sciences, involves a close relationship between theory and evidence.

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The chapter is divided into four major sections. In the first section, we make the important distinction between positive and normative statements and advice. Students must understand this distinction, and that the progress of any scientific discipline relies on researchers' ability to separate what evidence suggests is true from what they would like to be true. We conclude this section by explaining why economists are often seen to disagree even though there is a great deal of agreement among them on many specific issues. We have added a new box on where economists typically get jobs and the kind of work they often do.

The second section explains the elements of economic theories and how they are tested. We emphasise how a theory's or model's definitions and assumptions lead, through a process of logical deduction, to a set of conditional predictions. We then examine the testing of theories. It is here that we focus on the interaction of theory and empirical observation (Figure 2-1). We examine briefly several aspects of statistical analysis, including the difference between rejection and confirmation, and the even more crucial distinction between correlation and causation.

The chapter's third section deals with economic data. We begin by explaining the construction of index numbers, and we use them to compare the volatility of two sample time series. Index numbers are so pervasive in discussions of economic magnitudes that students must know what these are and how they are constructed. We then make the distinction between cross-sectional and time-series data, and at this point students are introduced to two types of graph.

This brings us to the chapter's final section, on graphing. We show how a relation can be expressed in words, in an equation, or on a graph. We then go into considerable detail on linear functions, slope, non-linear functions, and functions with minima and maxima. In this discussion, the student is introduced to the concept of the *margin*, described as the change in Y in response to a one-unit change in X. In all cases, the graphs apply to real-world situations rather than abstract variables. Pollution abatement, hockey-stick production, firm profits, and fuel consumption are our main examples.

Answers to Study Exercises

Question 1

a) normative ("The government should impose…" is inherently a value judgement.)

b) positive (In principle, we could determined the impact that foreign aid actually has.)

c) positive (In principle, we could determine the extent to which fee increases affect access.)

d) normative (What is or is not unfair is clearly based on a value judgement.)

e) normative (Use of the expression "too much" is a value judgement.)

Question 2

a) The issues concern the costs and benefits of applying fiscal or monetary stimulus to an economy (about which students cannot yet say a lot in detail). Some of the normative issues will relate to the reader's evaluation of the current government leaders, such as the Minister of Finance and the Governor of the Bank of Canada. This can be turned into an interesting illustration of how our value judgements can affect our assessment of positive but uncertain issues (in this case the costs and benefits of economic stimulation).

b) North Americans are likely to emphasize the economic harm to the rest of the world done by European farm subsidies; the Europeans are likely to stress the social (and political) harm done by eliminating them.

c) Positive questions relate to the effects of school competition on the quality of education actually delivered. Normative questions may relate to whether it is desirable to have the resulting changes in the quality of education or on the distribution of income.

d) Positive issues relate to whether waiting times for medical treatment would fall, whether the average quality of health care would rise, and whether incomes of those in the medical industry would be affected. Normative issues include whether it is desirable that some doctors make themselves available only to people that can afford to pay for the "extra billing".

e) Positive issues relate to which policy—carbon taxes or cap-and-trade systems or direct regulations on emissions—would lead to the largest reductions in greenhouse-gas emissions and at what cost, and about which policy instrument would be the easiest to administer. Normative issues include whether the government ought to focus on this issue at the expense of dealing with other pressing issues. There is also some remaining disagreement as to whether human activity is really responsible for the observed increases in global average temperature, but this disagreement is essentially a positive rather than normative one.

f) Positive issues relate to the extent to which regulations were the cause of the recent (2008-09) financial crisis and about how regulations might be reformed in a way to reduce the probability of future crises. Normative issues include choosing between alternative policies that may reduce the profitability of financial institutions but at the same time increase the stability of the overall financial system. To the extent that some regulatory changes alter the distribution of income, further normative issues will be raised.

Question 3

a) In the Canadian wheat sector, the amount of rainfall on the Canadian prairies is an exogenous variable; the amount of wheat produced is an endogenous variable.

b) To the Canadian market for coffee, the world price of coffee is exogenous; the price of a cup at Tim Horton's is endogenous.

c) To any individual student, the widespread unavailability of student loans is exogenous; their own attendance at university or college is endogenous.

d) To any individual driver, the tax on gasoline is exogenous; his or her own decision regarding which vehicle to purchase is endogenous.

Question 4

There are, of course, many possible answers to each part. Here we list only one possible answer.

a) When thinking about surveying (especially over small areas) it is very useful to ignore the curvature of the Earth.

b) When framing an equal-pay-for-equal-work statute, it is useful (even central!) to assume that here are no economic differences between men and women.

c) When analysing behaviour of the teams and players during the seventh (and final) game of the World Series, the assumption that "there is no tomorrow" is quite useful.

d) This assumption is useful, for example, for examining an individual's saving behaviour. In general, any issue in which time is important clearly cannot be examined with a one-period model.

Adding only a second period (and ignoring all others) often is all that is necessary to generate valuable insights about behaviour over time.

e) In a world with only one good, it is not possible to discuss substitution between goods. But in a model with many goods, it may be difficult to mentally keep track of all the substitution that is going on. Thus, if one wanted to think about how a tariff on good X would affect the production of other goods, for example, the central intuition would be well developed in a two-good model.

f) This assumption is a convenient simplification for the standard economic theory of utility maximization. As long as self-interest is the most important motive most of the time, then concentrating on it will be an acceptable simplification that will yield predictions that are accurate most of the time.

Question 5

a) models (or theories)

b) endogenous; exogenous

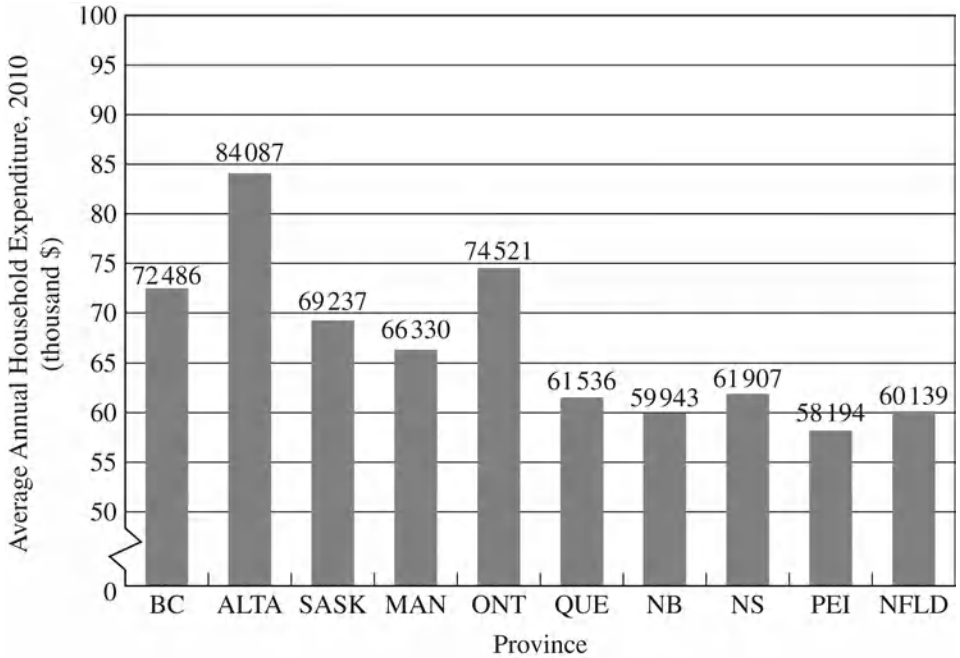
c) (conditional) prediction; empirical

d) (positively) correlated; causal

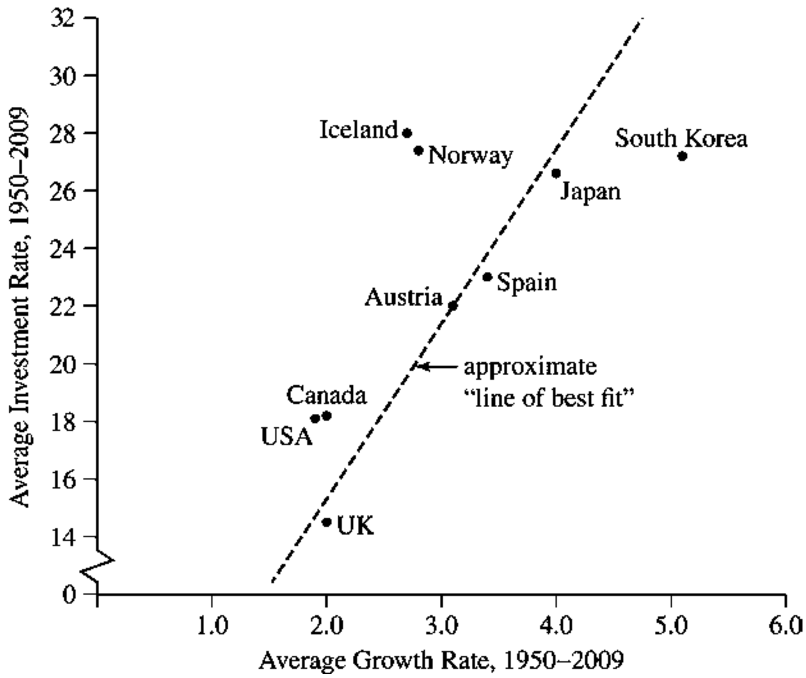
Question 6

a) These data are best illustrated with a time-series graph, with the month shown on the horizontal axis and the exchange rate shown on the vertical axis.

b) These cross-sectional data are best illustrated with a bar chart.



c) These cross-sectional data are best illustrated in a scatter diagram; the "line of best fit" is clearly upward sloping, indicating a positive relationship between average investment rates and average growth rates.



Question 7

a) Along Line A, Y falls as X rises; thus the slope of Line A is negative. For Line B, the value of Y rises as X rises; thus the slope of Line B is positive.

b) Along Line A, the change in Y is –4 when the change in X is 6. Thus the slope of Line A is $\Delta Y/\Delta X$ = -4/6 = -2/3. The equation for Line A is:

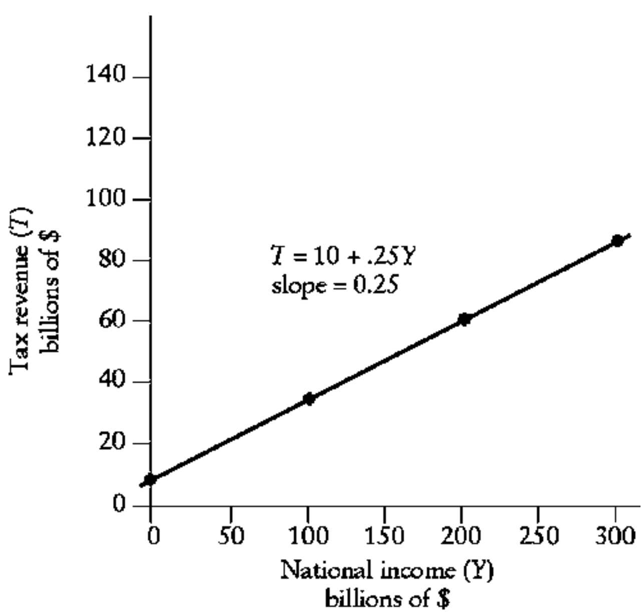
$$Y = 4 - (2/3)X$$

c) Along Line B, the change in Y is 7 when the change in X is 6. Thus the slope of Line B is $\Delta Y/\Delta X$ = 7/6. The equation for Line B is:

$$Y = 0 + (7/6)X$$

Question 8

Given the tax-revenue function $T = 10 + .25Y$, the plotted curve will have a vertical intercept of 10 and a slope of 0.25. The interpretation is that when Y is zero, tax revenues will be $10 billion. And for every increase in Y of $100 billion, tax revenues will rise by $25 billion. The diagram is as shown below:

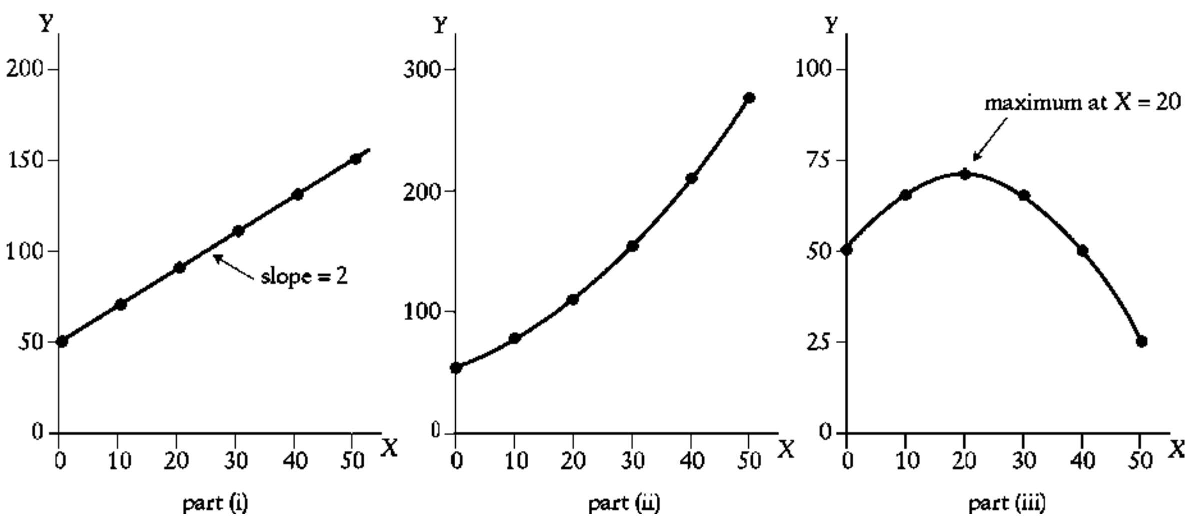


Question 9

a) For each relation, plot the values of Y for each value of X. Construct the following table:

(i) $Y = 50 + 2X$		(ii) $Y = 50 + 2X + .05X^2$		(iii) $Y = 50 + 2X - .05X^2$	
X	*Y*	*X*	*Y*	*X*	*Y*
0	50	0	50	0	50
10	70	10	75	10	65
20	90	20	110	20	70
30	110	30	155	30	65
40	130	40	210	40	50
50	150	50	275	50	25

Now plot these values on scale diagrams, as shown below. Notice the different vertical scale on the three different diagrams.



b) For part (i), the slope is positive and constant and equal to 2. For each 10-unit increase in *X*, there is an increase in *Y* of 20 units. For part (ii), the slope is always positive since an increase in *X* always leads to an increase in *Y*. But the slope is not constant. As the value of *X* increases, the slope of the line also increases. For part (iii), the slope is positive at low levels of *X*. But the function reaches a maximum at *X*=20, after which the slope becomes negative. Furthermore, when *X* is greater than 20, the slope of the line becomes more negative (steeper) as the value of *X* increases.

c) For part (i), the marginal response of *Y* to a change in *X* is constant and equal to 2. This is the slope of the line. In part (ii), the marginal response of *Y* to a change in *X* is always positive, but the marginal response increases as the value of *X* increases. This is why the line gets steeper as *X* increases. For part (iii), the marginal response of *Y* to a change in *X* is positive at low levels of *X*. But after *X*=20, the marginal response becomes negative. Hence the slope of the line switches from positive to negative. Note that for values of *X* further away from *X*=20, the marginal response of *Y* to a change in *X* is larger in absolute value. That is, the curve flattens out as we approach *X*=20 and becomes steeper as we move away (in either direction) from *X*=20.

Question 10

a) Using 2000 as the base year means that we choose $85 as the base price. We thus divide the actual prices in all years by $85 and then multiply by 100. In this way, we will determine, in percentage terms, how prices in other years differ from prices in 2000. The index values are as follows:

Year	**Price ($)**	**Physics textbook price index**
2000	85	(85/85) × 100 = 100
2001	87	(87/85) × 100 = 102.4
2002	94	(94/85) × 100 = 110.6
2003	104	(104/85) × 100 = 122.4
2004	110	(110/85) × 100 = 129.4
2005	112	(112/85) × 100 = 131.8
2006	120	(120/85) × 100 = 141.2
2007	125	(125/85) × 100 = 147.1
2008	127	(127/85) × 100 = 149.4
2009	127	(127/85) × 100 = 149.4
2010	130	(130/85) × 100 = 152.9

b) The price index in 2005 is 131.8, meaning that the price of the physics textbook is 31.8 percent higher in 2005 than in the base year, 2000.

c) From 2007 to 2010, the price index increases from 147.1 to 152.9—but this is *not* an increase of 5.8 percent. The percentage increase in the price index from 2007 to 2010 is equal to [(152.9-147.1)/147.1]×100 = 3.94 percent.

d) These are time-series data because the data are for the same product at the same place but at different points in time.

Question 11

a) Using Calgary as the "base university" means that we choose $6.25 as the base price. Thus we divide all actual prices by $6.25 and then multiply by 100. In this way, we will determine, in percentage terms, how prices at other universities differ from Calgary prices. The index values are as follows:

University	Price per pizza	Index of pizza prices
Dalhousie	$6.50	(6.50/6.25)×100 = 104
Laval	5.95	(5.95/6.25)×100 = 95.2
McGill	6.00	(6.00/6.25)×100 = 96
Queen's	8.00	(8.00/6.25)×100 = 128
Waterloo	7.50	(7.50/6.25)×100 = 120
Manitoba	5.50	(5.50/6.25)×100 = 88
Saskatchewan	5.75	(5.75/6.25)×100 = 92
Calgary	6.25	(6.25/6.25)×100 = 100
UBC	7.25	(7.25/6.25)×100 = 116
Victoria	7.00	(7.00/6.25)×100 = 112

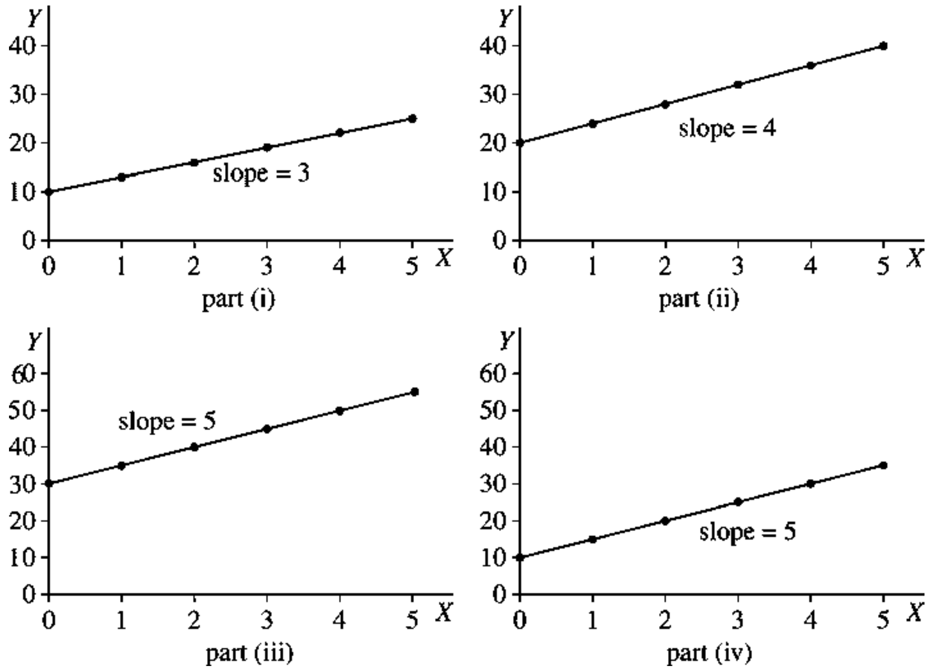
b) The university with the most expensive pizza is Queen's, at $8.00 per pizza. The index value for Queen's is 128, indicating that pizza there is 28 percent more expensive than at Calgary.

c) The university with the least expensive pizza is Manitoba, at $5.50 per pizza. The index value for Manitoba is 88, indicating that the price of pizza there is only 88 percent of the price at Calgary. It is therefore 12 percent cheaper than at Calgary.

d) These are cross-sectional data. The variable is the price of pizza, collected at different places at a given point in time (March 1, 2013). If the data had been the prices of pizza at a single university at various points in time, they would be time-series data.

Question 12

The four scale diagrams are shown on the next page, each with different vertical scales. In each case, the slope of the line is equal to the "rise over the run" – that is, the amount by which Y changes when X increases by one unit.



Question 13

This is a good question to make sure students understand the importance of using weighted averages rather than simple averages in some situations.

a) The simple average of the three regional unemployment rates is equal to (5.5 + 7.2 + 12.5)/3 = 8.4. Is 8.4% the "right" unemployment rate for the country as a whole? The answer is no because this simple, unweighted (or, more correctly, equally weighted) average does not account for the fact that the Centre is much larger in terms of the labour force than either the West or East, and thus should be given more weight than the other two regions.

b) To solve this problem, we construct a weighted average unemployment rate. We do so by constructing a weight for each region equal to that region's share in the total labour force. From the data provided, the country's total labour force is 17.2 million. The three weights are therfore:

West: weight = 5.3/17.2 = 0.308

Centre: weight = 8.4/17.2 = 0.488

East: weight = 3.5/17.2 = 0.203

These weights should sum exactly to 1.0, but due to rounding they do not quite do so. Using these weights, we now construct the average unemployment rate as the weighted sum of the three regional unemployment rates.

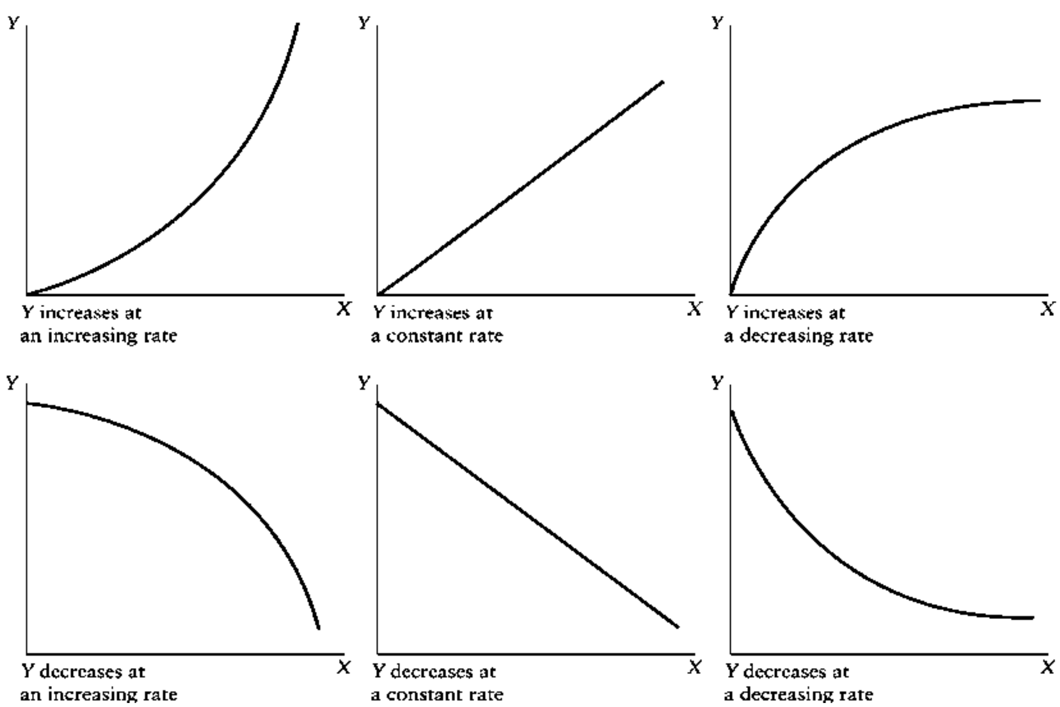
<u>Canadian weighted unemployment rate</u> = (.308 × 5.5) + (.488 × 7.2) + (.203 × 12.5) = 7.75

This is a better measure of the Canadian unemployment rate because it correctly weights each region's influence in the national total. Keep in mind, however, that for many situations the relevant unemployment rate for an individual or a firm may be the more local one rather than the national average.

Question 14

The six required diagrams are shown below. Note that we have not provided specific units on the axes. For the first three figures, the tax system provides good examples. In each case, think of earned income as being shown along the horizontal axis and taxes paid shown along the vertical axis. The first diagram might show a progressive income-tax system where the marginal tax rate rises as income rises. The second diagram shows a proportional system with a constant marginal tax rate. The third diagram shows marginal tax rates falling as income rises, even though total tax paid still rises as income rises.

For the second set of three diagrams, imagine the relationship between the number of rounds of golf played (along the horizontal axis) and the golf score one achieves (along the vertical axis). In all three diagrams the golf score falls (improves) as one golfs more times. In the first diagram, the more one golfs the more one improves on each successive round played. In the second diagram, the rate of improvement is constant. In the third diagram, the rate of improvement diminishes as the number of rounds played increases. The actual relationship probably has bits of all three parts—presumably there is a lower limit to one's score so eventually the curve must flatten out.



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