

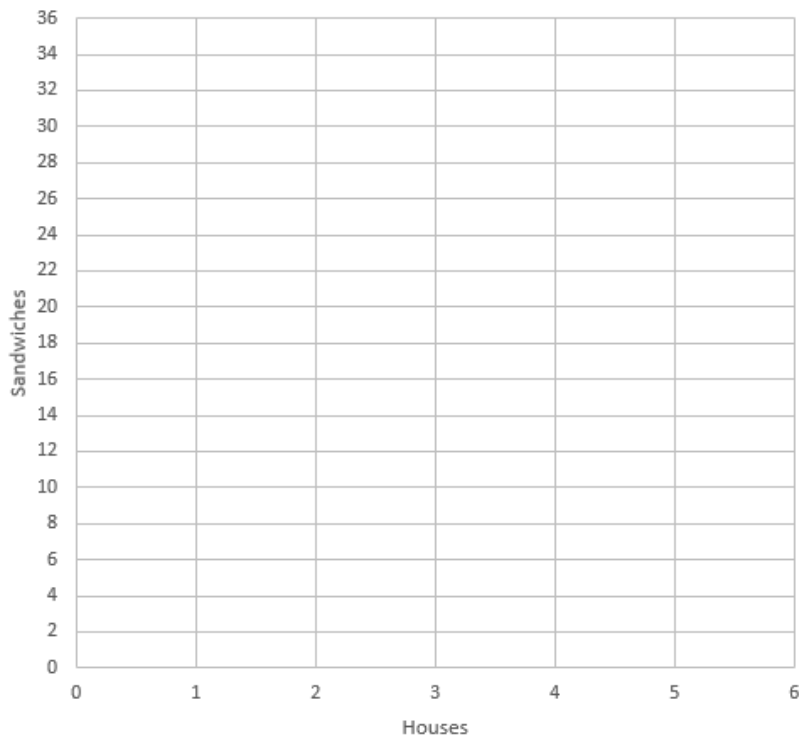
Production possibilities frontiers: Practice problems

Dr. Amy McCormick Diduch

Imagine a society that can produce two goods: houses and sandwiches. The Production Possibilities table lists the production choices for this society.

	Houses	Sandwiches
A	0	28
B	1	24
C	2	18
D	3	10
E	4	0

Step 1: Plot the PPF using the data in the table.



Step 2: Identify efficient, inefficient and unattainable points.

Fill in the blanks with either "efficient", "inefficient" or "unattainable".

The combination of 2 Houses and 14 sandwiches is _____

The combination of 0 Houses and 28 sandwiches is _____

The combination of 3 Houses and 15 sandwiches is _____

The combination of 1 House and 22 sandwiches is _____

The combination of 4 Houses and 3 sandwiches is _____

The combination of 1 House and 24 sandwiches is _____

Step 3: calculate opportunity cost

	Houses	Sandwiches
A	0	28
B	1	24
C	2	18
D	3	10
E	4	0

The "cost" of the first House (from A to B) is _____ sandwiches.

The cost of the second House (from B to C) is _____ sandwiches.

The cost of the third House is _____ sandwiches.

The cost of the fourth House is _____ sandwiches.

Step 4: Economic growth

a. "Biased" technological change

A new process is discovered that allows for greater live plant production from any given quantity of inputs. The new production possibilities are as follows:

	Houses	Old technology: Sandwiches	New technology: Sandwiches
A	0	28	36
B	1	24	30
C	2	18	22
D	3	10	12
E	4	0	0

*** Sketch the NEW PPF on the diagram above.

Look at the change in efficient, inefficient and unattainable points

Before adoption of the new technology, was the combination of 3 Houses and 10 sandwiches efficient, inefficient or unattainable? _____ After adoption of the new technology, is this combination efficient, inefficient, or unattainable? _____.

Under the old technology, the combination of 2 Houses and 30 sandwiches was _____ but under the new technology is _____.

Calculate opportunity cost of Houses under the new technology

The opportunity cost of the first House is now _____ sandwiches

The opportunity cost of the second House is now _____

The opportunity cost of the third House is now _____

The opportunity cost of the fourth House is now _____

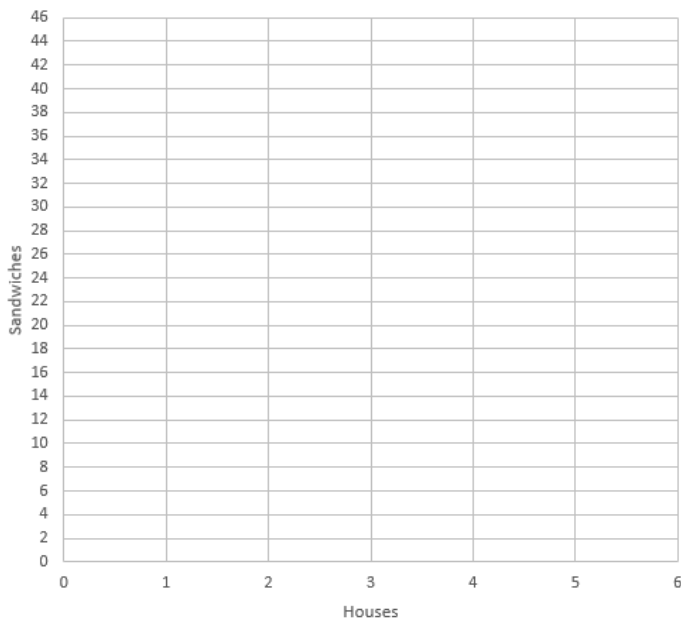
b. Change in quantity of inputs

Suppose that workplace training initiatives have succeeded and fish industry workers are more productive. For each hour worked, they can produce more Houses, more Sandwiches, or more of both.

	Old houses	New houses	Old sandwiches	New sandwiches
A	0	0	28	40
B	1	1	24	36
C	2	2	18	30
D	3	3	10	22
E	4	4	0	12
F		5		0

Plot the old and new PPFs in the graph space below and shade in the area under the new PPF that would have been unattainable using previous production methods.

Economic growth / unbiased technological change



Calculating opportunity cost – again

	Houses	Sandwiches
A	0	28
B	10	24
C	16	18
D	20	10
E	22	0

- Suppose we are at combination A. What is the opportunity cost of increasing house production from 0 to 10?
- Suppose we are at combination C. What is the opportunity cost of increasing house production from 16 to 20?
- Does this PPF exhibit increasing opportunity costs?

Increasing or constant opportunity costs?

Consider the following production possibilities schedule:

Corn	Soybeans
0	100
10	80
20	60

30	40
40	20
60	0

Does this PPF for corn and soybeans exhibit increasing opportunity costs? Explain.

Technological change and prices in the real world

Read the *Wall Street Journal* article “While Services Sector Booms, Productivity Gains Remain Elusive” (Adam Creighton, October 30, 2016) at the end of this tutorial and consider the following questions:

- What were the relative shares of U.S. workers working in the manufacturing and high-growth (education, health, food-and-beverage) services sectors in 2000? What are these relative shares today? Why have these employment sector shares shifted so much over the past 16 years?
- In which sector has productivity grown the most? The least?
- What is the relationship between productivity growth in a given sector and prices in that sector?
- As we become more efficient at producing goods in the manufacturing sector, resources are released that can be employed in the service sector. What does the article suggest about the effectiveness of these resources? Are they well-suited to production in the service sector?
- Is it possible to achieve productivity gains in the service sector?

While Services Sector Booms, Productivity Gains Remain Elusive

Health care and education ranks in U.S. swell as workforce shifts out of manufacturing

By *Adam Creighton, The Wall Street Journal*, Oct. 30, 2016

Does anyone really want a faster haircut or a speedier dentist?

Economists seeking to explain slowing productivity growth have pointed to a downturn in global innovation. Overlooked in that debate is how hard it is to innovate in services, which are lapping up a growing share of consumers’ budgets as goods prices fall. Technology has transformed many services—think of TurboTax, for instance—but has left many sectors like education relatively untouched.

Growth in productivity—the goods and services a worker produces in an hour, a key determinant of wages and living standards—has petered out along with a slowdown in technological advances, which typically reduce the time spent to build a laptop or car.

It has been even more stubborn, though, on the services front. People want their hairdressers and therapists—and even their accountants and lawyers—to take their time, often the definition of good service.

American economist William Baumol dug into this phenomenon decades ago, exploring how an expanding service sector can hobble productivity growth. He illustrated his thesis with the extreme example of the performing arts. “It’s fairly difficult to reduce the number of actors necessary for a performance of Henry IV,” Mr. Baumol, now a New York University professor, wrote in his landmark 1965 article.

American households spent \$8.3 trillion on services last year, more than double their expenditure on goods, while in China the rapidly growing service sector surpassed 50% of GDP for the first time.

Meanwhile, the share of Americans employed in the more-productive manufacturing sector has shriveled from 13% to 8% since 2000. At the same time, those working in the fast-growing health, education and food-and-beverage services has swollen from 17% to 23%.

This is where the big drag is: Average annual productivity growth in these three sectors—from hospitals to the corner bar—ranged from minus-0.6% a year to zero over the 10 years to 2014.

“The changing distribution of workers might be able to explain up to one-half of the slowdown in labor productivity growth from 2.5% to 1.5% per year since the 1960s,” said Dietrich Vollrath, a University of Houston economist. Indeed, this effect has accelerated since 2000, when workers, in aggregate, started to move from higher to lower productivity sectors.

Services productivity, besides its natural disadvantage, may be facing an added headwind: The sector is absorbing millions of workers whose underlying skills may not be well suited to the jobs they take on.

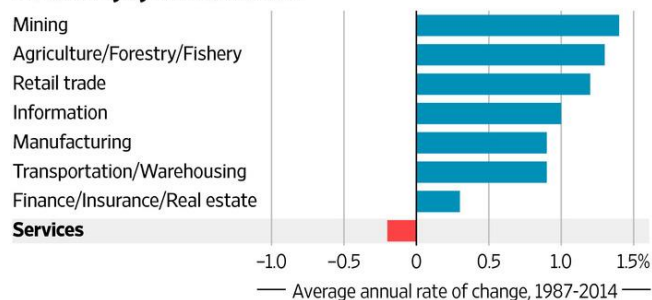
If people start doing work they are relatively good at, and if manufacturers shed their least efficient workers first, manufacturing productivity will improve as it downsizes but services-sector productivity will suffer as it absorbs workers who are a poor fit.

That shift almost entirely [explains the difference](#) between measured annual productivity growth of 1.6% in manufacturing and 0.2% in services in 18 OECD countries over 1970 to 2005, according to Alwyn Young, an economist at the London School of Economics.

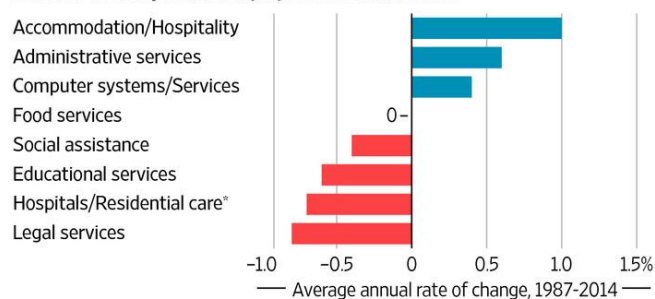
Are You Being Served?

Services productivity has declined overall since the 1980s, especially in the fast-growing health and education sectors.

Productivity by selected sectors



Services sector productivity by selected industries



*Includes nursing Source: Brookings Institution

THE WALL STREET JOURNAL.

Even if the productivity of services is naturally constrained, that doesn't mean they can't improve. The gap between the productivity of the top 5% of service firms and the rest has been growing rapidly, according to [OECD research](#) by Dan Andrews and others that examined 24 countries since 2000. The most productive firms were 3 to 4 times more productive than the laggards in 2013, exhibiting labor productivity growth of 3.6% a year on average, almost 10 times as fast as the bottom 95%.

That suggests reforms that remove barriers to entry and promote competition in services, especially in health and education, could have a massive impact on aggregate productivity growth. Economist Morris Kleiner at the University of Minnesota points out that almost 30% of jobs in the U. S.—from carpenters and accountants to florists, dance teachers and interior designers—now require an occupational license, up from 5% in the 1950s. “An occupational license raises wages similar to trade union membership, and it can sap productivity,” he says.

Boosting competition is easier said than done. Some popular policies might even undermine productivity, such as mandating smaller class sizes at schools and child-care centers. Health and education workforces tend to be relatively well unionized and enjoy significant government subsidies, directly or indirectly. Many studies suggest up to a third of health-care spending is unnecessary.

Absent such reforms, the service sector, expected to generate almost 95% of new jobs in the next decade, might be a ball and chain on

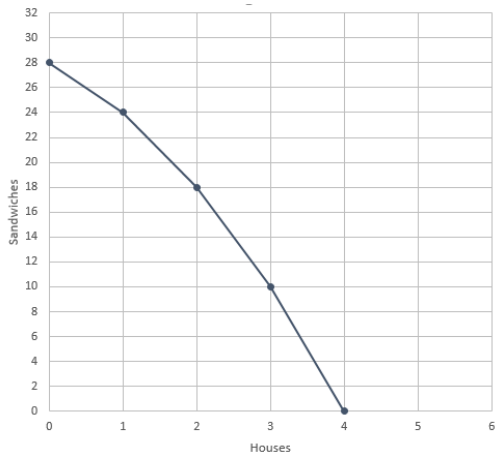
productivity growth for some time. Nurses and personal care and home health aides—just three occupations among more than 800 tracked by the Bureau of Labor Statistics—are projected to make up 1.2 million of the 9.8 million new jobs expected by 2024.

But applicants shouldn't worry about their wage prospects. Mr. Baumol's eponymous “cost disease” also showed how the “inexorable march of technological change in other parts of the economy,” mainly in manufacturing, would ensure real wages continued to rise throughout the economy.

Write to Adam Creighton at adam.creighton@dowjones.com

Answers - DO NOT CHECK THESE ANSWERS UNTIL YOU HAVE COMPLETED ALL OF THE QUESTIONS

1. Plot the PPF



2: Identify efficient, inefficient and unattainable points.

The combination of 2 Houses and 14 sandwiches is attainable but *inefficient*

The combination of 0 Houses and 28 sandwiches is *efficient*

The combination of 3 Houses and 15 sandwiches is *unattainable*

The combination of 1 House and 22 sandwiches is attainable but *inefficient*

The combination of 4 Houses and 3 sandwiches is *unattainable*

The combination of 1 House and 24 sandwiches is *efficient*

3: calculate opportunity cost

	Houses	Sandwiches
A	0	28
B	1	24
C	2	18
D	3	10
E	4	0

The “cost” of the first House is $28-24 = 4$ sandwiches.

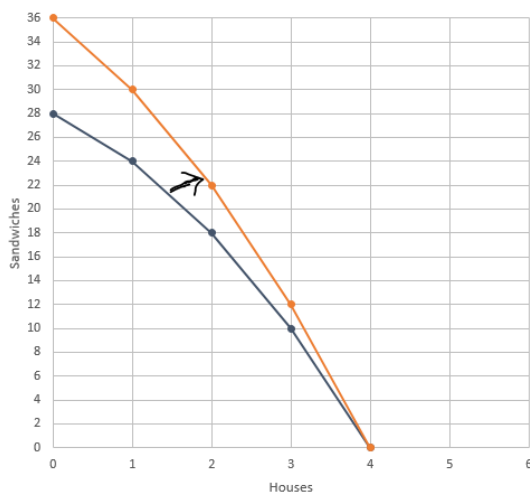
The cost of the second House is **6** sandwiches.

The cost of the third House is **8** sandwiches.

The cost of the fourth House is **10** sandwiches.

Notice that this PPF DOES exhibit increasing opportunity cost.

4: Economic growth questions



PPF after biased technological change:

Before adoption of the new technology, was the combination of 3 Houses and 10 sandwiches efficient, inefficient or unattainable? It was efficient

After adoption of the new technology, is this combination efficient, inefficient, or unattainable? inefficient

Under the old technology, the combination of 2 Houses and 24 sandwiches was unattainable but under the new technology is efficient

The cost of the first House is now 6

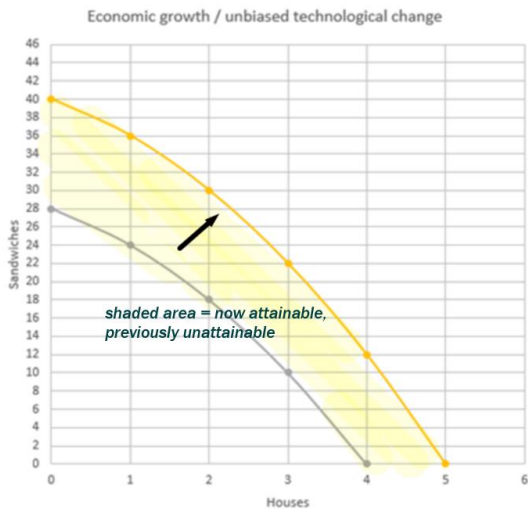
The cost of the second House is 8

The cost of the third House is 10

The cost of the fourth House is 12

(In other words, Houses have become relatively more “expensive” compared to sandwiches)

PPF after increase in inputs



Calculating opportunity cost – again

	Houses	Sandwiches
A	0	28
B	10	24
C	16	18
D	20	10
E	22	0

- Suppose we are at combination A. What is the opportunity cost of increasing house production from 0 to 10?
We lose 4 sandwiches to gain 10 houses, so the “cost per house” is $4/10$ or $2/5$ (or 0.4).
- Suppose we are at combination C. What is the opportunity cost of increasing house production from 16 to 20?
We lose 8 sandwiches to gain 4 houses, so the “cost per house” is $8/4 = 2$
- Does this PPF exhibit increasing opportunity costs? **Yes, it does!**

Increasing or constant opportunity costs?

The opportunity cost of increasing corn production is always $(-20)/(+10) = 2$ soybeans per corn. Thus, there are NOT increasing opportunity costs along this PPF.

Wall Street Journal questions:

The first two are answered in the article.

- What is the relationship between productivity growth in a given sector and prices in that sector? *Prices tend to fall in sectors with faster productivity growth relative to prices in sectors with slower growth, all other things held constant.*
- As we become more efficient at producing goods in the manufacturing sector, resources are released that can be employed in the service sector. What does the article suggest about the effectiveness of these resources? Are they well-suited to production in the service sector? *The article suggests that the least skilled*

workers are the most likely to lose their jobs. They aren't prepared to be highly productive in the service sector without retraining.

- *Is it possible to achieve productivity gains in the service sector? Yes! One suggestion from the article: reduce occupational licensing requirements.*