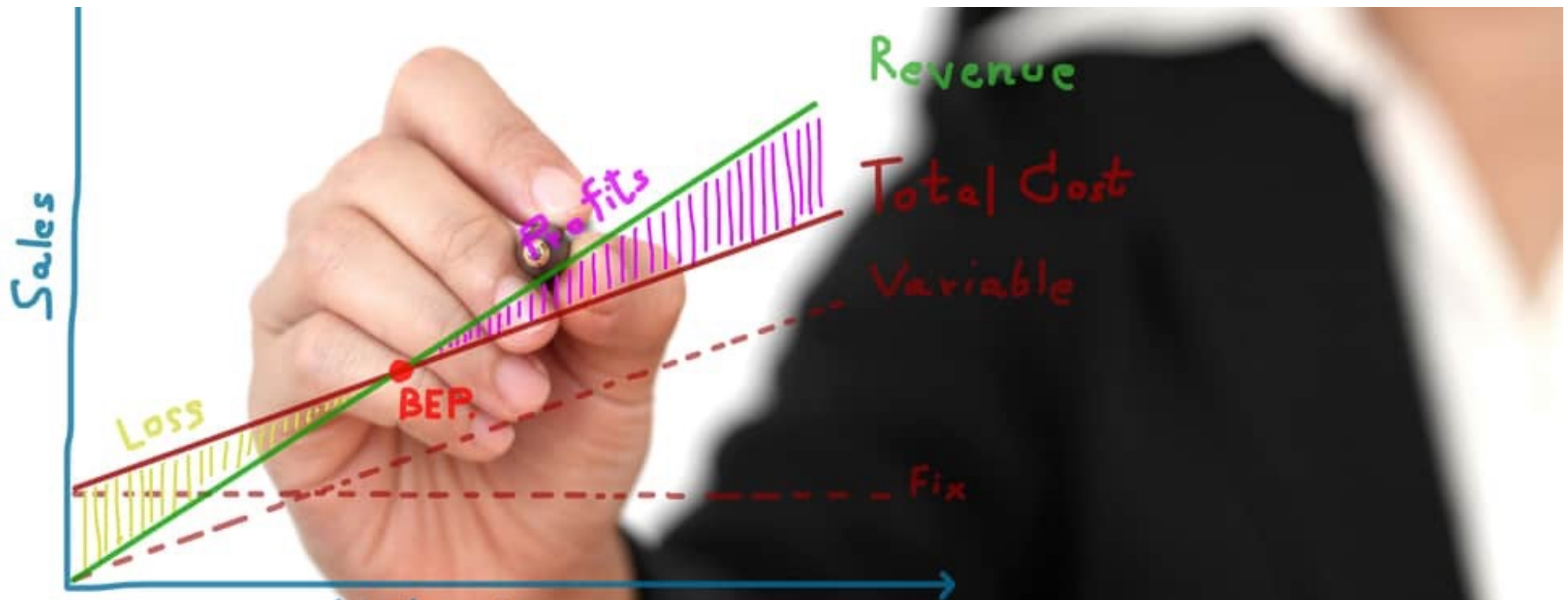
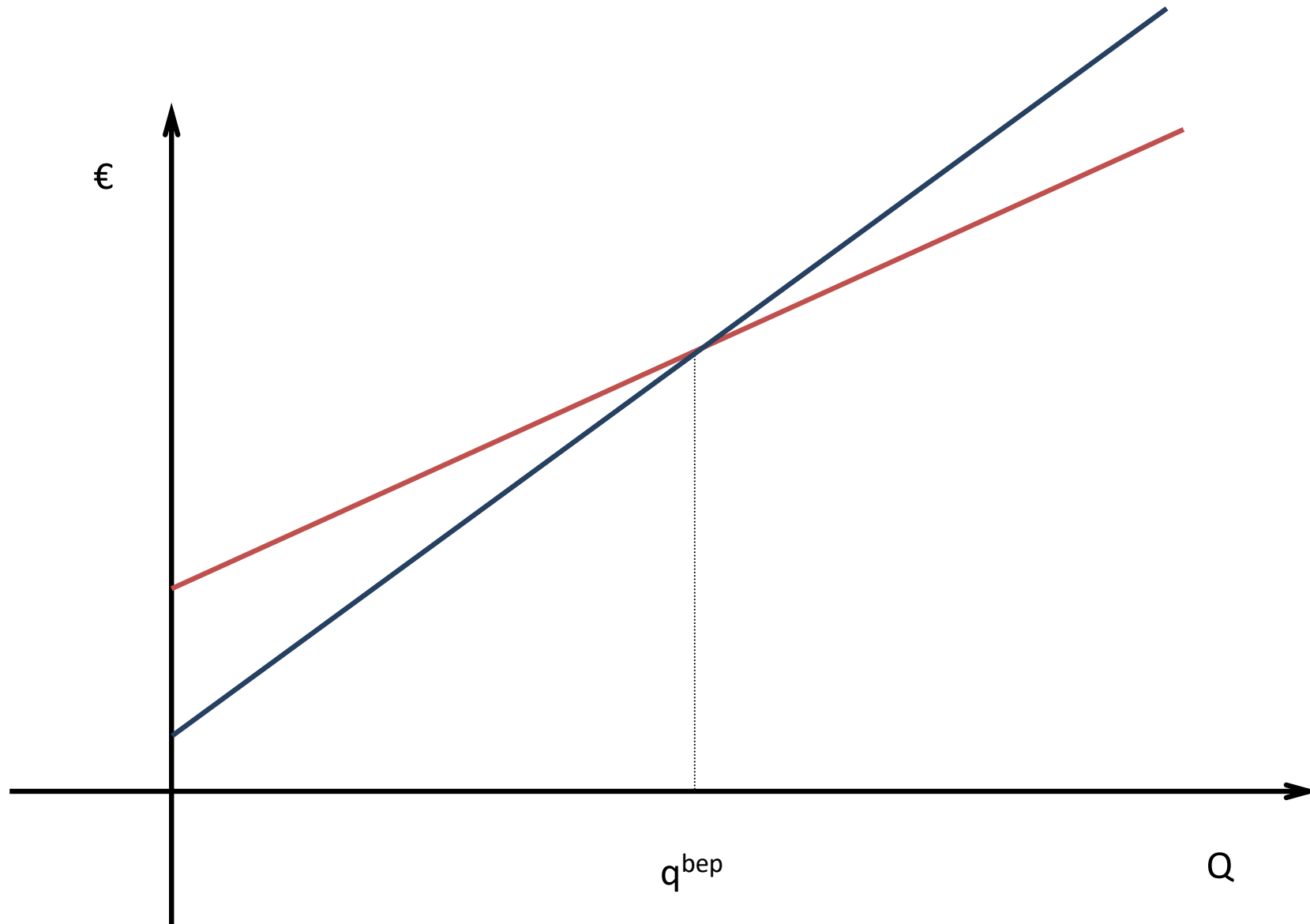


COST-VOLUME-PROFIT ANALYSIS

A review of the basic concepts and an increase in the level of sophistication of the model



COST-VOLUME-PROFIT ANALYSIS



MENTAL MODELS

In 1971 Jay Wright Forrester defined mental models as follows:

“The image of the world around us, which we carry in our head, is just a model. Nobody in his head imagines all the world, government or country. He has only **selected concepts, and relationships between them**, and uses those to represent the real system”

Mental model is an explanation of someone's thought process about how something works in the real world. It is a representation of the surrounding world, the relationships between its various parts and a person's intuitive perception about his or her own acts and their consequences. Mental models can help shape behavior and set an approach to solving problems (similar to a personal algorithm) and doing tasks.

A mental model is a kind of internal symbol or representation of external reality, hypothesized to play a major role in cognition, reasoning and decision-making. Kenneth Craik suggested in 1943 that the mind constructs "small-scale models" of reality that it uses to anticipate events.

SOURCE: https://en.wikipedia.org/wiki/Mental_model



MENTAL MODELS

Abstract Model

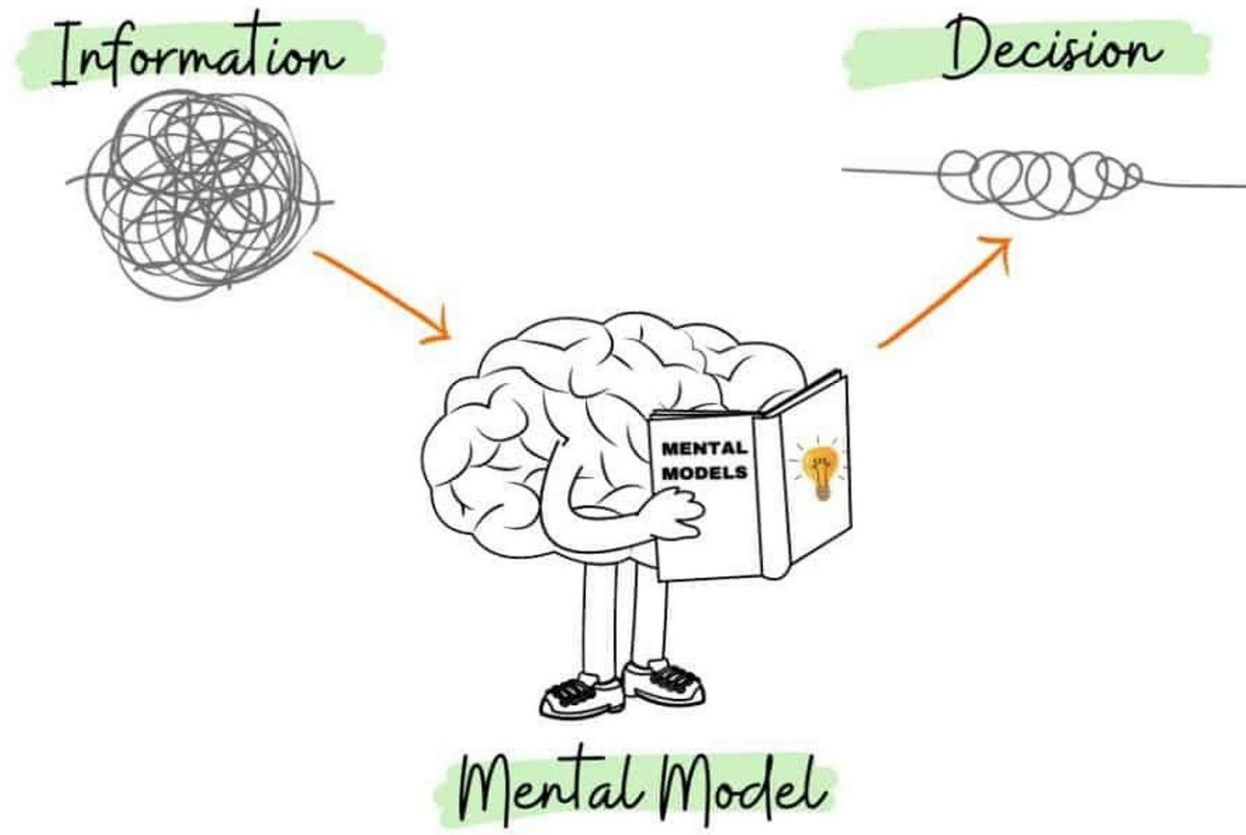


Complex Reality



A mental model is a simplified observation of a certain part of reality that you can keep in your head.

MENTAL MODELS



SOURCE: <https://thewizdomproject.com/mental-models-basics>



MENTAL MODELS

“One thing all managers know is that many of the best ideas never get put into practice. Brilliant strategies fail to get translated into action. Systemic insights never find their way into operating policies. A pilot experiment may prove to everyone's satisfaction that a new approach leads to better results, but widespread adoption of the approach never occurs.

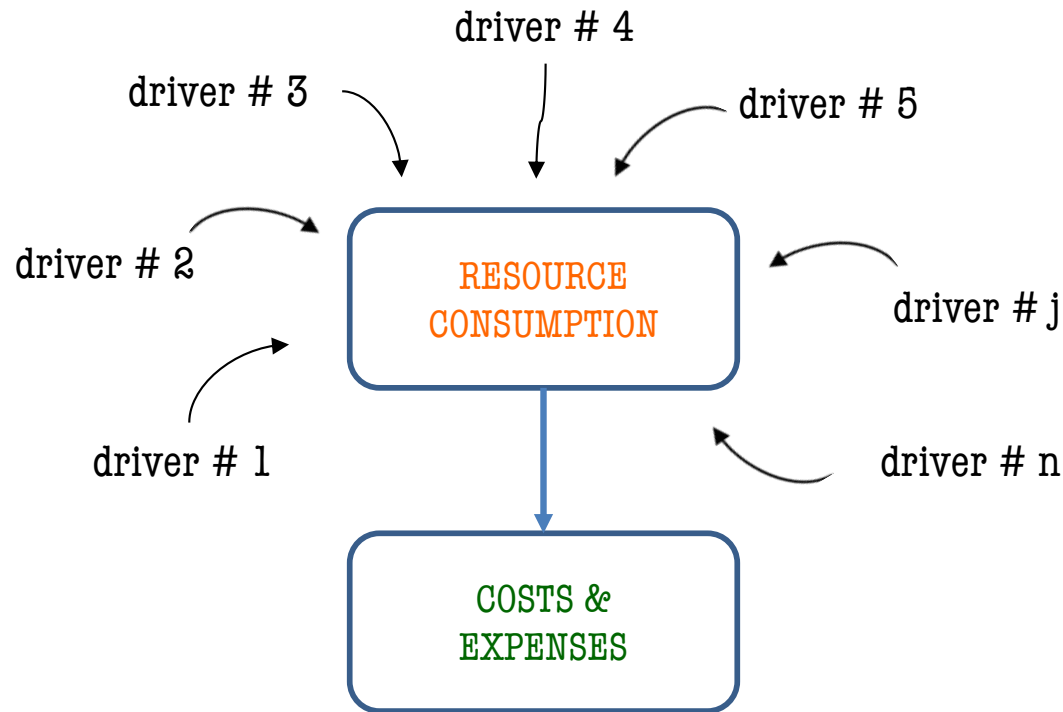
We are coming increasingly to believe that this "slip 'twixt cup and lip" stems, not from weak intentions, wavering will, or even nonsystemic understanding, but from mental models. More specifically, **new insights fail to get put into practice because they conflict with deeply held internal images of how the world works, images that limit us to familiar ways of thinking and acting.** That is why the discipline of managing mental models—surfacing, testing, and improving our internal pictures of how the world works— “promises to be a major breakthrough for building learning organizations. **None of us can carry an organization in our minds—or a family, a community. What we carry in our heads are images, assumptions, and stories. [...]**

Our "mental models" determine not only how we make sense of the world, but how we take action.”

Excerpt From: Peter M Senge. “The Fifth Discipline: The Art and Practice of the Learning Organization: First Edition.” iBooks.



COSTS, RESOURCES AND DRIVERS

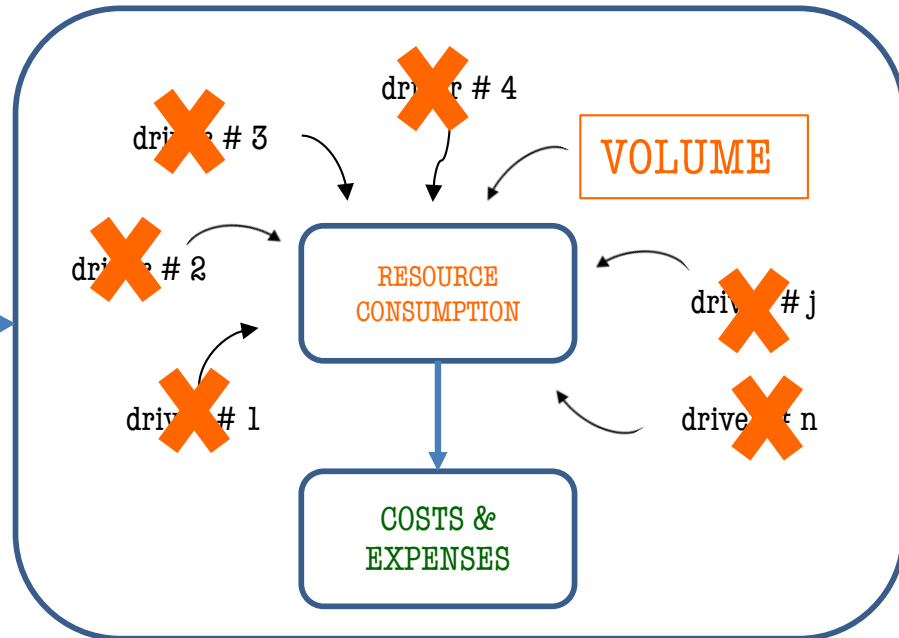


A **cost** is a sacrifice of resources. More precisely the cost (and therefore an expense) is the **monetary reflection of the sacrifice of one or more resources** that are used in order to perform business processes. The usage of a resource is determined by different kinds of causes (generally indicated in accounting as drivers)

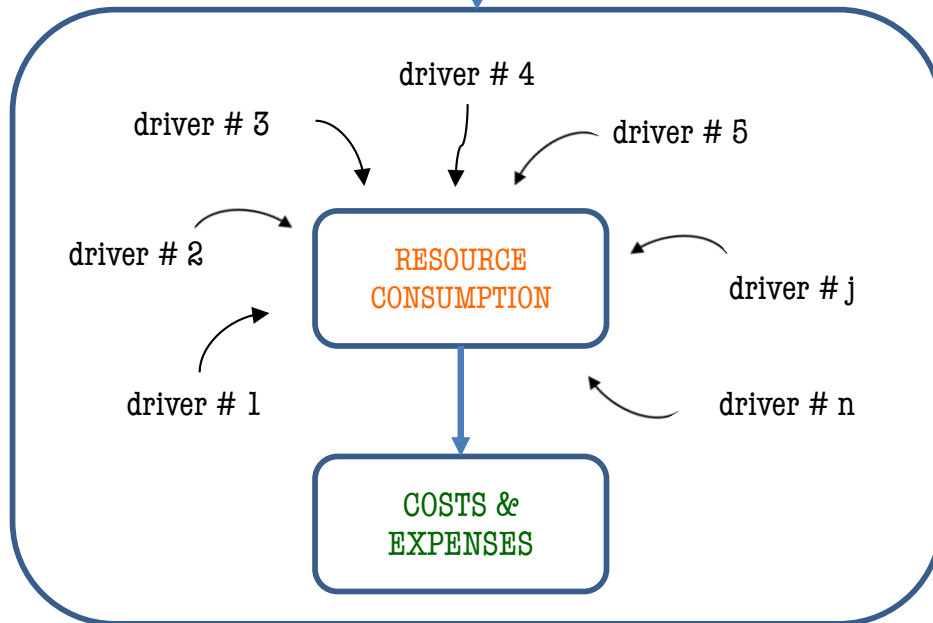
«The objective of **managerial costing** is to provide a monetary reflection of the utilization of business resources and related cause and effect insights».

COST-VOLUME-PROFIT MODEL

SELECTED CONCEPTS AND
SELECTED RELATIONSHIPS
BETWEEN THEM



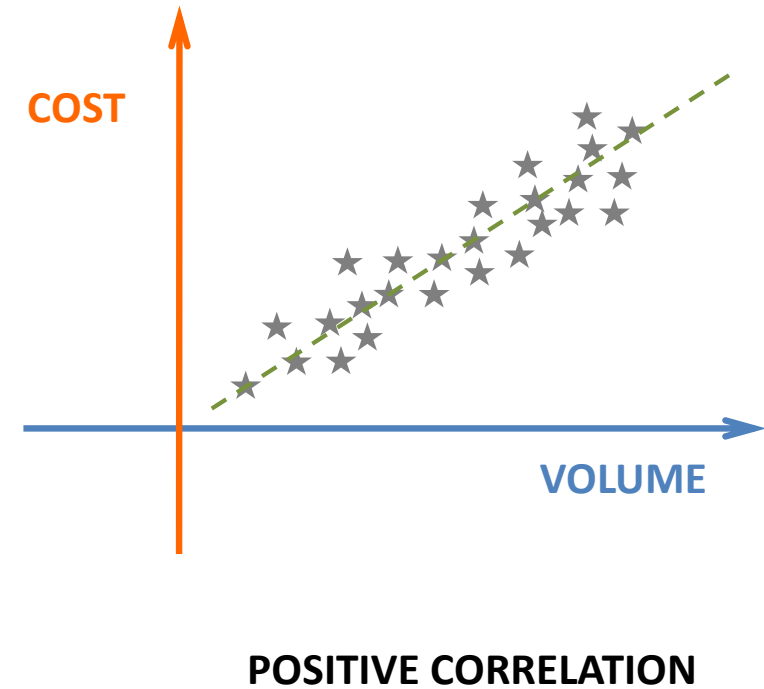
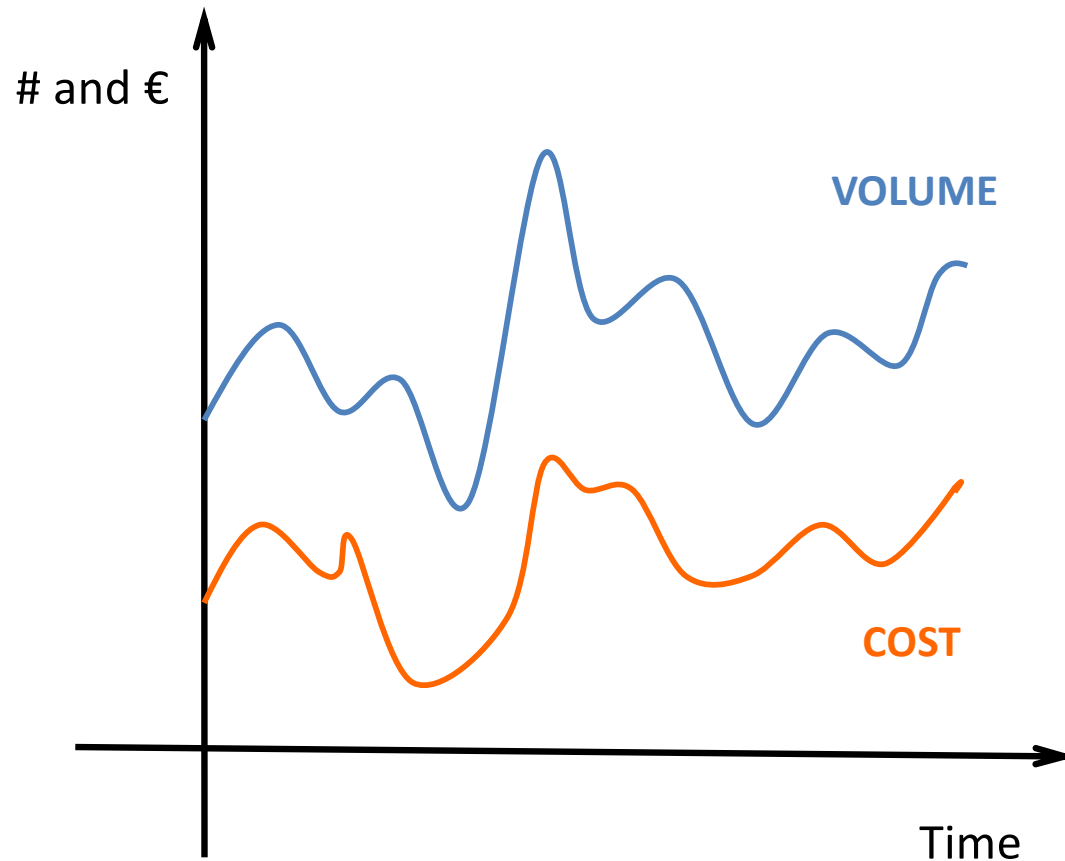
DECISION MODEL



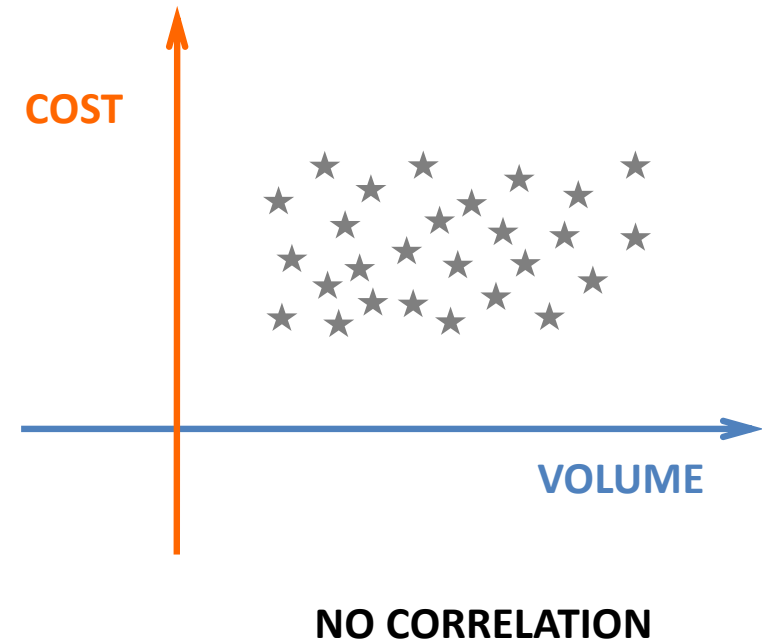
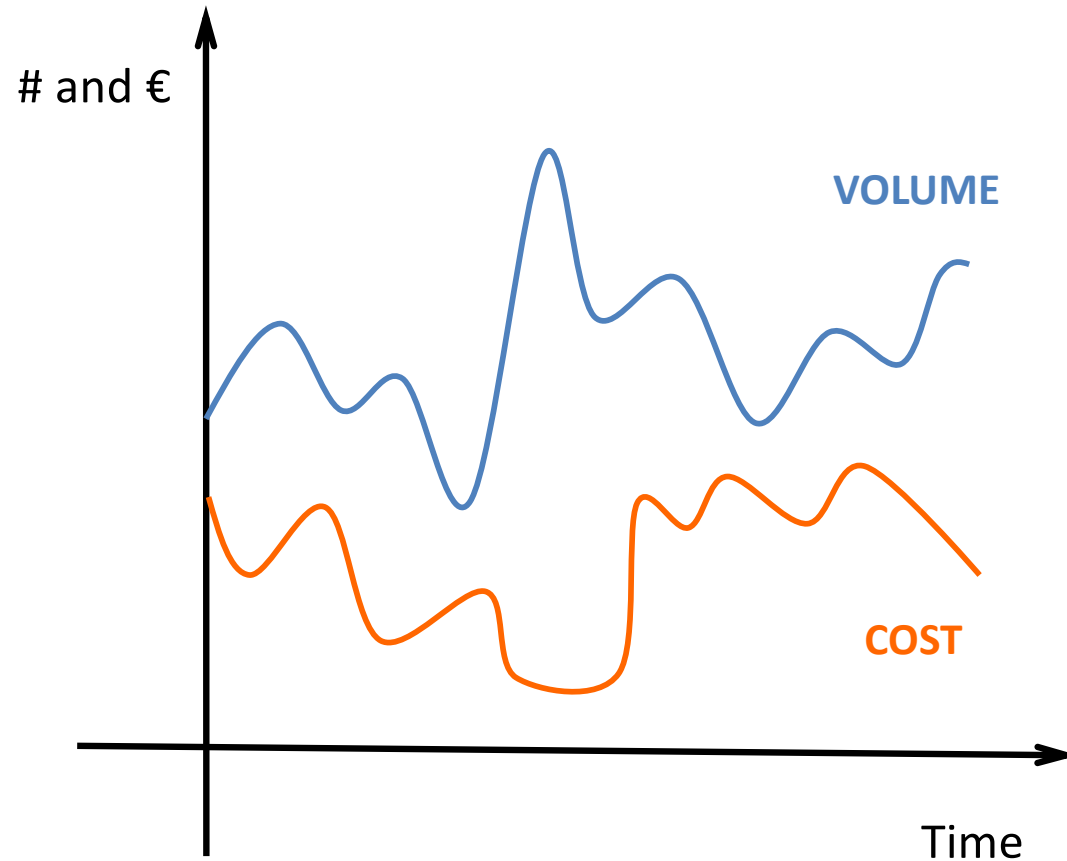
REALITY



VARIABLE: CORRELATED



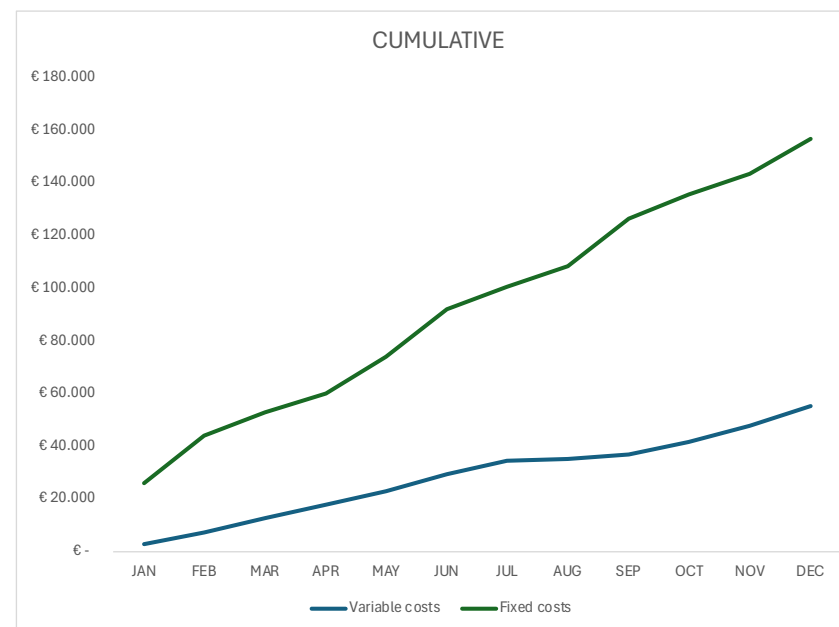
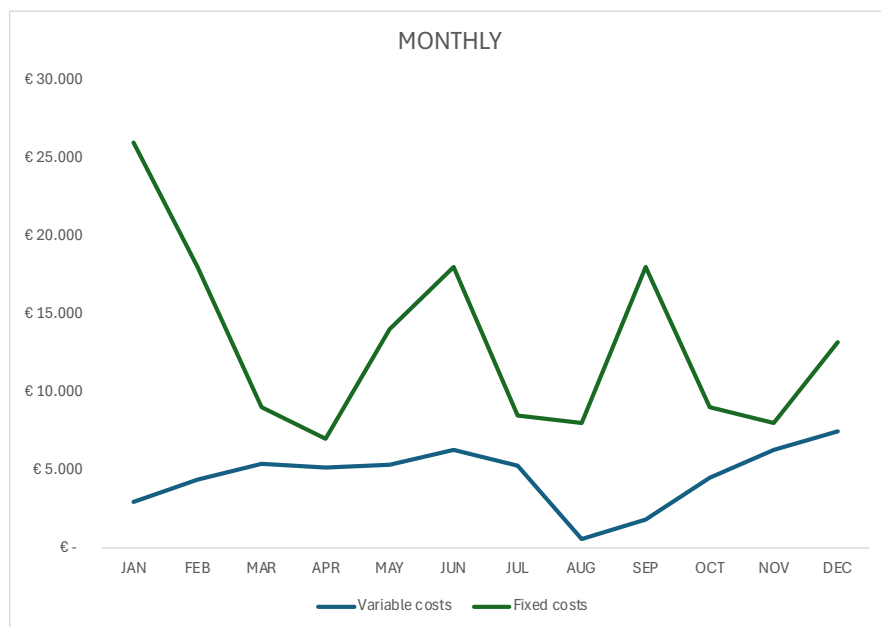
FIXED: UN-CORRELATED



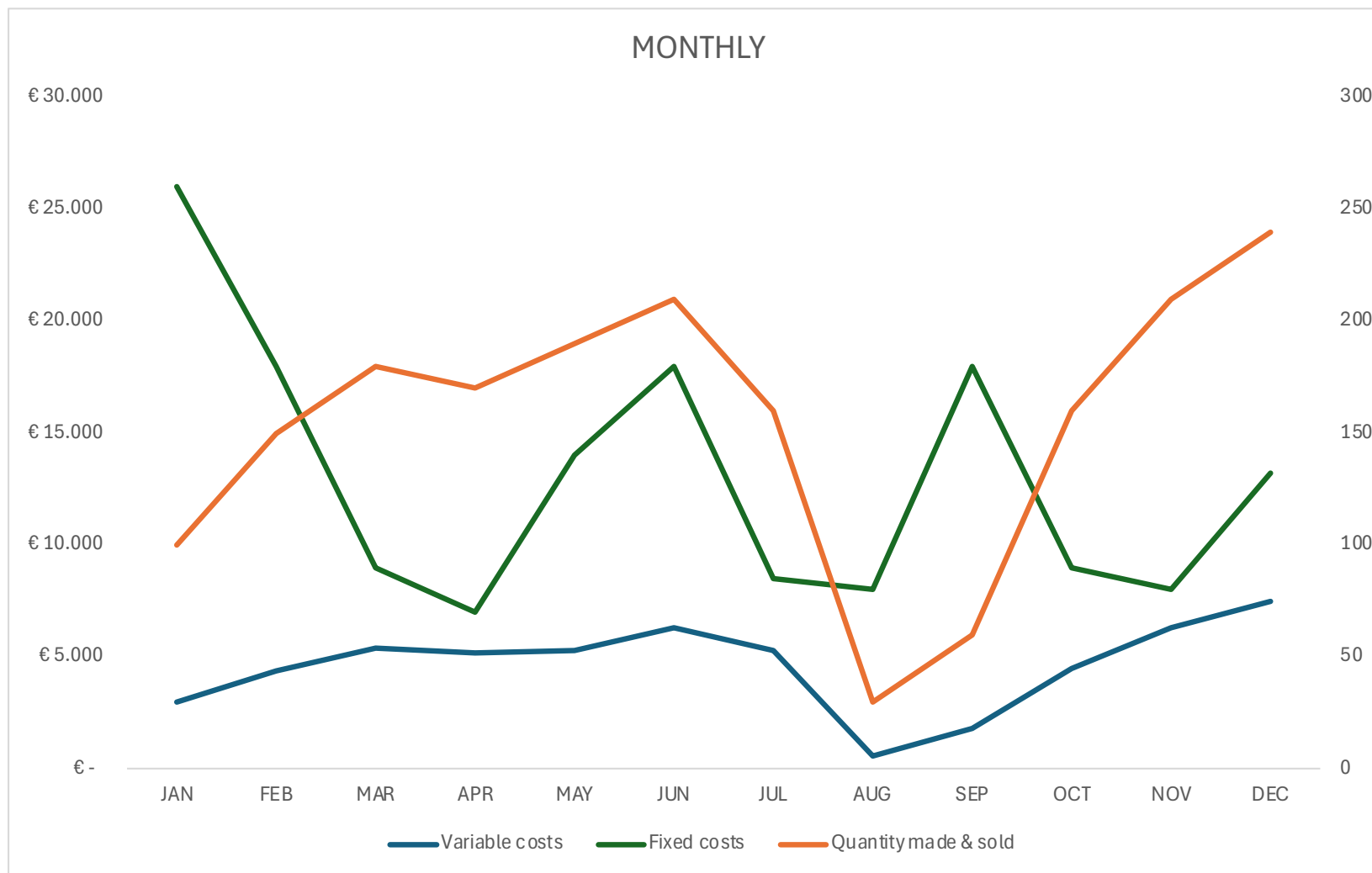
AN EXAMPLE (FOR EDUCATIONAL PURPOSES)

MONTHLY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Quantity made & sold	100	150	180	170	190	210	160	30	60	160	210	240
Variable costs	€ 2.884	€ 4.586	€ 5.178	€ 4.686	€ 5.257	€ 6.630	€ 5.088	€ 1.240	€ 2.059	€ 4.646	€ 6.458	€ 6.938
Fixed costs	€ 26.000	€ 18.000	€ 9.000	€ 7.000	€ 14.000	€ 18.000	€ 8.500	€ 8.000	€ 18.000	€ 9.000	€ 8.000	€ 13.200

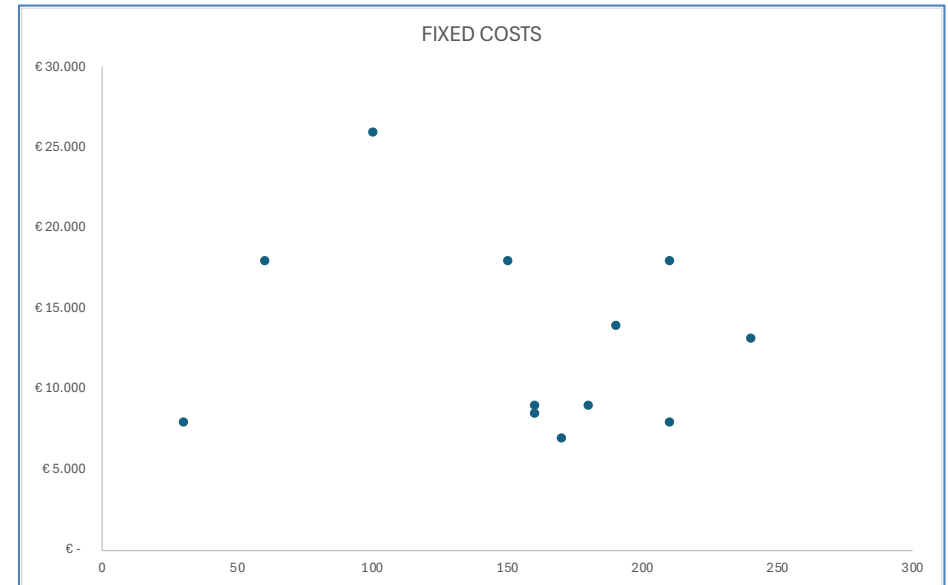
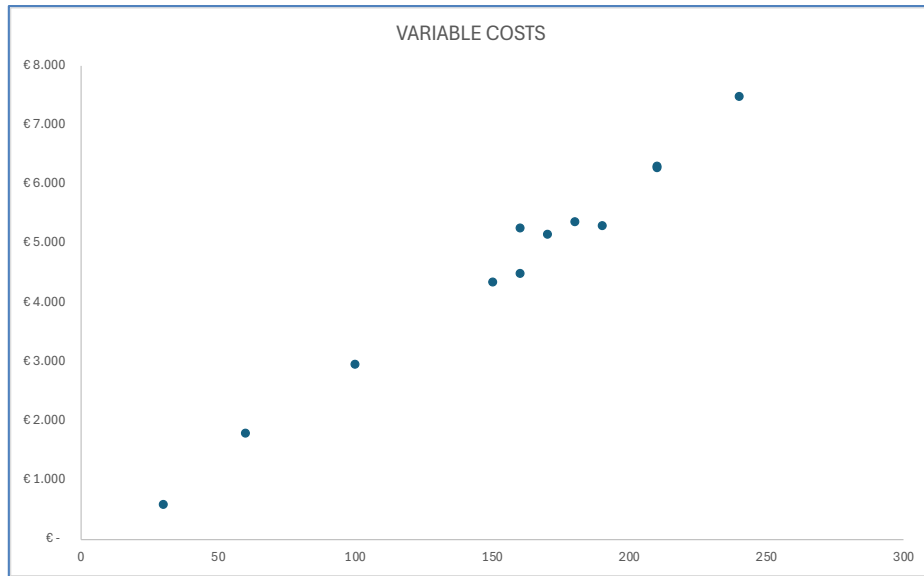
CUMULATIVE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Quantity made & sold	€ 100	€ 250	€ 430	€ 600	€ 790	€ 1.000	€ 1.160	€ 1.190	€ 1.250	€ 1.410	€ 1.620	€ 1.860
Variable costs	€ 2.884	€ 7.470	€ 12.648	€ 17.334	€ 22.591	€ 29.221	€ 34.309	€ 35.549	€ 37.608	€ 42.254	€ 48.712	€ 55.650
Fixed costs	€ 26.000	€ 44.000	€ 53.000	€ 60.000	€ 74.000	€ 92.000	€ 100.500	€ 108.500	€ 126.500	€ 135.500	€ 143.500	€ 156.700



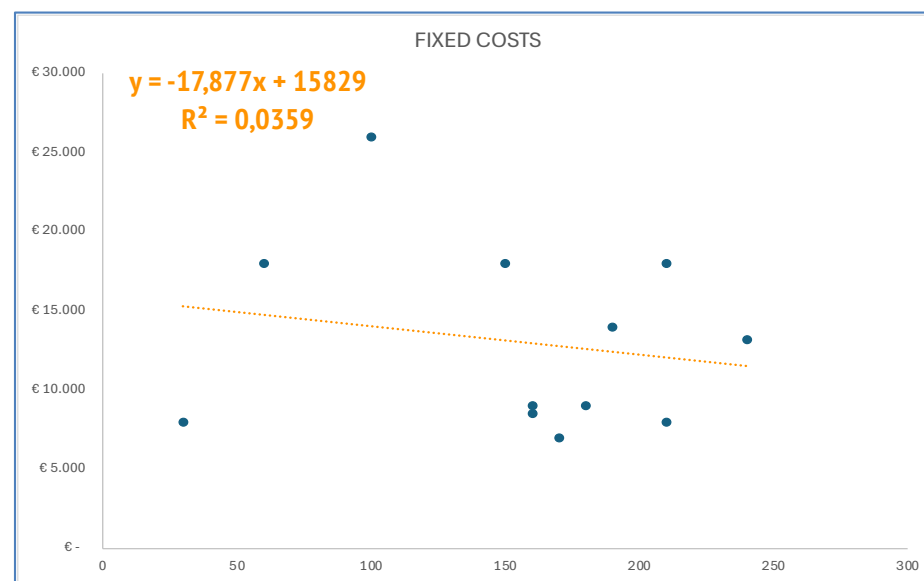
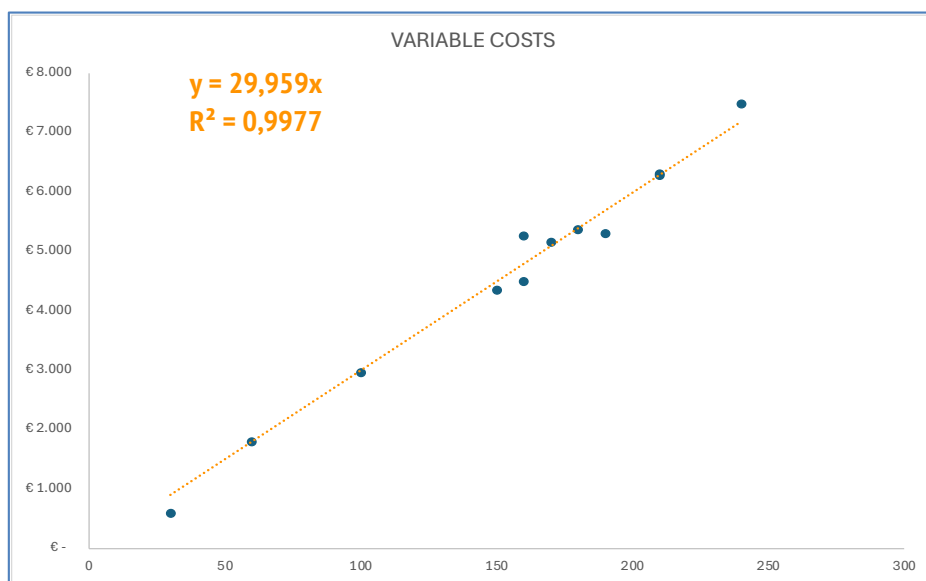
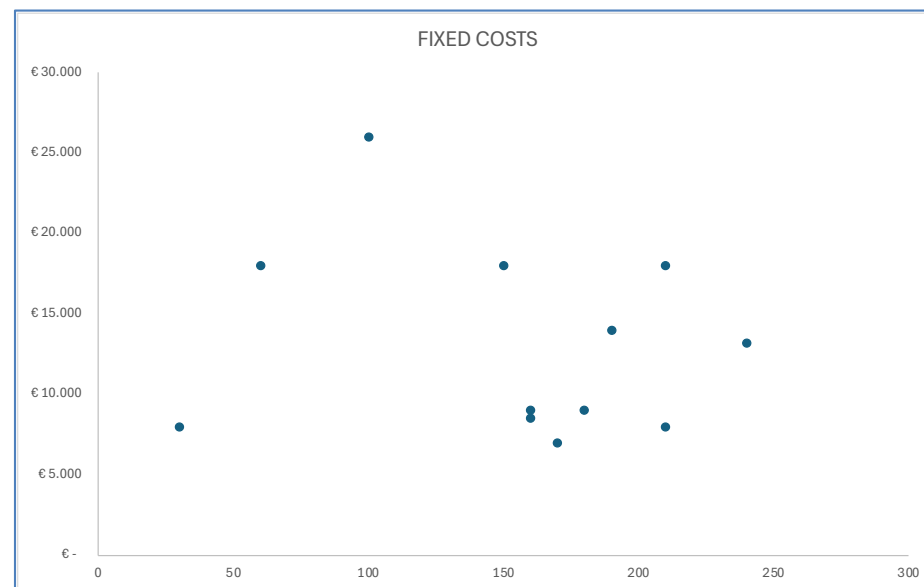
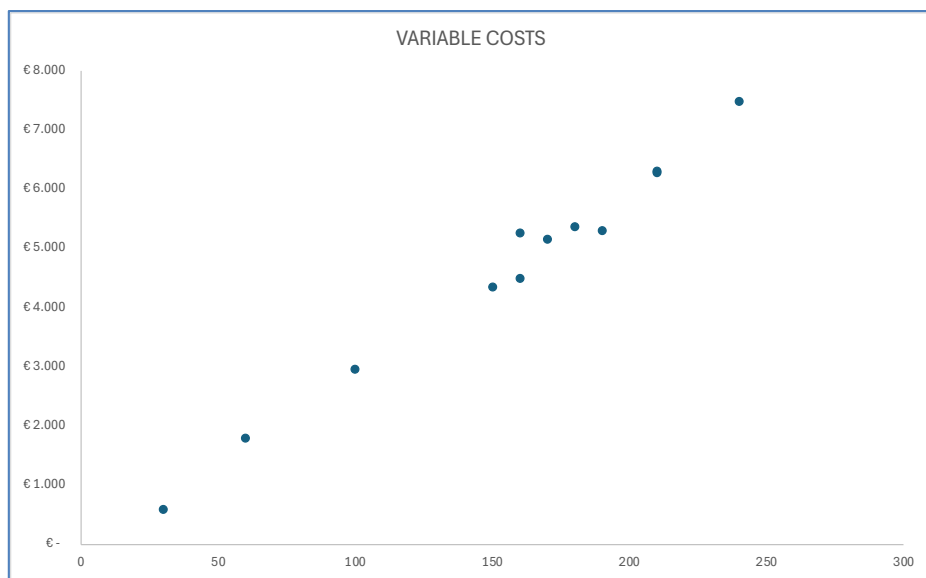
CORRELATED OR UN-CORRELATED?



CORRELATED OR UN-CORRELATED?

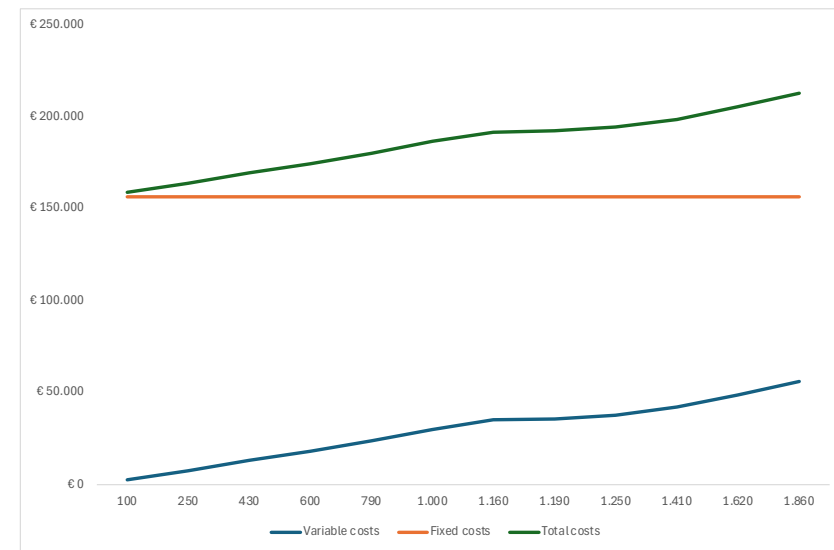
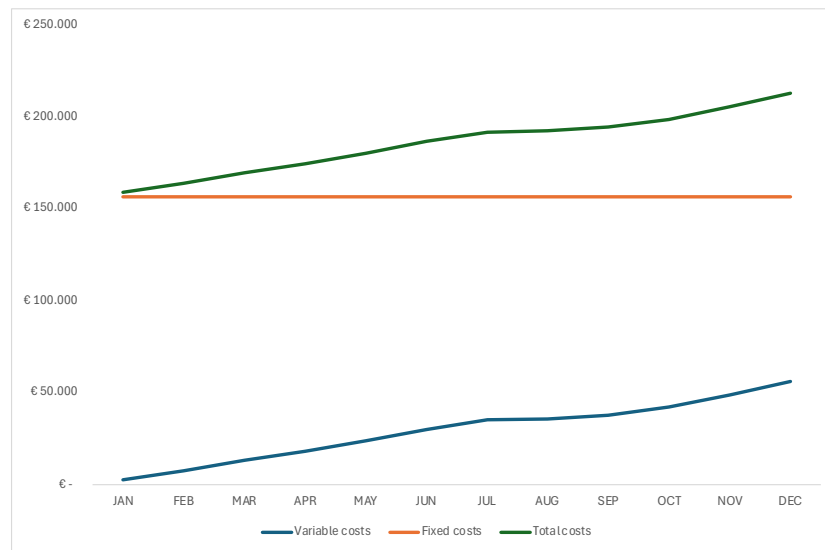


CORRELATED OR UN-CORRELATED?



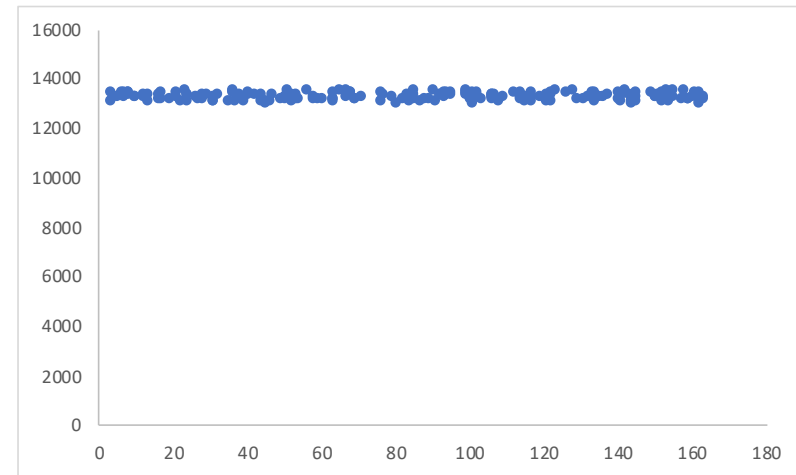
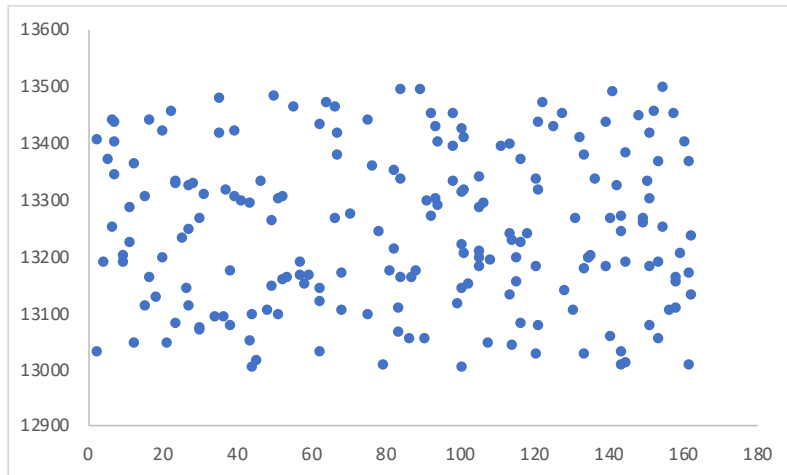
VARIABLE AND FIXED: “MONTHLY” (?) TRENDS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Quantity made & sold	100	250	430	600	790	1.000	1.160	1.190	1.250	1.410	1.620	1.860
Variable costs	€ 2.607	€ 7.408	€ 13.087	€ 18.050	€ 23.792	€ 29.985	€ 35.176	€ 35.858	€ 37.763	€ 42.196	€ 48.938	€ 56.134
Fixed costs	€ 156.700	€ 156.700	€ 156.700	€ 156.700	€ 156.700	€ 156.700	€ 156.700	€ 156.700	€ 156.700	€ 156.700	€ 156.700	€ 156.700
Total costs	€ 159.307	€ 164.108	€ 169.787	€ 174.750	€ 180.492	€ 186.685	€ 191.876	€ 192.558	€ 194.463	€ 198.896	€ 205.638	€ 212.834



In this slide, just to help understanding, an analysis has been developed that shows the evolution of variable costs over the different months, while the value of fixed costs is held constant over the annual value. Note that although months are shown in the x-axis, this indication refers more correctly to the quantities sold in the different months (as read more correctly in the graph on the right). Also note that since the quantity sold in different months is not constant, the variable cost function appears to take a different slope in different months. In reality, the slope is always the same if (as one should correctly do) the cost of the individual month is related to the quantity sold in that month.

UNCORRELATED BUT NORMALLY QUITE STABLE



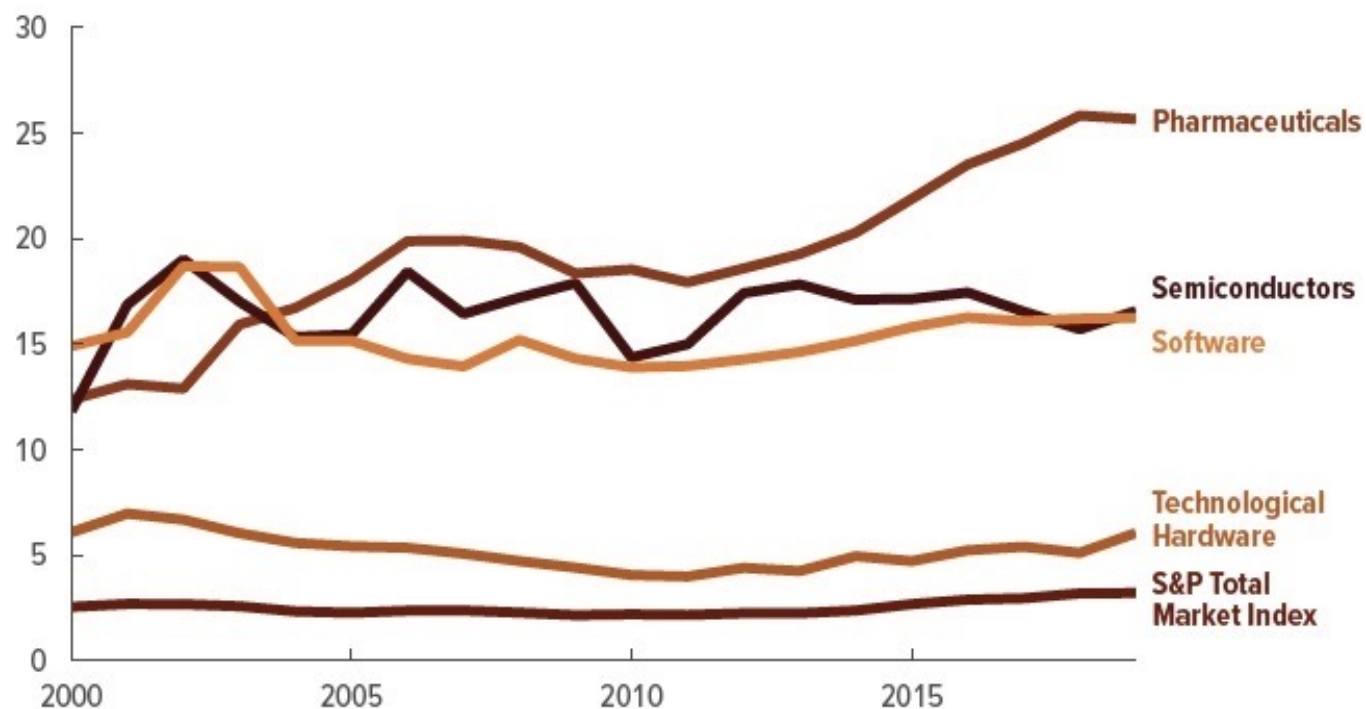
If nothing 'structural' changes (in particular, if there are no changes in production capacity or significant changes in prices), we can assume that the amount of fixed costs, while varying, remains sufficiently stable. This, of course, is hardly true in the long run precisely because in the long run structural changes are inevitable. In particular, production capacity will hopefully have to grow in order to follow the evolution of sales volumes. In the long run, therefore, all costs are variable.

ARE R&D EXPENSES VARIABLE?

Figure 1.

Average R&D Intensities for Publicly Traded U.S. Companies, by Industry

Percent



Pharmaceutical companies have devoted a growing share of their net revenues to R&D activities, averaging about 19 percent over the past two decades. By comparison, other research-intensive industries, like software and semiconductors, averaged about 15 percent.

Data source: Congressional Budget Office, using data from Bloomberg, limited to U.S. firms as identified by Aswath Damodaran, "Data: Breakdown" (accessed January 13, 2020), <https://tinyurl.com/yd5hq4t6>. See www.cbo.gov/publication/57025#data.

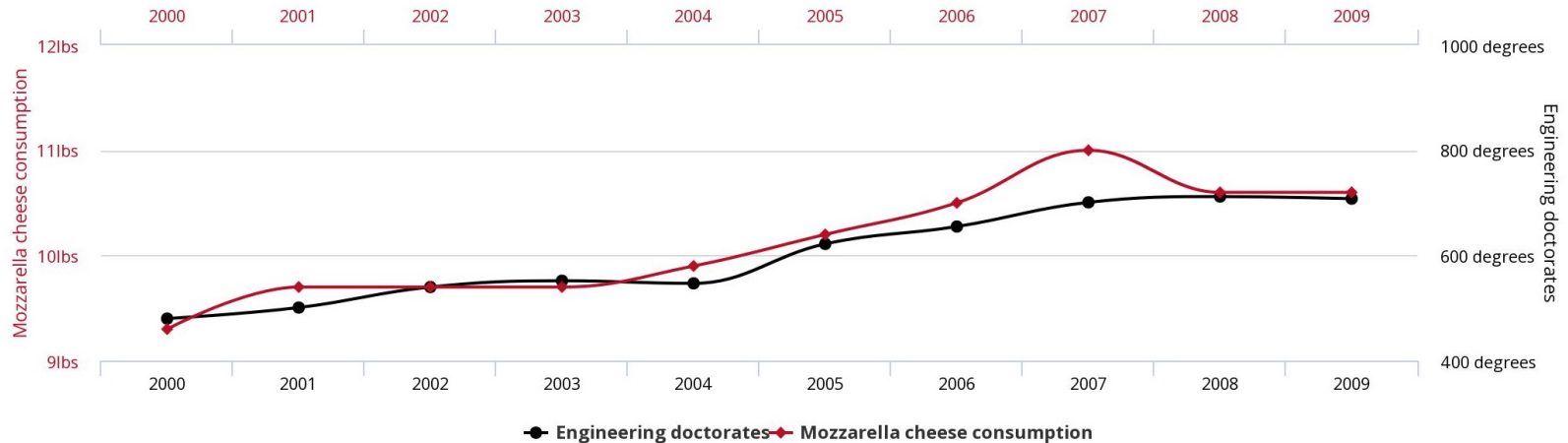
R&D intensity is research and development spending as a share of net revenues (sales less expenses and rebates).

R&D = research and development; S&P = Standard and Poor's.



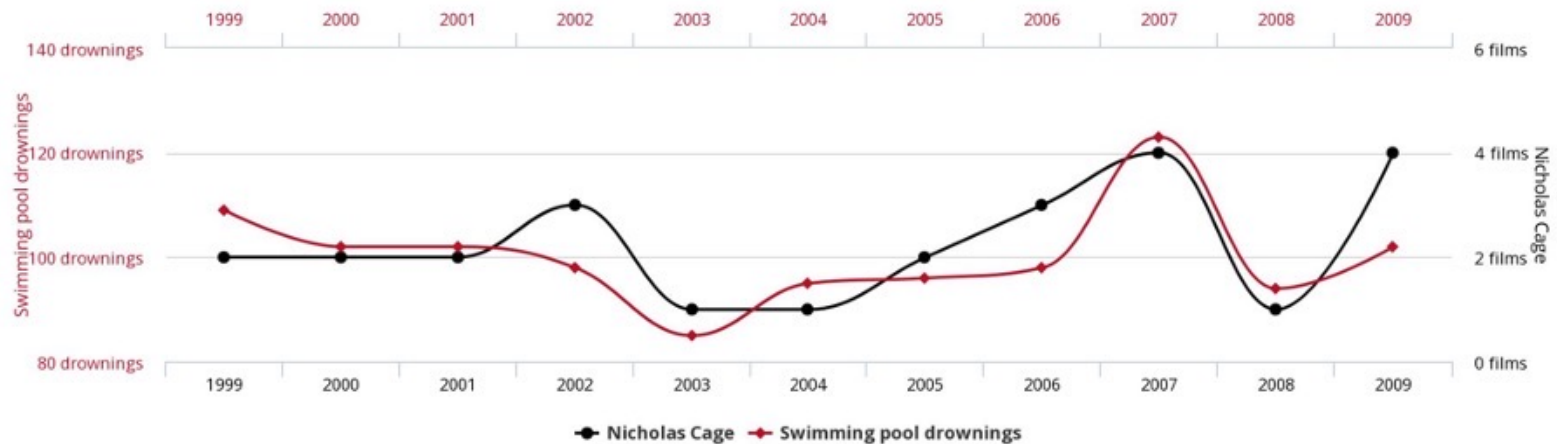
“CORRELATION IS NOT CAUSATION”

Per capita consumption of mozzarella cheese
correlates with
Civil engineering doctorates awarded



tylervigen.com

Number of people who drowned by falling into a pool
correlates with
Films Nicolas Cage appeared in



tylervigen.com



“CORRELATION IS NOT CAUSATION”



<https://youtu.be/esOnPjLNsi0>



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KAPLAN FINANCIAL



For over 25 years, Kaplan Financial has been helping medical schools and training hospitals promote financial literacy in their graduates. [...] Our seminars have been refined and updated throughout the years to focus on the specific financial issues that most directly impact physicians in training. In a recently published study of lectures designed to help medical students with their financial literacy, Kaplan Financial received the highest marks from attendees of any speaker.

Contact us today to schedule a seminar or to learn more about Kaplan Financial's complimentary lecture series.



KAPLAN FINANCIAL - SEMINAR COSTS

- ✧ Speaker
- ✧ Flipchart pads
- ✧ Markers
- ✧ Binders, notepads, pens
- ✧ Auditorium, conference room,
- ✧ Coffee, beverages, fruit and snacks
- ✧ Computer and Projector
- ✧ Energy costs



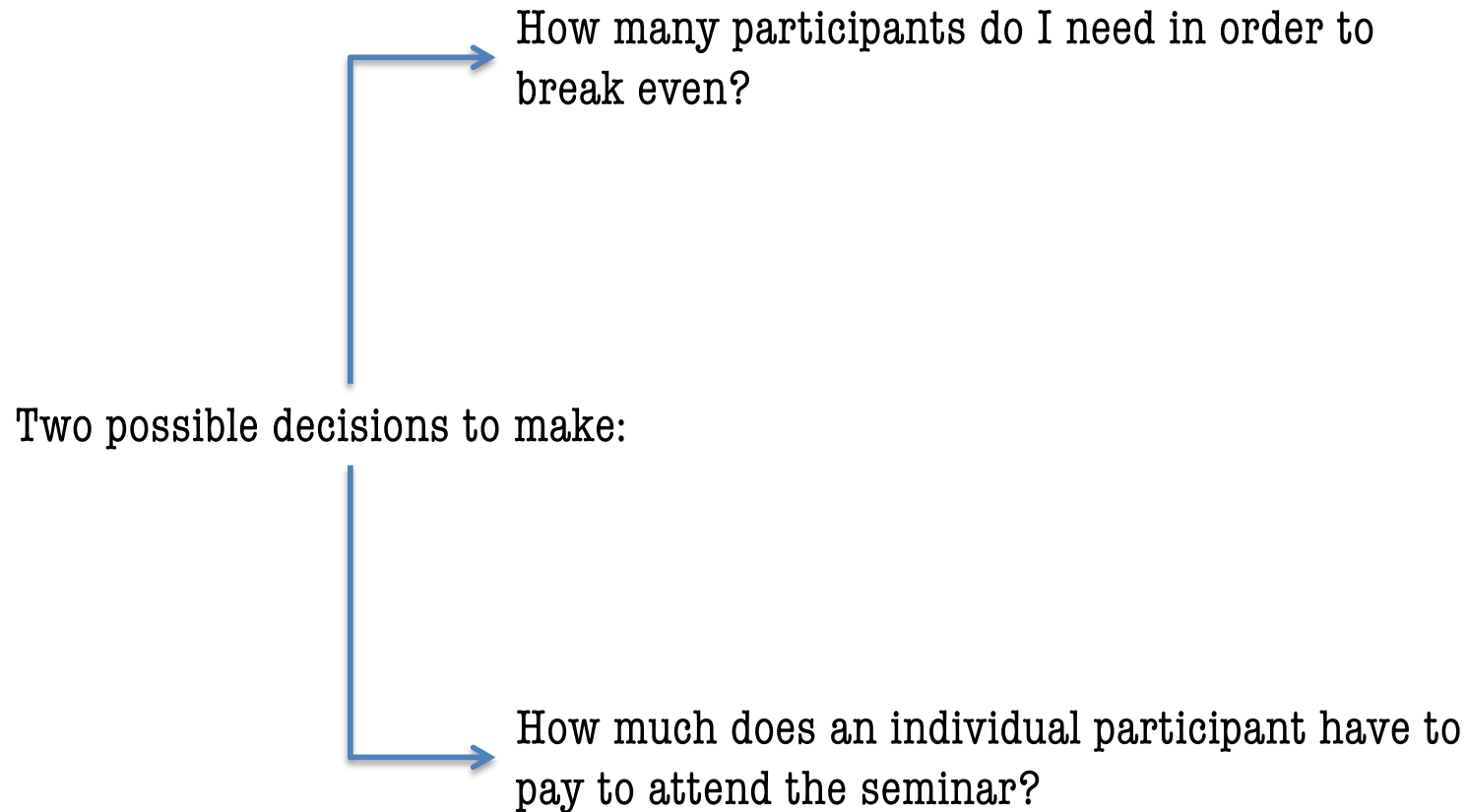
COHERENCE BETWEEN INFORMATION AND DECISIONS



DECISION MODELS

The information must be **RELEVANT** for the decisions that managers, operating in a particular business environment with a particular strategy, make.

KAPLAN FINANCIAL - SEMINAR COSTS

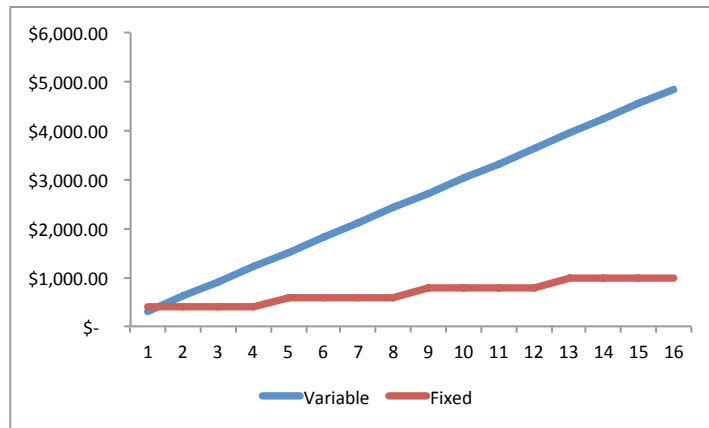


FIXED OR VARIABLE?

	# PARTECIPANTS	# HOURS
Speaker	Fixed	Variable
Flipchart pads	Fixed	Variable
Markers	Fixed	Variable
Binders, notepads, pens	Variable	Fixed/Variable
Auditorium, conference room,	Fixed	Variable
Coffee, beverages, fruit and snacks	Variable	Fixed/Variable
Computer and Projector	Fixed	Variable
Energy costs	Fixed/Variable	Variable

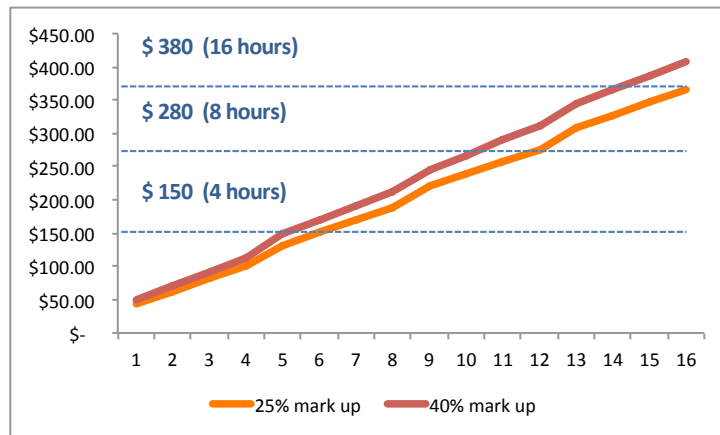


HOW MUCH DOES AN INDIVIDUAL PARTICIPANT HAVE TO PAY?



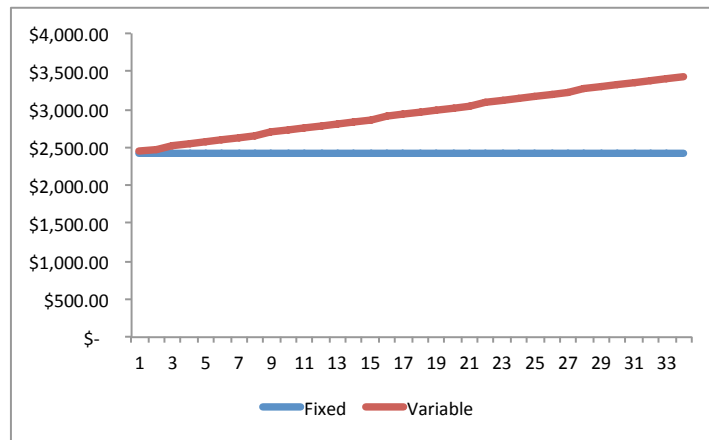
Analysis of cost behavior using “number of hours” as a parameter

Target number of participants: 20

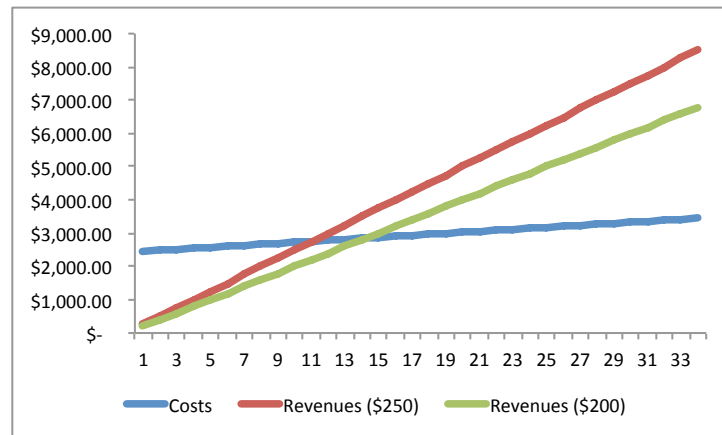


Comparison with competitors' prices for different “formats”

HOW MANY PARTICIPANTS DO I NEED IN ORDER TO BREAK EVEN?



Analysis of cost behavior using “number of participants ” as a parameter



Break even point in term of number of participants needed

TELECOM SERVICE PROVIDERS: ORIGINALLY

BT Business Communications
Ref: W0500/F
Walton House
34 St James' Street
Nottingham NG1 1BA

Your Customer No. CM 5970
Date (and tax point) 26 May 1993

Tel Billing enquiries call
0800 526309
Mon-Sat 8am - 6pm
Fax 0602 484020
Telex 444781

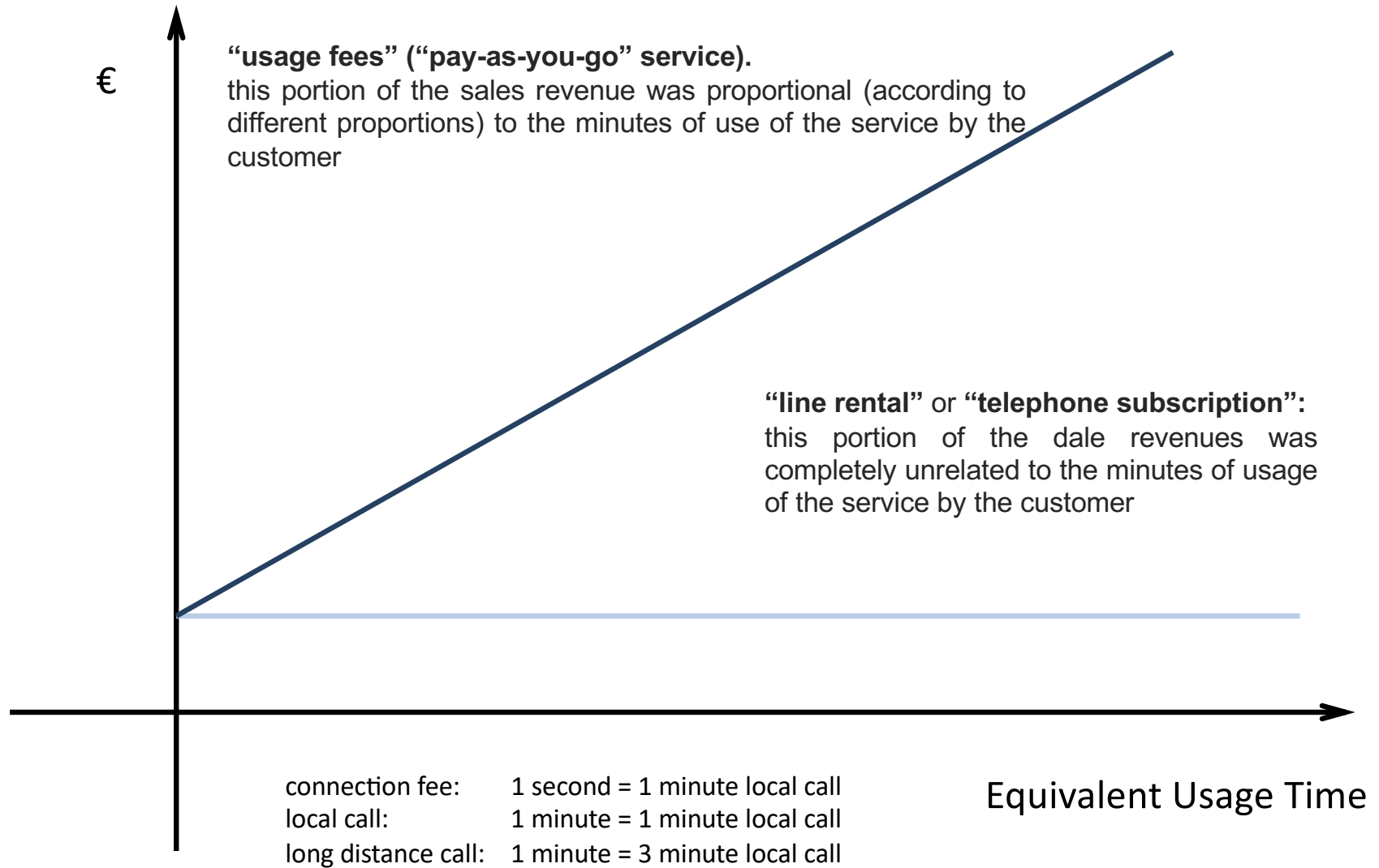
Phone bill for 021-360

Your bill is	£ 123.21	Call charges	£ 123.213 for direct-dialled calls <small>See Breakdown pages L-7</small>
plus	£ 31.65	Advance charges from 1 May 93 to 31 Jul 93	£ 31.65 for the rental of your line
	£ 154.86	Subtotal excluding VAT	
plus	£ 27.10	VAT at 17.5%	
	£ 181.96	Total amount now due	

variable sales revenue (points to Call charges)

fixed sales revenue (points to Total amount now due)

TELECOM SERVICE PROVIDERS: ORIGINALLY



TELECOM SERVICE PROVIDERS: NOW

att.com



Monthly Statement

JOHN G DOE
123 ANY STREET
DULUTH GA 30097-1234

Page 1 of 2
Account Number 678 123-1234 545 1889
Billing Date Mar 05, 2010

Web Site att.com

Bill-At-A-Glance	
Previous Bill	29.05
Payment Received 2-11 Thank You!	29.05CR
Adjustments	.00
Balance	.00
Current Charges	29.05
Total Amount Due	\$29.05
Amount Due in Full by	Mar 27, 2010

AT&T Benefits

- Smarter TV. Better value. AT&T U-verse. There has never been a better time to get AT&T U-verse. Now you can get incredible channels and features at a better value than cable. Plus, you can take advantage of some of our best offers ever. Geographic and service restrictions apply. Call 1.866.291.2278 or go online at att.com/uversenow today!

Plans and Services

Monthly Service - Mar 5 thru Apr 4	
1. Residential Line	17.55

Billing Summary

Questions? Visit att.com	Page	
Plans and Services	1	29.05
1 888-757-6500		
PIN: 9999		
Repair Service:		
611		
Total Current Charges		29.05

Surcharges and Other Fees

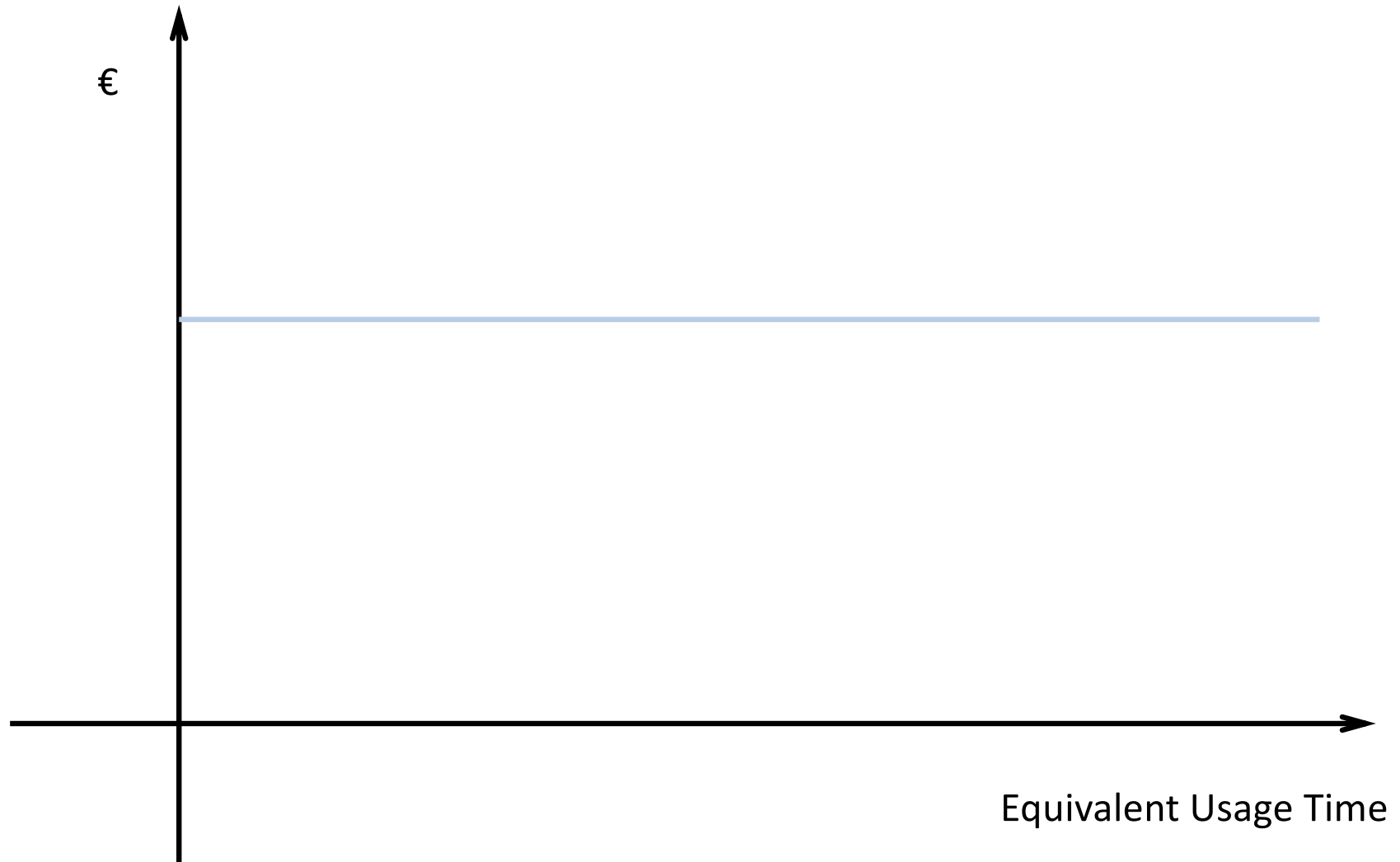
Item	No.	Description	Quantity	
	2.	Federal Universal Service Fee	1	.91
	3.	Federal Subscriber Line Charge	1	6.50
Total Surcharges and Other Fees				7.41

Government Fees and Taxes

Item	No.	Description	Quantity	
	4.	Federal Excise Tax		.74
	5.	GA - State/Local Tax		1.27
	6.	GA-Johns Creek Franchise Fee		.53
	7.	Telecommunication Relay Svc Fund	1	.05
	8.	Emergency 911 - Johnscreek	1	1.50
Total Government Fees and Taxes				4.09
Total Plans and Services				29.05

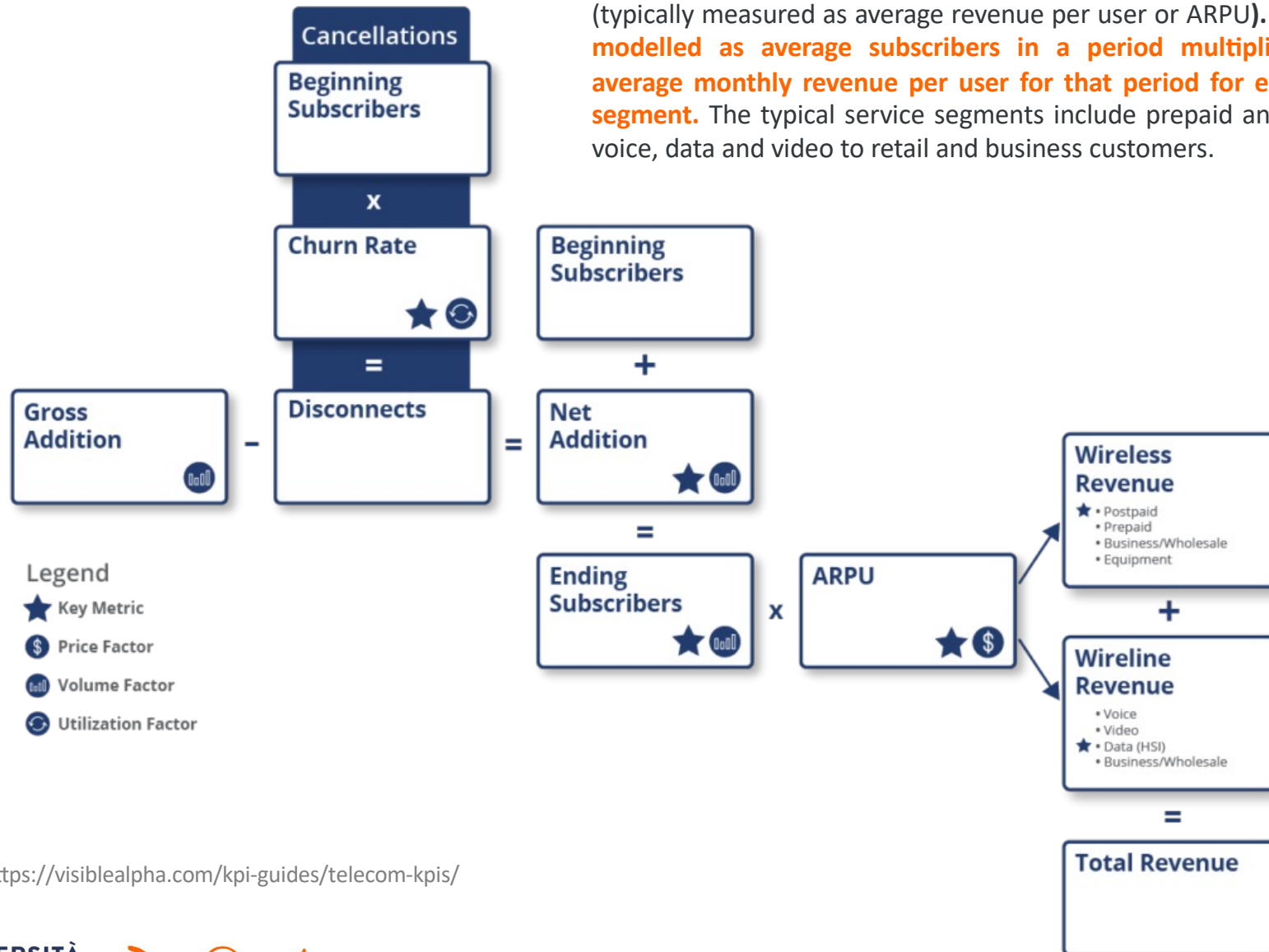


TELECOM SERVICE PROVIDERS: NOW



TELECOM SERVICE PROVIDERS: NEW BUSINESS MODEL

A TSP's primary business model is driven by the volume of their subscribers and the price they charge for the services rendered (typically measured as average revenue per user or ARPU). **Revenue is modelled as average subscribers in a period multiplied by the average monthly revenue per user for that period for each service segment.** The typical service segments include prepaid and post-paid voice, data and video to retail and business customers.



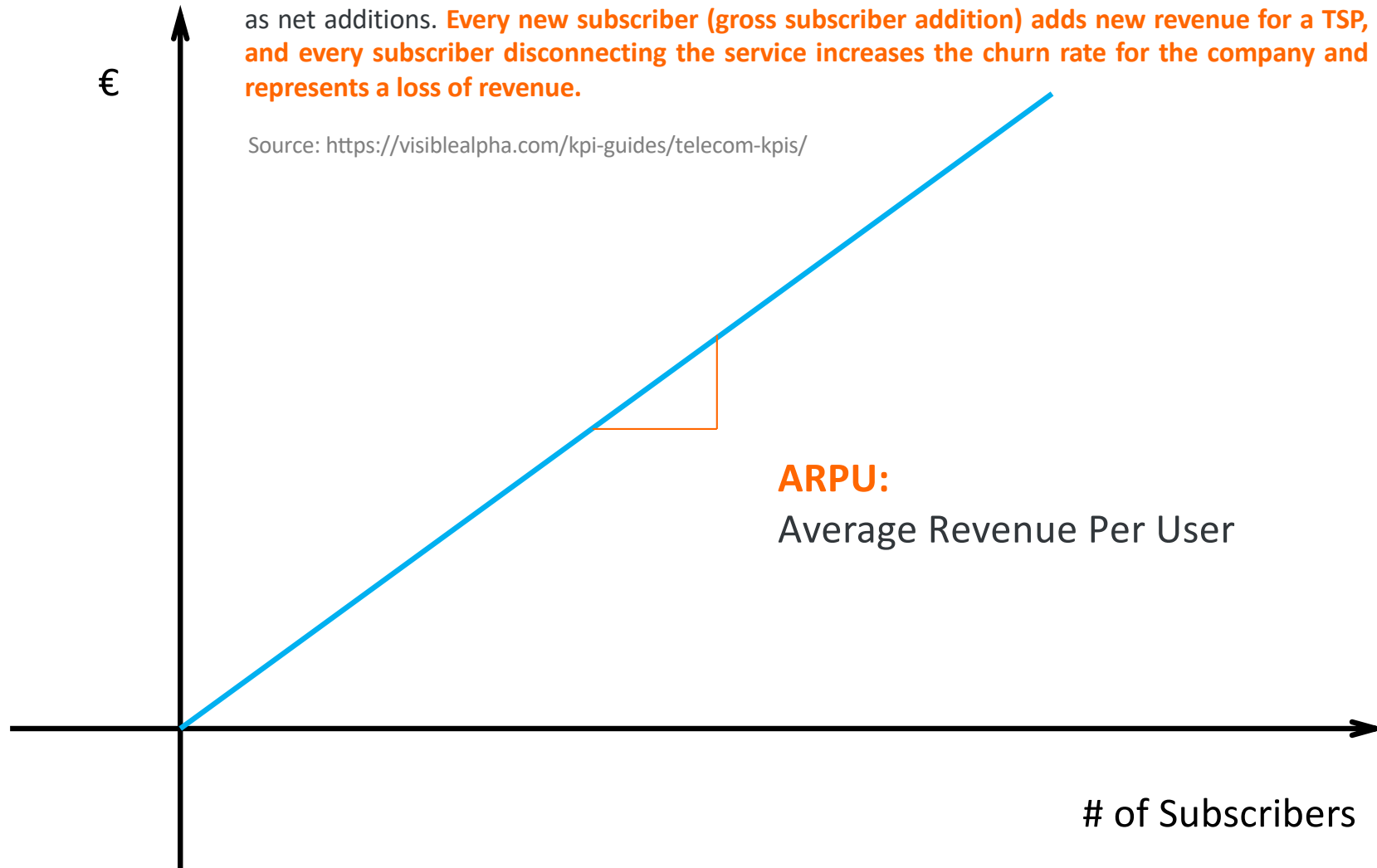
Source: <https://visiblealpha.com/kpi-guides/telecom-kpis/>



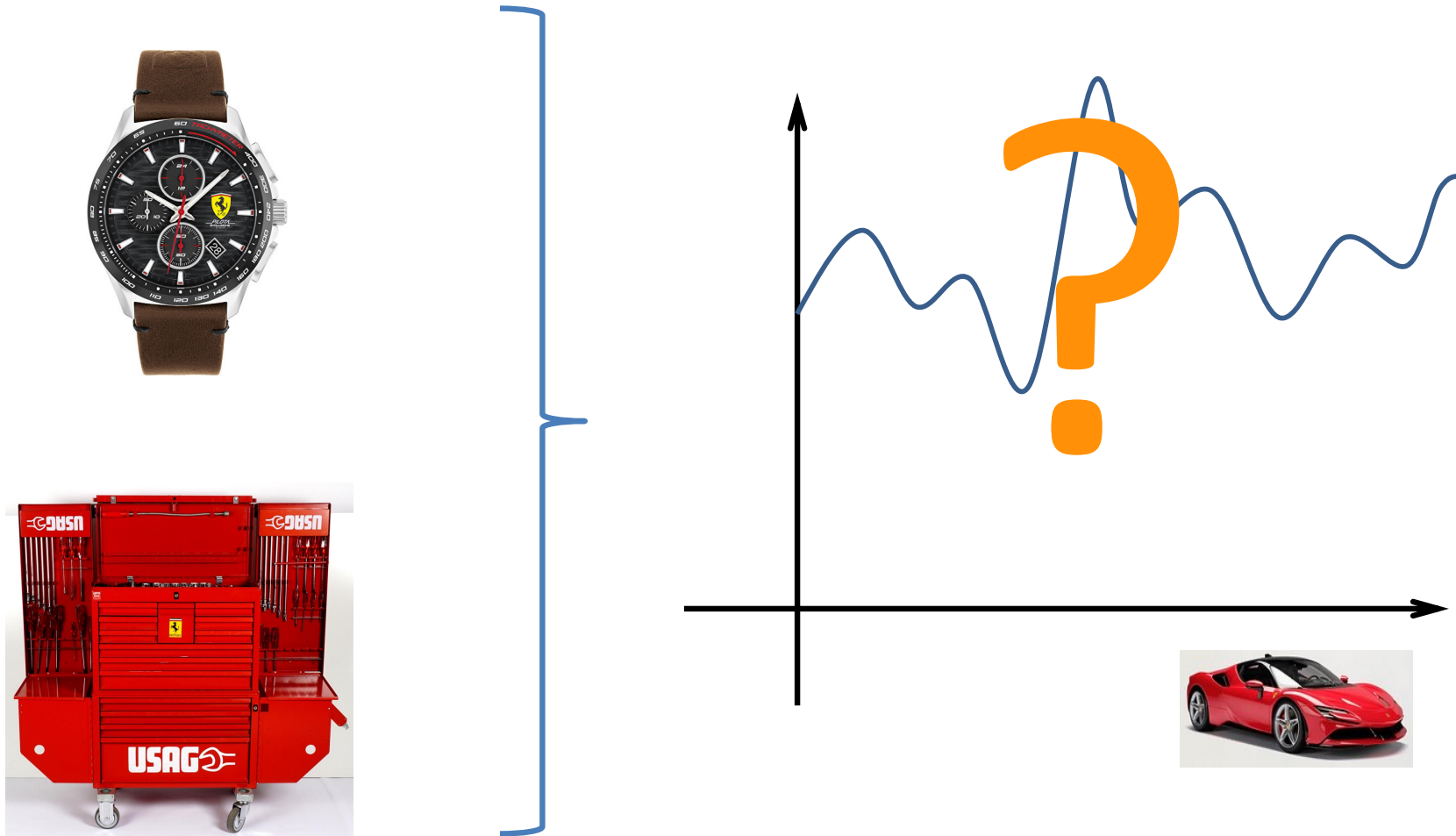
TELECOM SERVICE PROVIDERS: NOW

As a customer-facing business, **one of the key metrics tracked by investors for TSPs is ending subscribers**. Increases and decreases in subscribers are also closely monitored and are identified as net additions. **Every new subscriber (gross subscriber addition) adds new revenue for a TSP, and every subscriber disconnecting the service increases the churn rate for the company and represents a loss of revenue.**

Source: <https://visiblealpha.com/kpi-guides/telecom-kpis/>

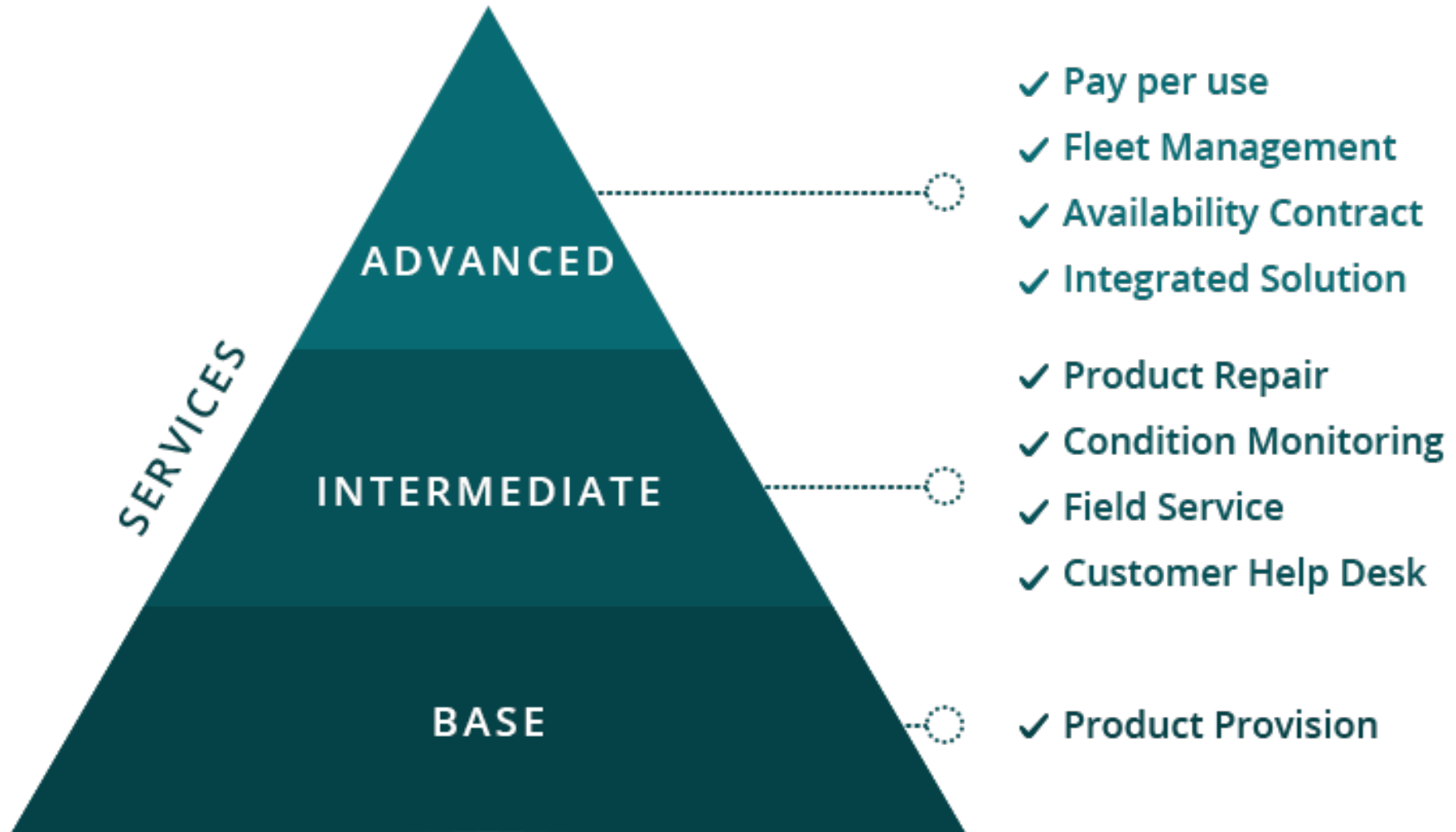


REVENUES FROM TRADEMARK USE (ROYALTIES)



A royalty is a legally binding payment made to an individual or company for the ongoing use of their assets, including copyrighted works, franchises, and natural resources.

SERVITIZATION



SOURCE: <https://caddify.com/2019/12/07/why-does-successful-servitization-require-mobile-apps/>



WHAT IS SERVITIZATION?

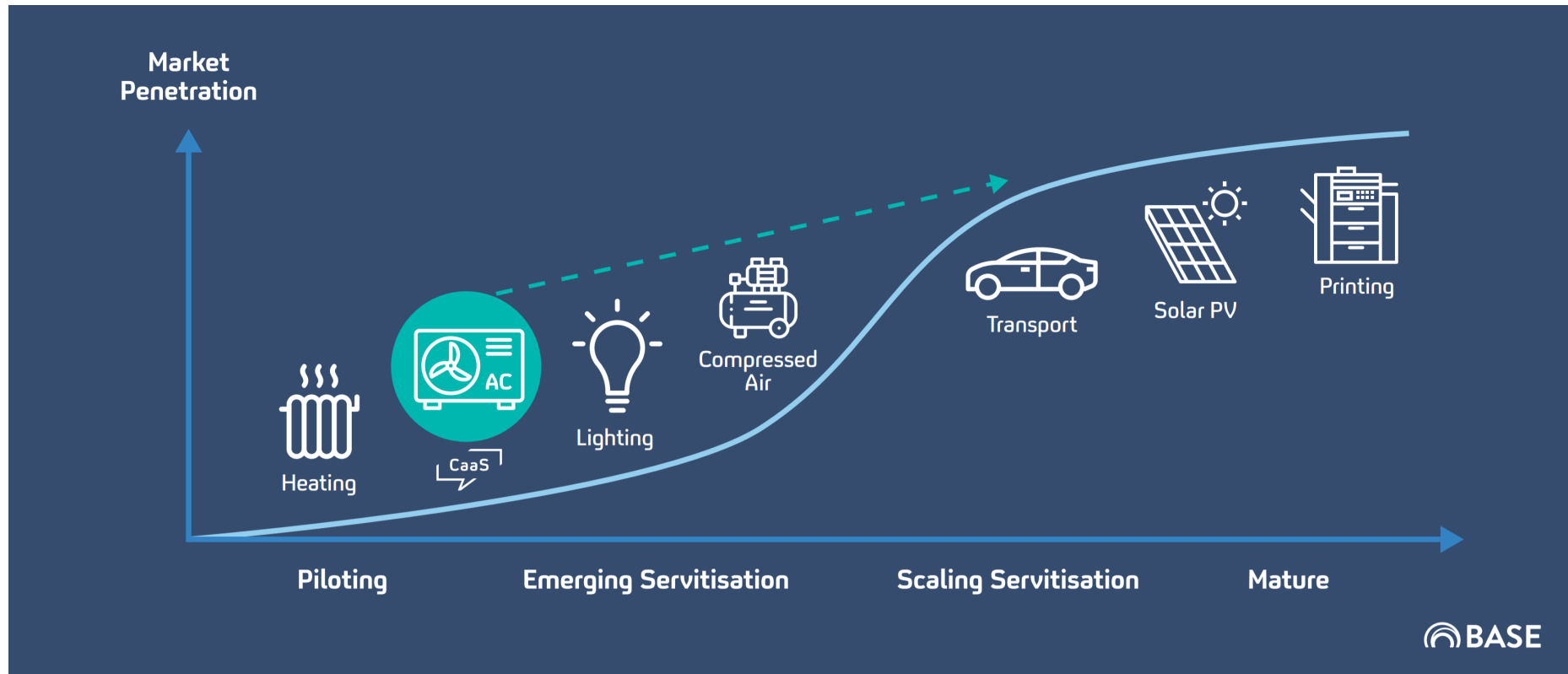
With a servitization model, the customer pays a fixed fee per unit of service consumed, while the ownership of the system remains with the technology provider, who remains responsible for all operation costs. As such, the model strongly incentivises the equipment owner – that is, the service provider – to think long-term when designing and selecting the technology. By offering state-of-the-art maintenance, the provider can minimise operating costs, in particular energy use, which is the largest cost component over the life cycle of the equipment. Keeping ownership of the equipment also encourages service providers to rethink the development of modular systems, which is key to a circular economy.

Examples include the printing company Xerox that offers 'pay-per-copy', and SunEdison, which has pioneered power purchase agreements (PPAs) for solar photovoltaics (PV); this enables rapid uptake of solar PV by allowing customers to purchase solar energy instead of investing in the panels themselves. Lighting company Signify has also adopted the model with their light-as-a-service product, which has been implemented at Amsterdam's Schiphol Airport and other locations.

SOURCE: <https://www.weforum.org/stories/2020/11/what-is-servitization-and-how-can-it-help-save-the-planet/>



A RAPIDLY EVOLVING PHENOMENON



SOURCE: <https://www.weforum.org/stories/2020/11/what-is-servitization-and-how-can-it-help-save-the-planet/>



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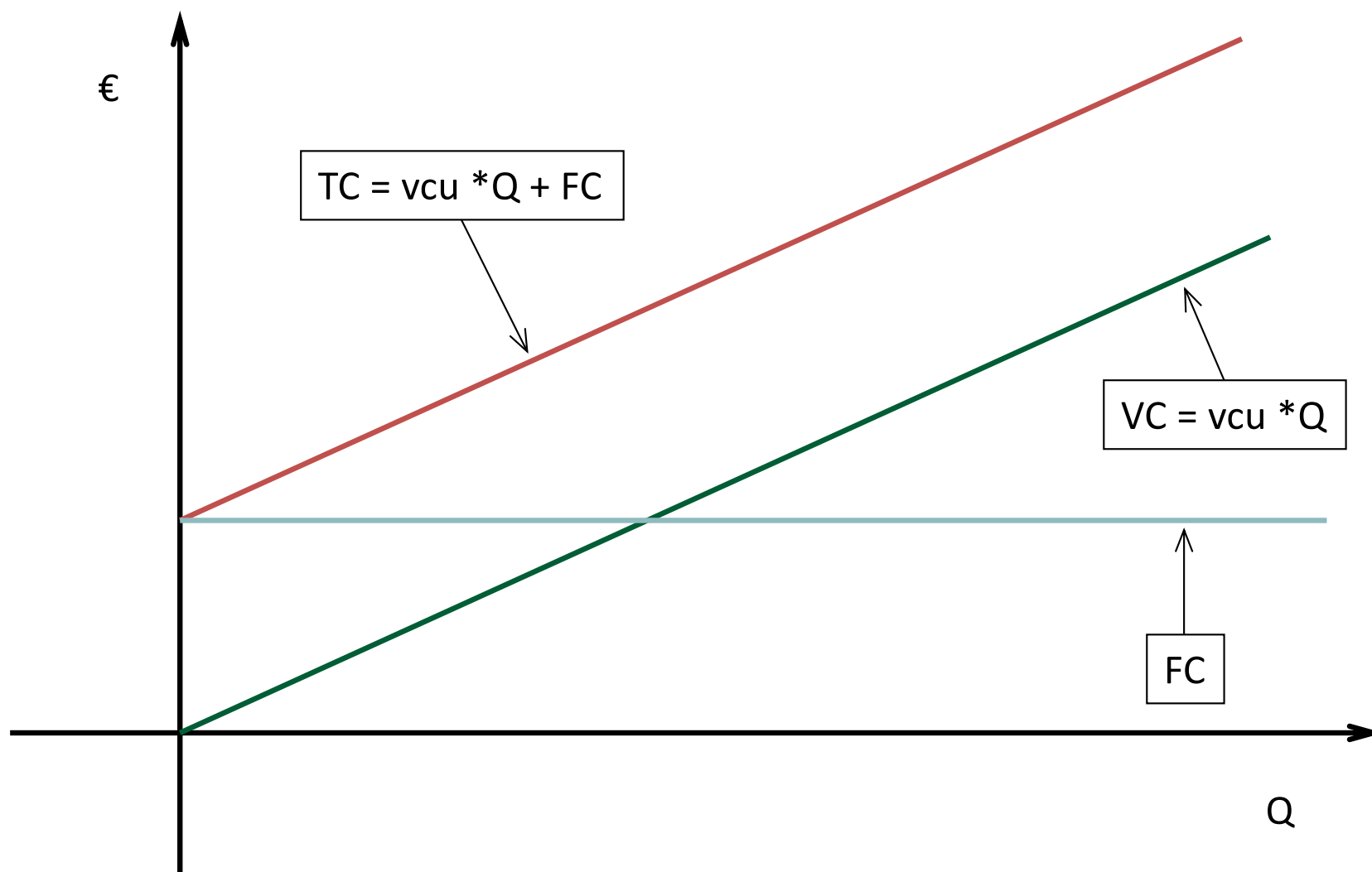
SELECTED COMPANY THAT HAVE INTRODUCED PAY-PER-USE

Company	Product	Offer	Pricing model
Winterhalter	Domestic electrical appliances	Next Level Solution	Pay-per-wash
Rolls Royce	Aeronautic engines	Total Care	Pay-per-hour-flown
Atlas Copco	Compressed air	Air Plan	Pay-per-m ³
Zipcar	Mobility	Car Sharing	Pay-per-hour
Amazon Web Service	IT services	Cloud Computing	Pay-per-GB
Michelin	Tires	Michelin Effitires	Pay-per-mile
Samoa Air	Air transport	Intera offerta	Pay-per-kilo

SOURCE: Danilo Zatta, *The Pricing Model Revolution: How Pricing Will Change the Way We Sell and Buy On and Offline*, John Wiley & Sons, 2022.

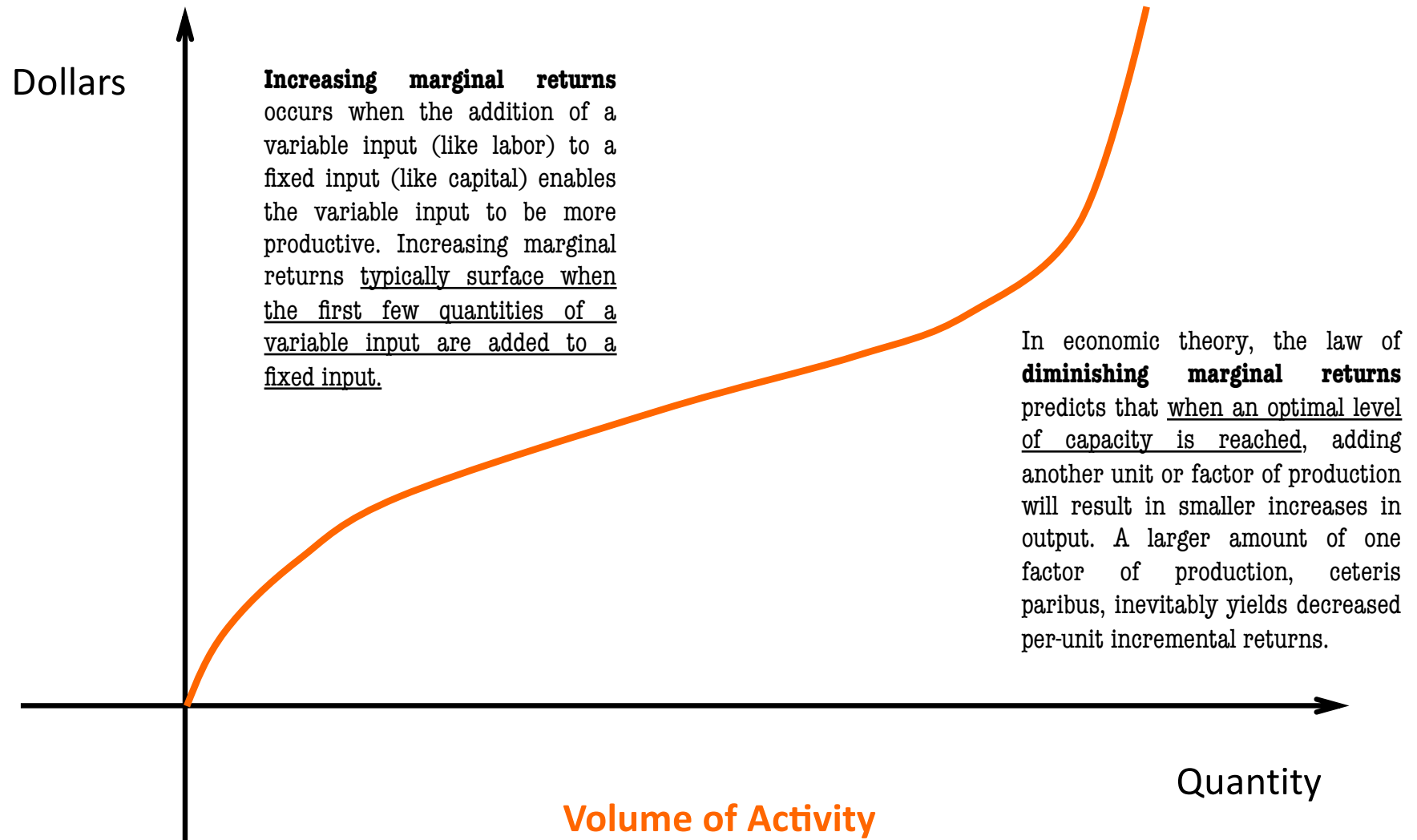


VARIABLE AND FIXED COSTS IN GRAPHIC FORM

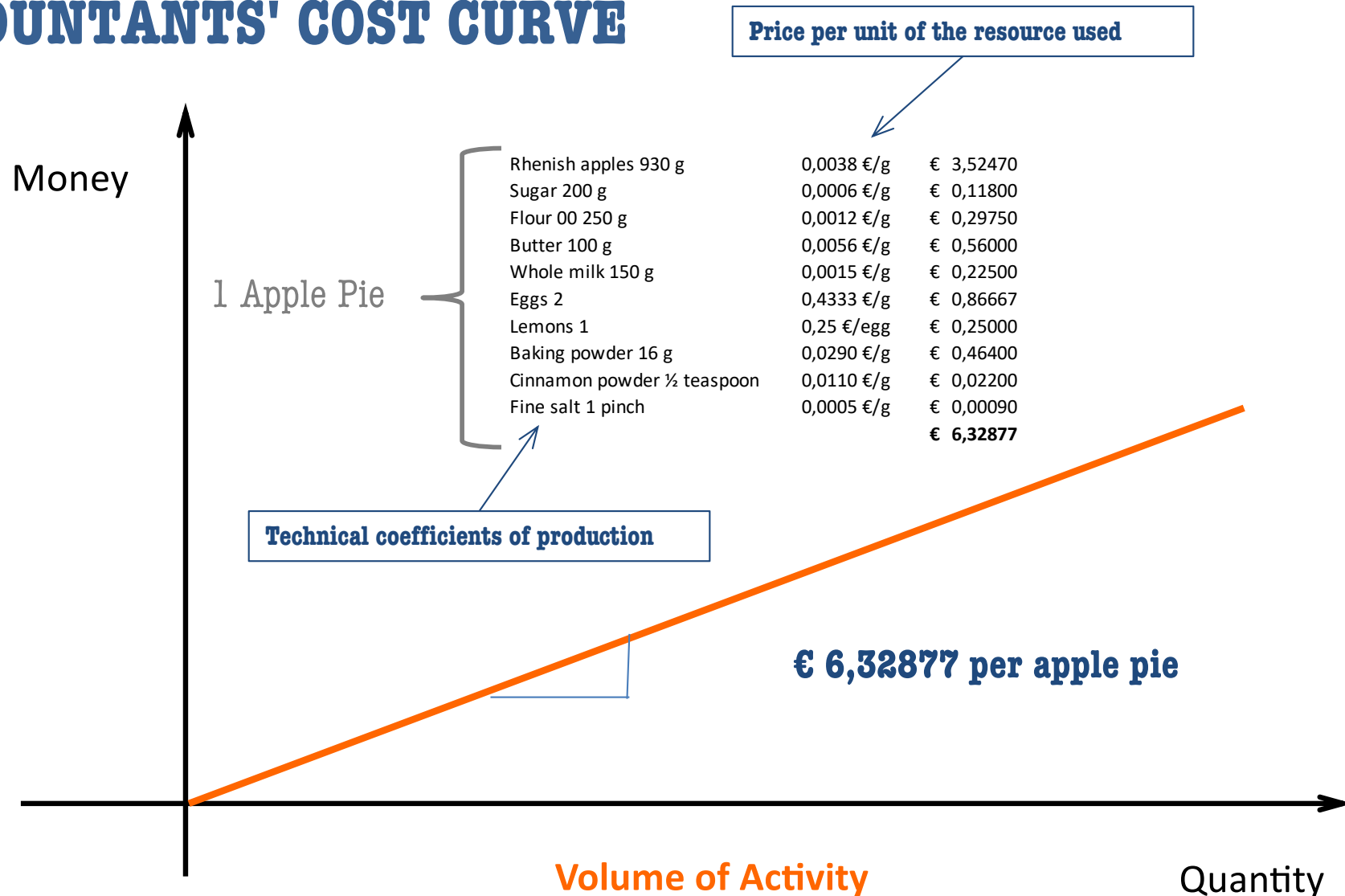


ECONOMISTS' COST CURVE

Economists correctly point out that many costs that the accountant classifies as variable actually behave in a *curvilinear* fashion.



ACCOUNTANTS' COST CURVE



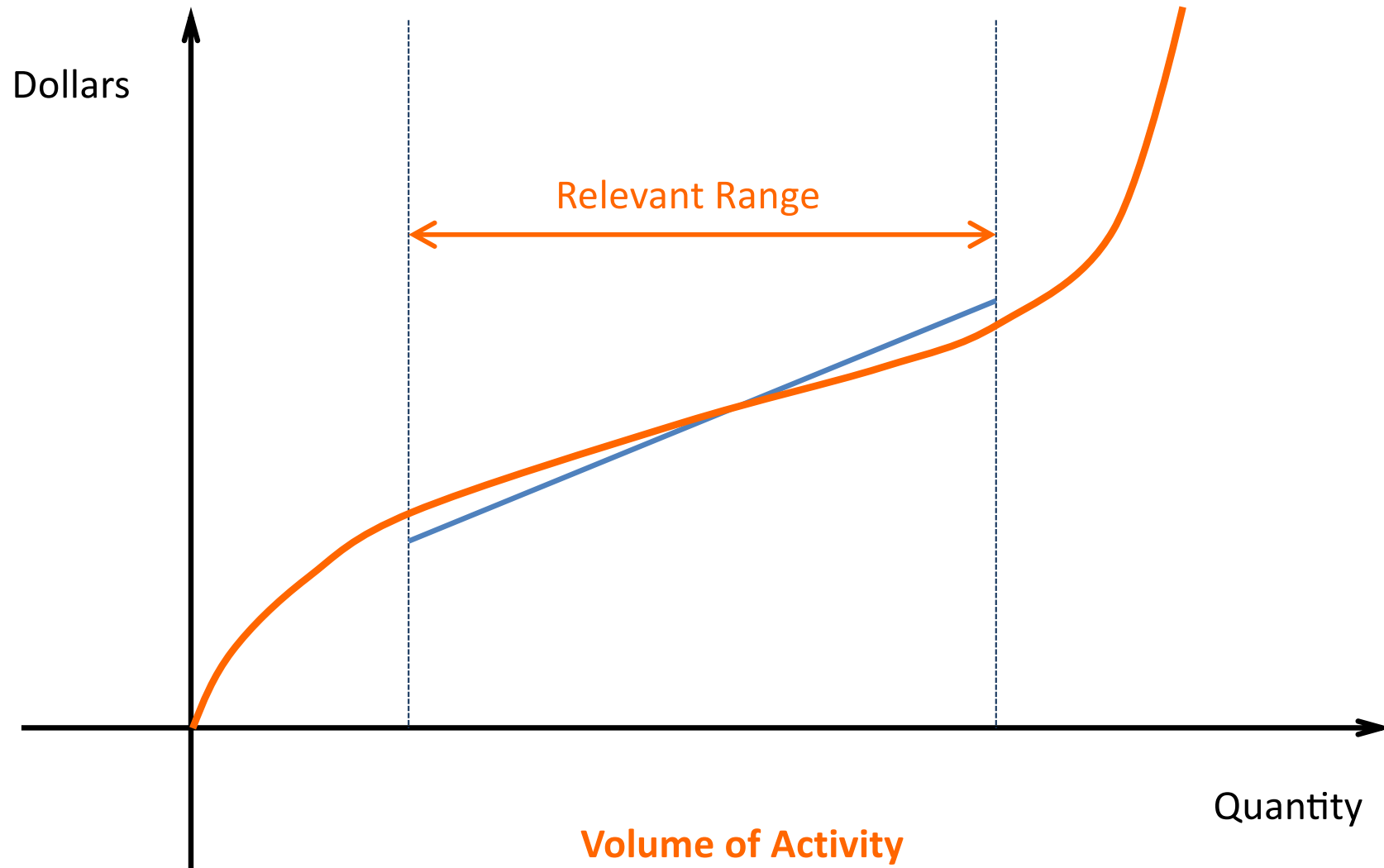
The assumption of setting a limited capacity range (so-called relevant range) is necessary, among other things, to be able to assume invariance of variable unit cost. In fact, the variable unit cost depends on the physical consumption of resources per unit of product produced (a fact, this, summarized by the values of the so-called **technical coefficients of production**) and the **unit price of the resources used**. If the production capacity range were too wide, both elements could vary.

AMANUENSI (SCRIBE) MONKS



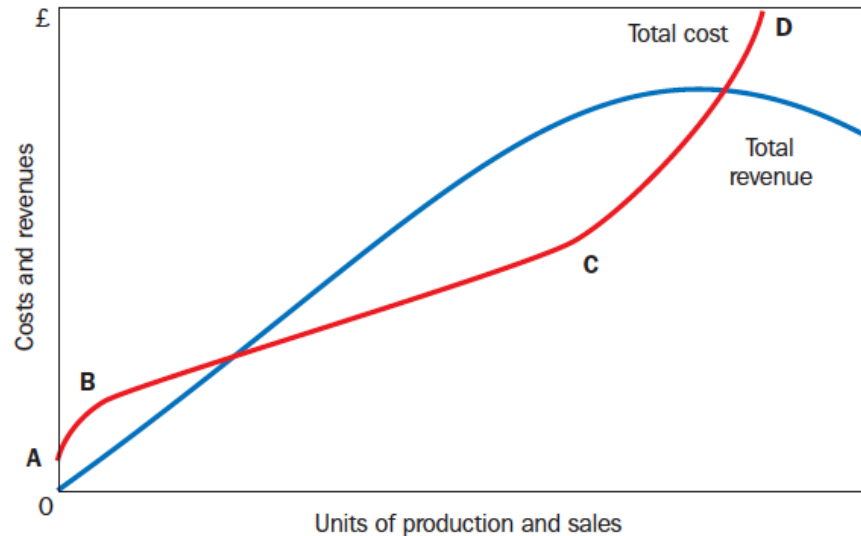
RELEVANT RANGE

Economists correctly point out that many costs that the accountant classifies as variable actually behave in a *curvilinear* fashion.

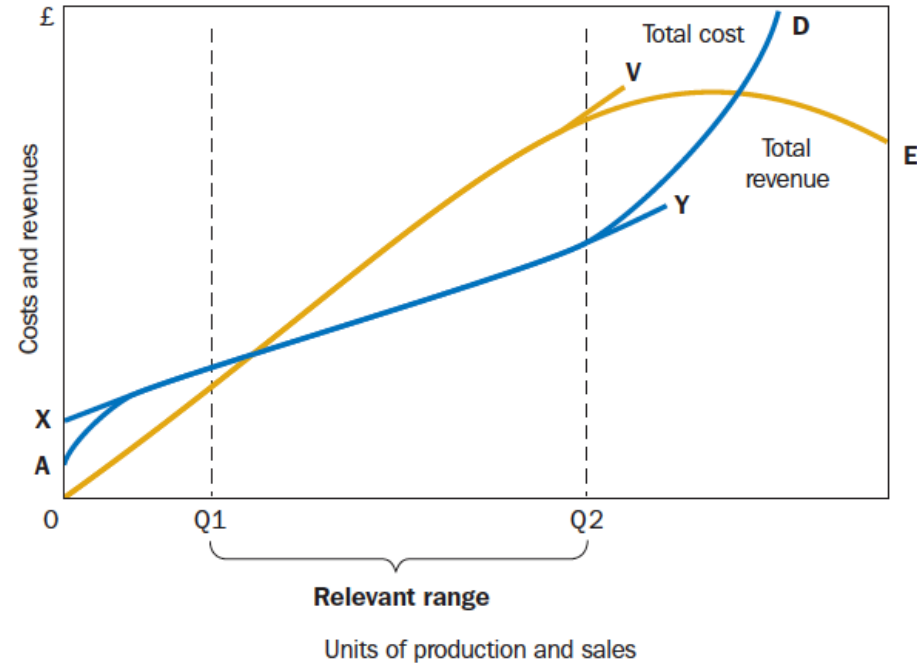


RELEVANT RANGE

ECONOMIST'S VIEW



ACCOUNTANTS'S VIEW



«Linear relationships are not intended to provide an accurate representation of total cost and total revenue throughout all ranges of output. The objective is to represent the behaviour of total cost and revenue over the range of output at which a firm expects to be operating within a short-term planning horizon. [...] The term **relevant range** is used to refer to the output range at which the firm expects to be operating within a short-term planning horizon. This relevant range also broadly represents the output levels that the firm has had experience of operating in the past and for which cost information is available. [Within the relevant range] the cost and revenue relationships are more or less linear. It would be unwise, however, to make this assumption for output levels outside the relevant range. **CVP analysis should therefore only be applied within the relevant range. If the relevant range changes, different fixed and variable costs and selling prices must be used.**»

Source: Colin Drury, "Management and Cost Accounting", eighth edition, Cengage Learning

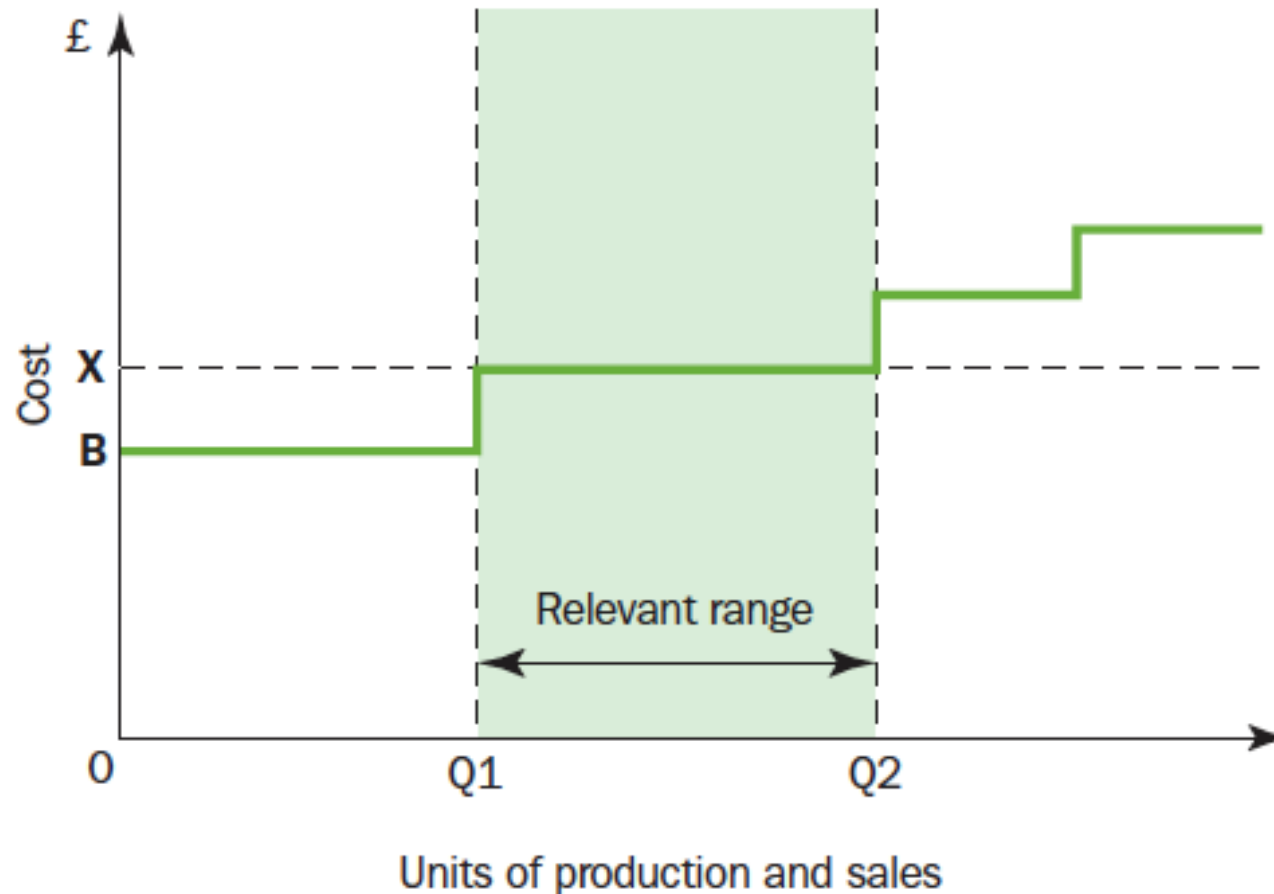


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DI TRIESTE



BRUNO DE ROSA – PARTNER E SCIENTIFIC DIRECTOR DYN@MIKA S.R.L.

FIXED COSTS APPLICABLE WITHIN THE RELEVANT RANGE



Source: Colin Drury, "Management and Cost Accounting", eighth edition, Cengage Learning



RELEVANT RANGE

Relevant range is the band of normal activity level or volume in which there is a specific relationship between the level of activity or volume and the cost in question.

For example, a fixed cost is fixed only in relation to a given wide range of total activity or volume (at which the company is expected to operate) and only for a given time span (usually a particular budget period).

Fixed costs may change from one year to the next.

The basic assumption of the relevant range also applies to variable costs. That is, outside the relevant range, variable costs, such as direct materials, may not change proportionately with changes in production volume. For example, above a certain volume, direct material costs may increase at a lower rate because of price discounts on purchases greater than a certain quantity.



COMMITTED FIXED COSTS

Those costs that **can't be significantly reduced even for short periods of time** without making fundamental changes.

Examples include depreciation of buildings and equipment, real estate taxes, insurance expenses, and salaries of top management and operating personnel. Even if operations are interrupted or cut back, committed fixed costs remain largely unchanged in the short term.

During a recession, for example, a company won't usually eliminate key executive positions or sell off key facilities—the basic organizational structure and facilities ordinarily are kept intact.

The costs of restoring them later are likely to be far greater than any short-run savings that might be realized.

SOURCE: Noreen–Brewer–Garrison, “Managerial Accounting for Managers”, Second Edition



DISCRETIONARY FIXED COSTS

Often referred to as *managed fixed costs* usually **arise from annual decisions by management to spend on certain fixed cost items.**

Examples of discretionary fixed costs include advertising, research, public relations, management development programs, and internships for students.

Two key differences exist between discretionary fixed costs and committed fixed costs.

First, **the planning horizon for a discretionary fixed cost is short term—usually a single year.** By contrast, committed fixed costs have a planning horizon that encompasses many years.

Second, **discretionary fixed costs can be cut for short periods of time with minimal damage to the long-run goals of the organization.** For example, spending on management development programs can be reduced because of poor economic conditions. Although some unfavorable consequences may result from the cutback, it is doubtful that these consequences would be as great as those that would result if the company decided to economize by laying off key personnel.

SOURCE: Noreen–Brewer–Garrison, “Managerial Accounting for Managers”, Second Edition



IS LABOR A VARIABLE OR A FIXED COST?

Wages and salaries may be fixed or variable.

The behavior of wage and salary costs will differ from one country to another, depending on labor regulations, labor contracts, and custom.

In some countries, such as Italy, France, Germany, and Japan, management has little flexibility in adjusting the labor force to changes in business activity. In countries such as the United States and the United Kingdom, management typically has much greater latitude. However, even in these less restrictive environments, managers may choose to treat employee compensation as a fixed cost for several reasons.

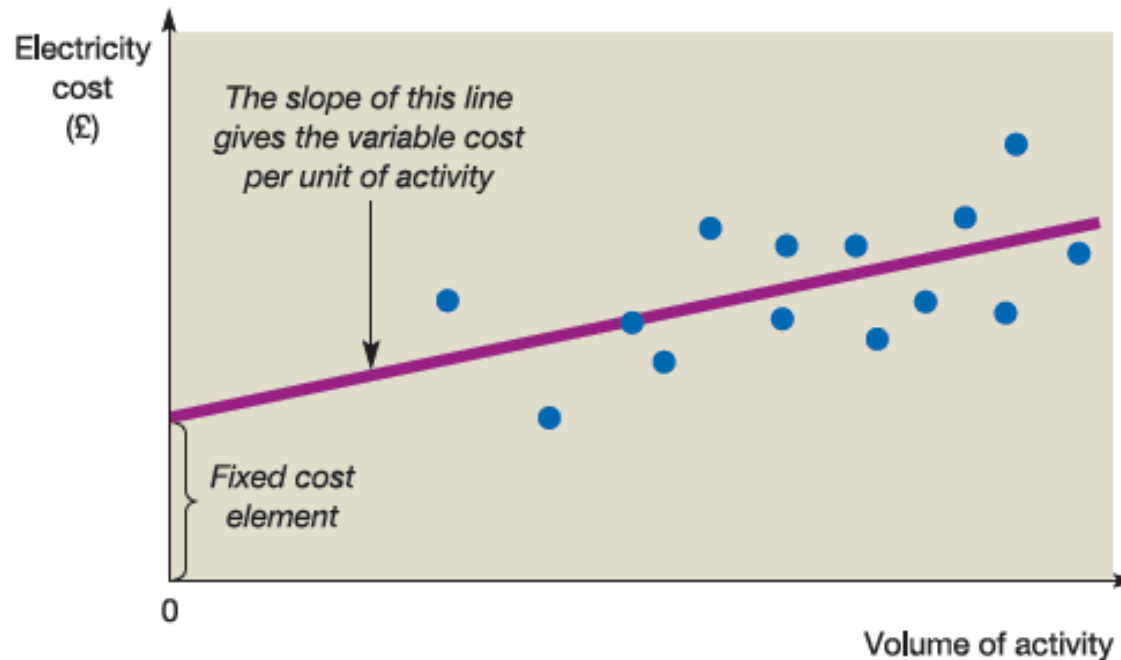
First, many managers are reluctant to decrease their workforce in response to short term declines in sales. These managers realize that the success of their businesses hinges on retaining highly skilled and trained employees. If these valuable workers are laid off, it is unlikely that they would ever return or be easily replaced. Furthermore, laying off workers undermines the morale of those employees who remain.

Second, managers do not want to be caught with a bloated payroll in an economic downturn. Therefore, managers are reluctant to add employees in response to short-term increases in sales. Instead, more and more companies rely on temporary and part-time workers to take up the slack when their permanent, full-time employees are unable to handle all of the demand for their products and services. In such companies, labor costs are a complex mixture of fixed and variable costs.



ESTIMATING SEMI-FIXED (SEMI-VARIABLE) COST

Figure 3.4 Graph of electricity cost against the volume of activity



Here the electricity bill for a time period (for example, three months) is plotted against the volume of activity for that same period. This is done for a series of periods. A line is then drawn that best 'fits' the various points on the graph. From this line we can then deduce both the cost at zero activity (the fixed element) and the slope of the line (the variable element).

Source: Peter Attrill and Eddie McLaney, "Management accounting for decision makers, 6th edition, FT Prentice Hall

VARIABLE AND FIXED REVENUES

There are two basic types of cost-behavior patterns that could be found in accounting systems.

A **variable revenue** is a cost that varies, in total, in direct proportion to changes in the level of activity.

A **fixed revenue** is a revenue that remains constant, in total, regardless of changes in the level of activity. Unlike variable revenue, fixed revenue are therefore not affected by changes in the parameter used to measure the activity performed.

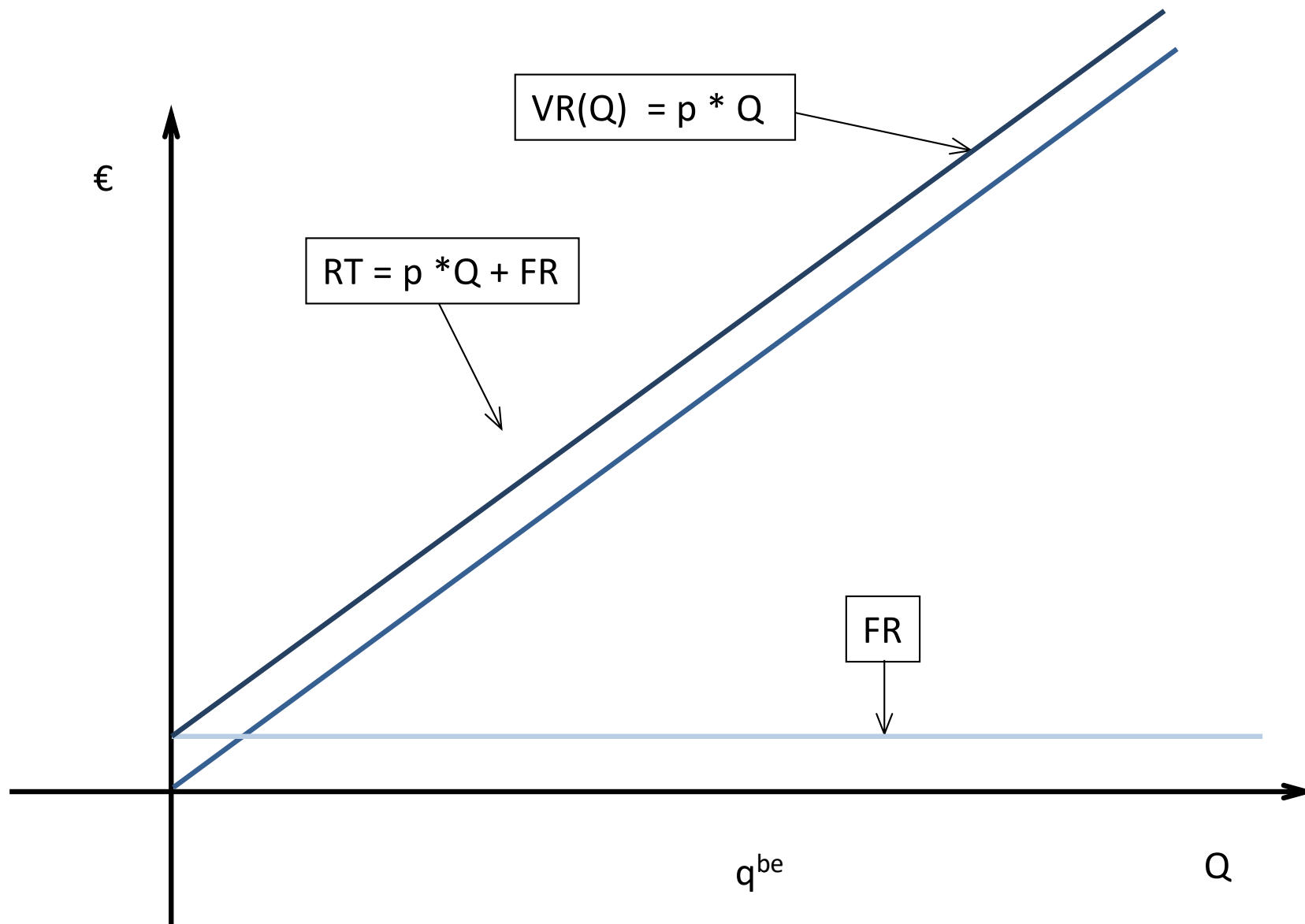
The amount of **other operating income** or **sundry income** (rent revenues, late fees, profits on the sales of minor assets or foreign exchange gains) generally is not linked to the level of units sold.

Total Operating Revenues = Variable Costs + Fixed Costs

$$TR = VR(Q) + FR$$



VARIABLE AND FIXED REVENUES IN GRAPHIC FORM



COST-VOLUME-PROFIT ANALYSIS

Cost-volume-profit (CVP) analysis is a powerful tool that helps managers understand the relationships behavior and relationship among total revenues, total costs, and income as changes occur in the level of the “activity performed” (volume).

Operating Income = Total Operating Revenues – Total Operating Costs

$$OI = TR - TC$$

Cost-volume-profit analysis focuses on how profits are affected by the following five factors:

1. Selling prices.
2. Sales volume.
3. Unit variable costs.
4. Total fixed costs revenue.
5. Total fixed costs revenue.



CVP RELATIONSHIPS IN EQUATION FORM

Operating Income = Total Operating Revenues – Total Operating Costs

Total Operating Revenues = Variable Revenues + Fixed Revenues

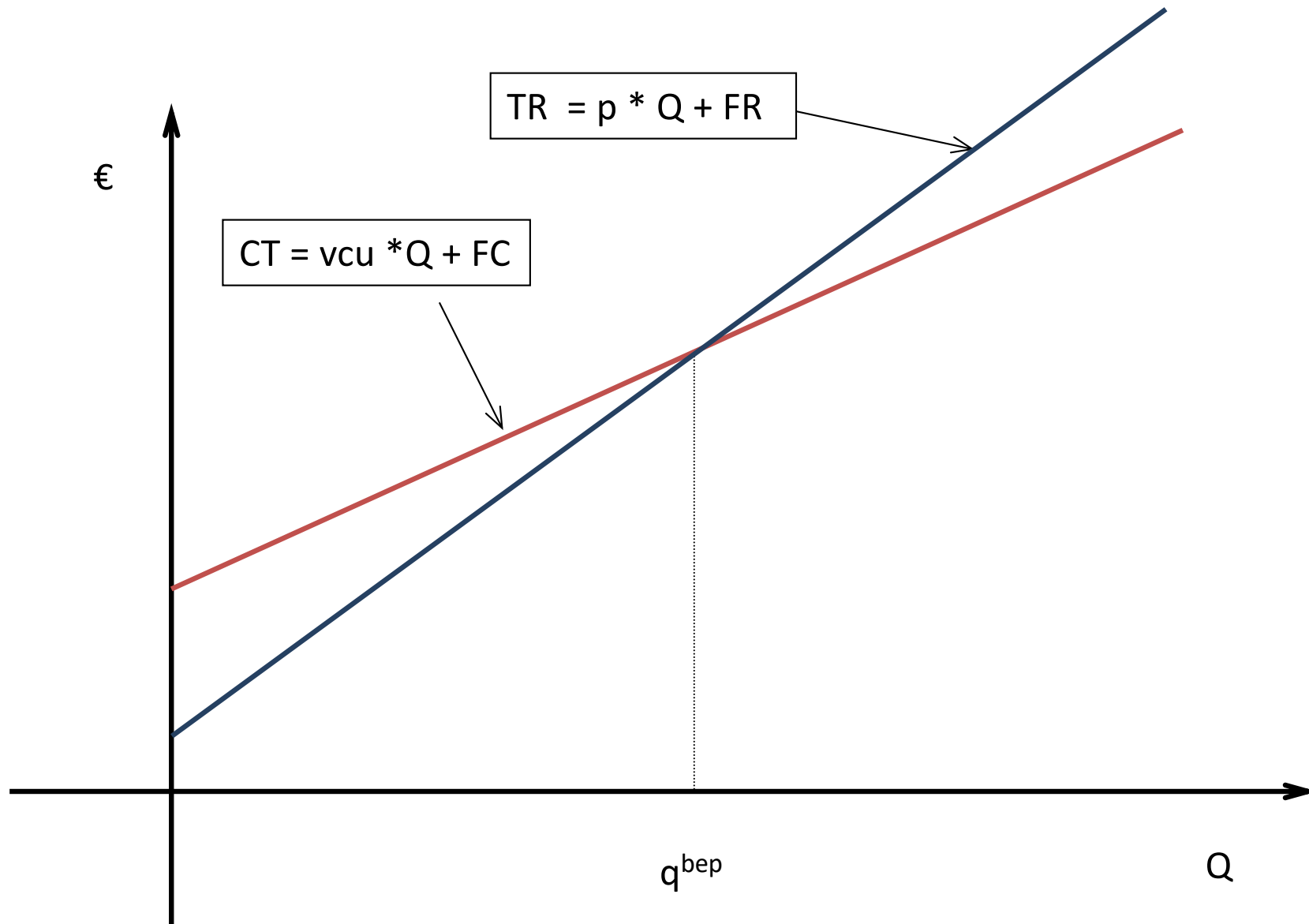
Variable Revenues = Selling price per unit * Quantity of units sold

Total Operating Expenses = Variable Costs + Fixed Costs

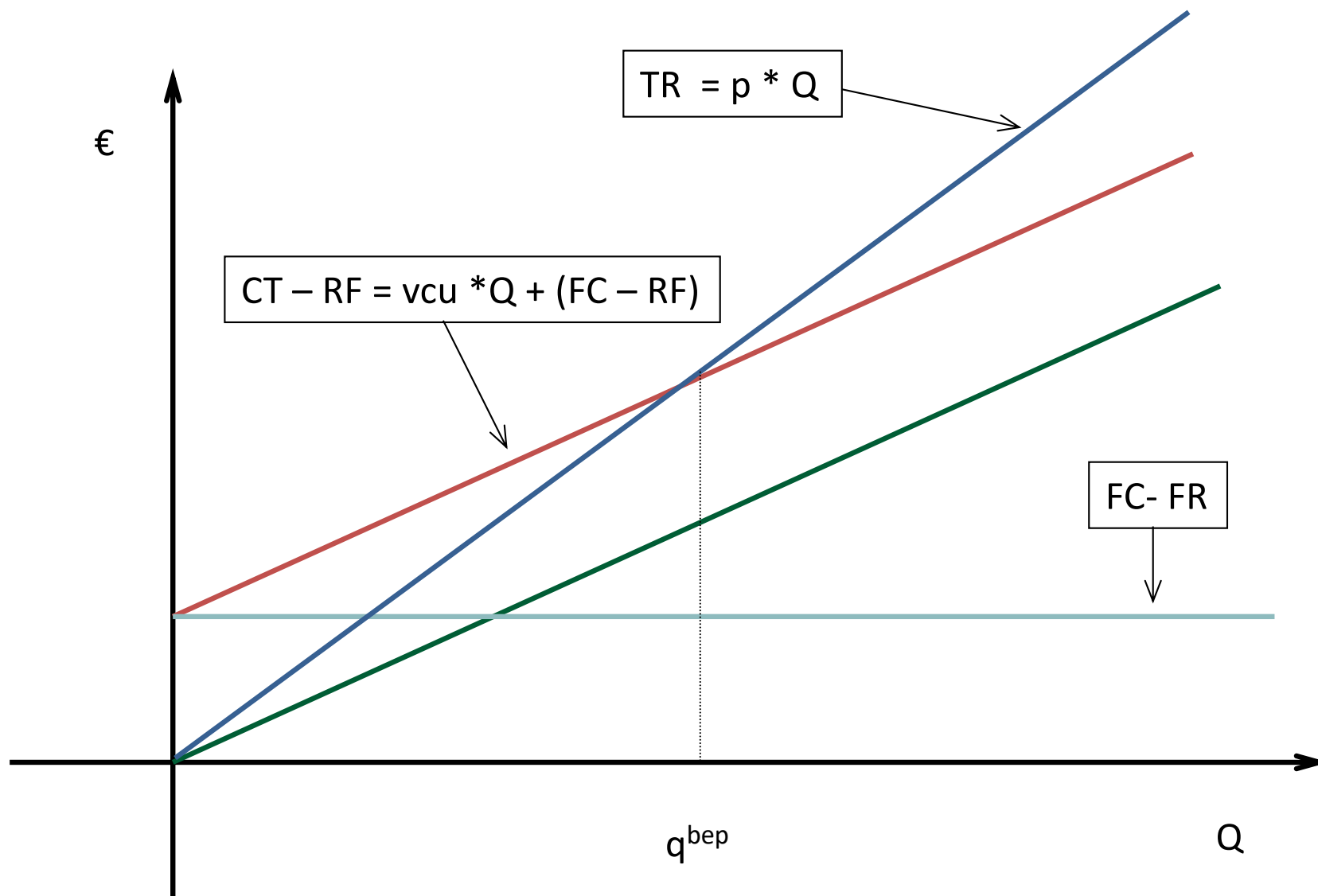
Variable Costs = Variable cost per unit * Quantity of units sold

$$\begin{aligned}OI &= [(p * Q) + FR] - [(vcu * Q) + FC] \\ &= [(p * Q) - (vcu * Q)] - (CF - RF) \\ &= (p - vcu) * Q - RFC\end{aligned}$$

CVP RELATIONSHIPS IN GRAPHIC FORM (1)



CVP RELATIONSHIPS IN GRAPHIC FORM (2)



CONTRIBUTION MARGINS & CONTRIBUTION MARGIN PER UNIT

The difference between total variable revenues and total variable costs is called **contribution margin**. That is,

$$\text{Contribution margin} = \text{Total variable revenues} - \text{Total variable costs}$$

Contribution margin indicates why operating income changes as the number of units sold changes.

Contribution margin per unit is a useful tool for calculating contribution margin and operating income. It is defined as,

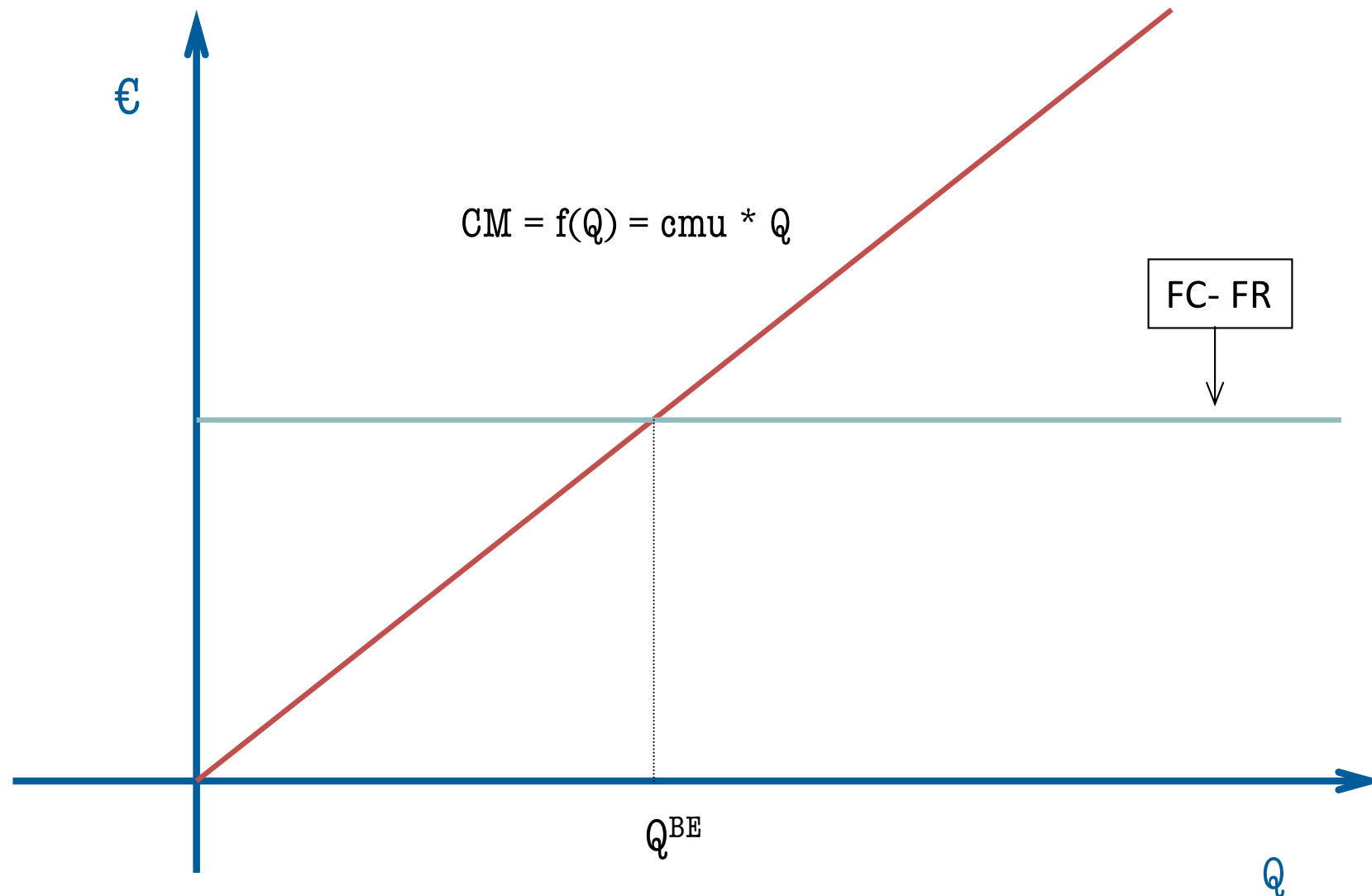
$$\text{Contribution margin per unit} = \text{Selling price} - \text{Variable cost per unit}$$

Contribution margin per unit provides a second way to calculate contribution margin:

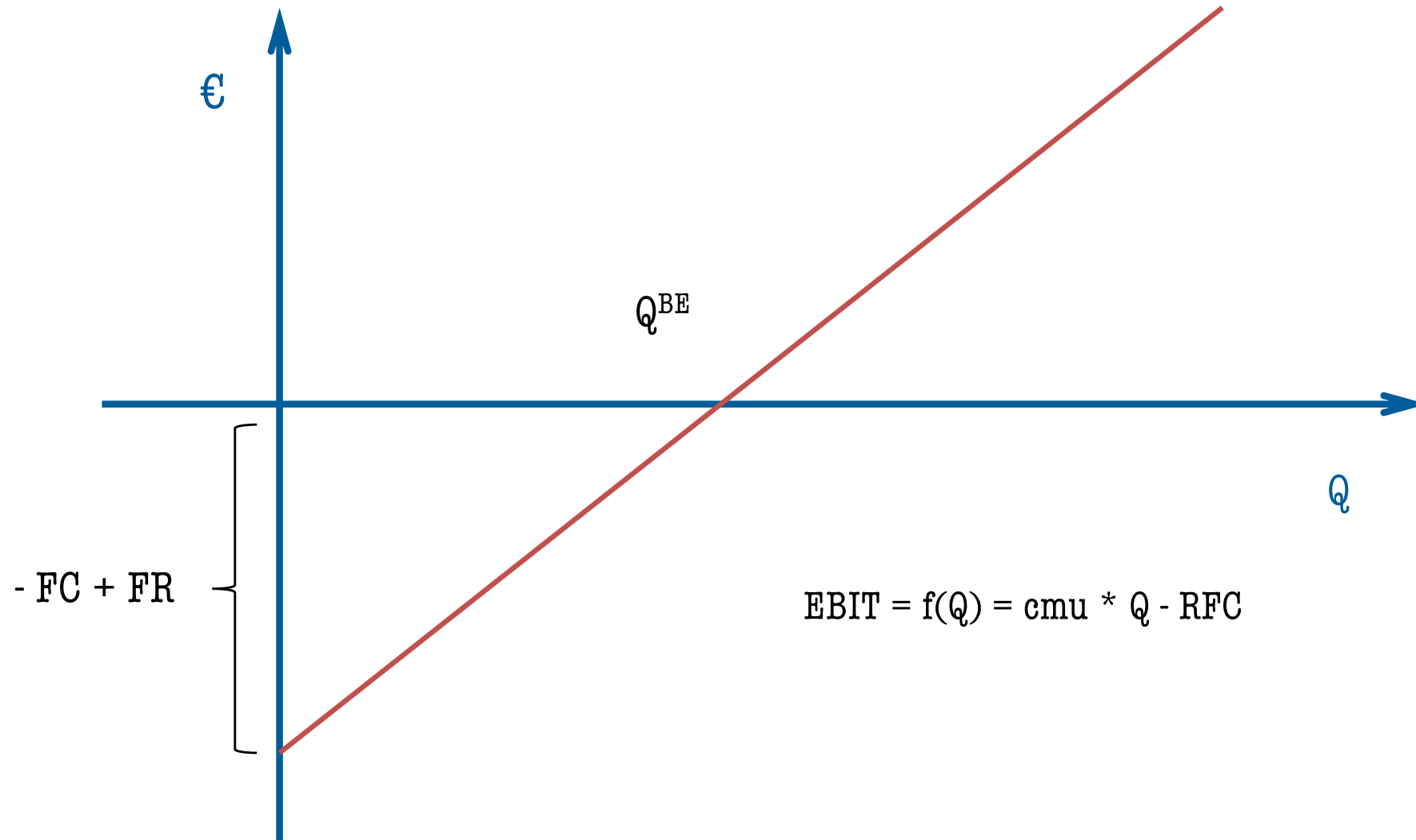
$$\text{Contribution margin} = \text{Contribution margin per unit} * \text{Number of units sold}$$



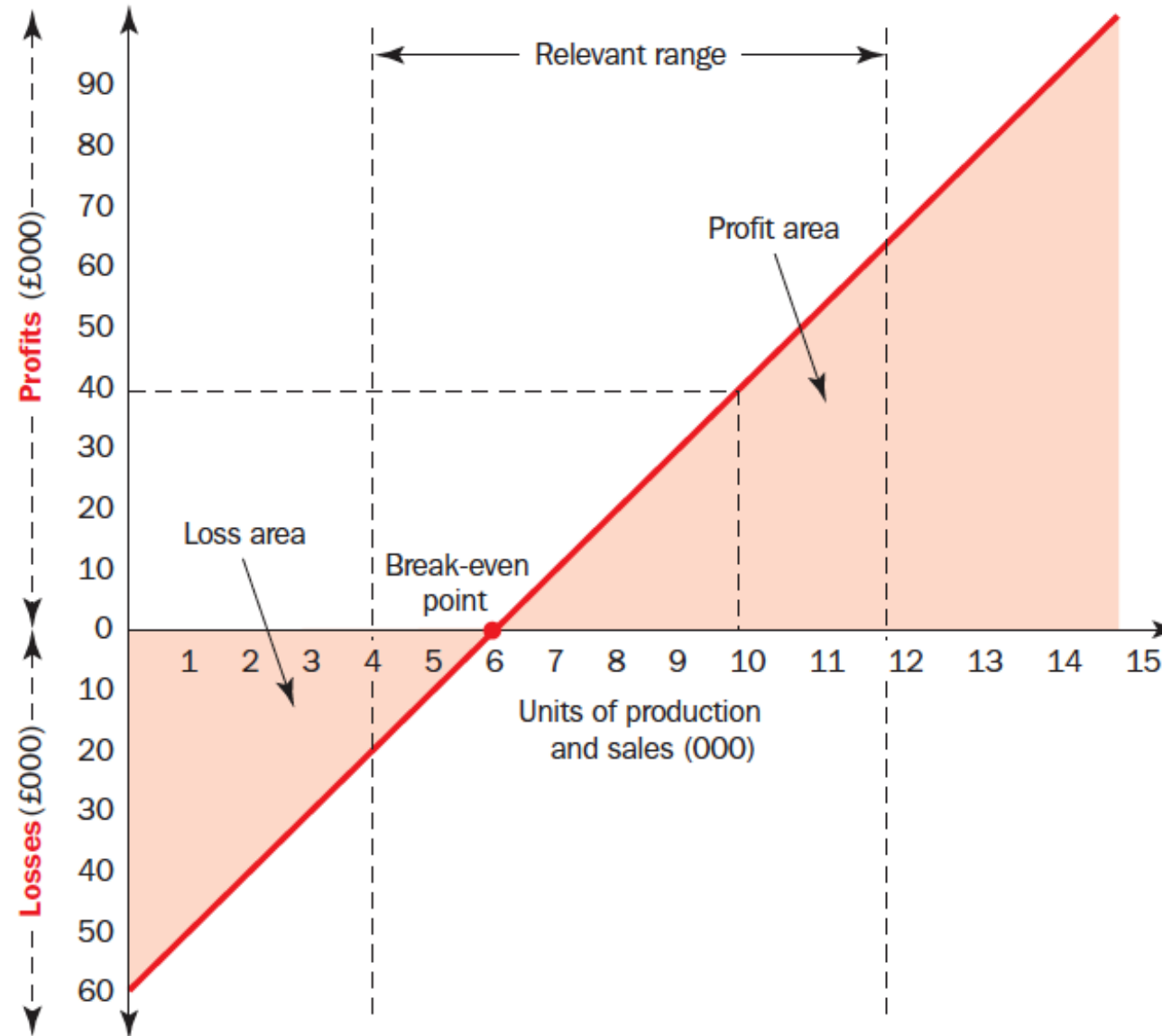
THE CONTRIBUTION MARGIN FUNCTION



THE EBIT FUNCTION



PROFIT-VOLUME GRAPH



Source: Colin Drury, "Management and Cost Accounting", eighth edition, Cengage Learning



FOOD FOR THOUGHTS

Exercise 1

Knowing the following information:

EBIT:	negative for \$ 123,574
Unit sale price:	\$ 29.10
Unit variable cost:	\$12.70
Quantity sold:	21,040

Determine

- the break-even quantity.
- the level of residual fixed costs
- by how much would the break-even quantity change if the unit selling price decreased by 9%?



JUNE 17, 2024 EXAM

Exercise MC_1 – Cost-Profit-Volume Model

The following information is known about Zumba Inc.:

Description	20X0	20X1
Capacity	18.000	18.000
Quantity made	11.650	10.275
Quantity sold	8.600	12.600
Manufacturing variable cost per unit	€ 38	€ 38
Selling variable cost per unit	€ 12	€ 12
EBIT	-€ 52.000	€ 48.000

Required:

Assuming that in the two fiscal years the level of average selling price and that of residual fixed costs was the same, determine:

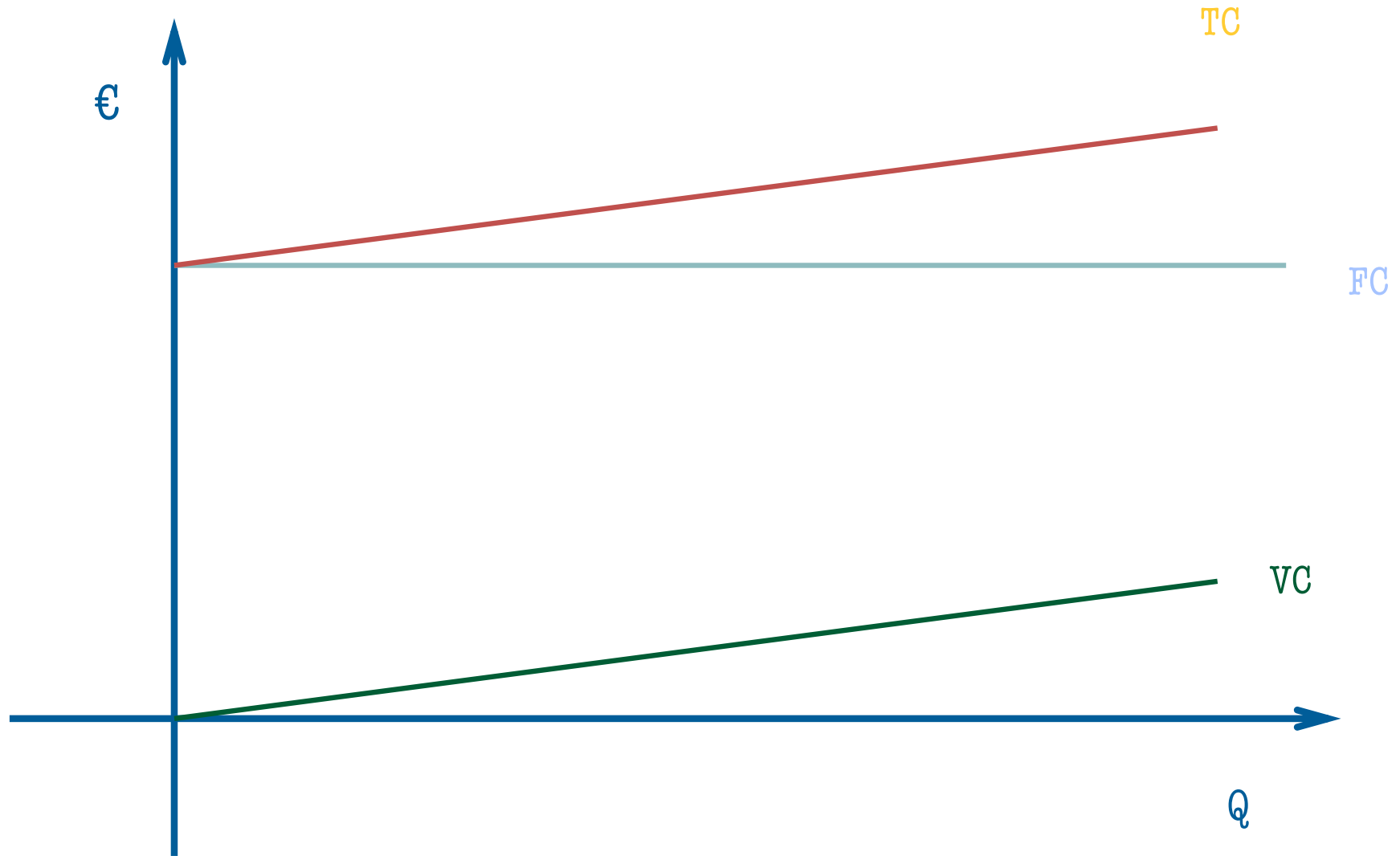
1. The contribution margin per unit.
2. The amount of residual fixed costs.
3. The break-even quantity for the two fiscal years just ended.

CONTRIBUTION INCOME STATEMENT

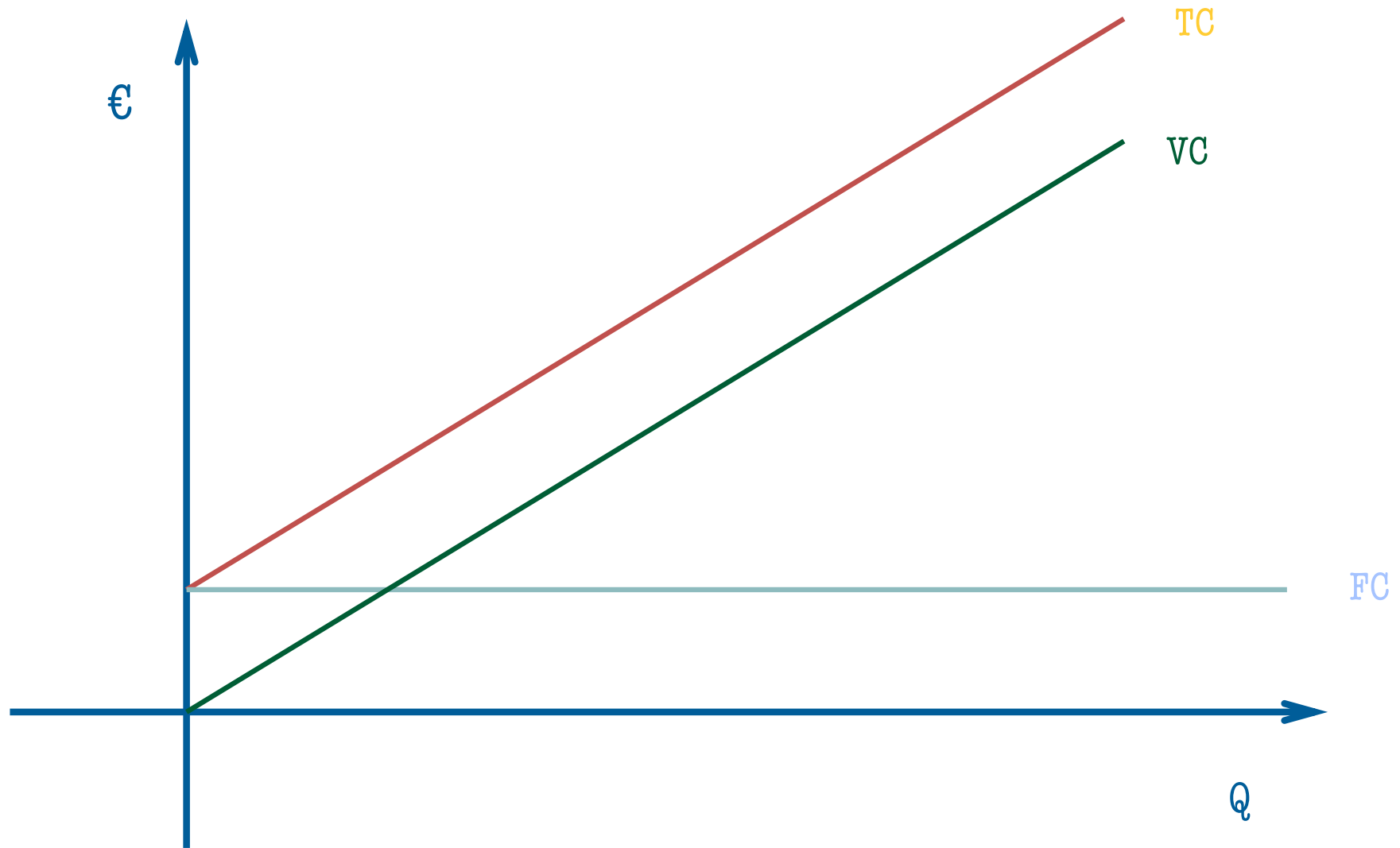
+ Variable Revenue	\$	2,000.00
- Variable Costs	\$	(650.00)
= Contribution Margin	\$	1,350.00
+ Fixed Revenue	\$	180.00
- Fixed Costs	\$	(1,150.00)
= Operating Income	\$	380,00



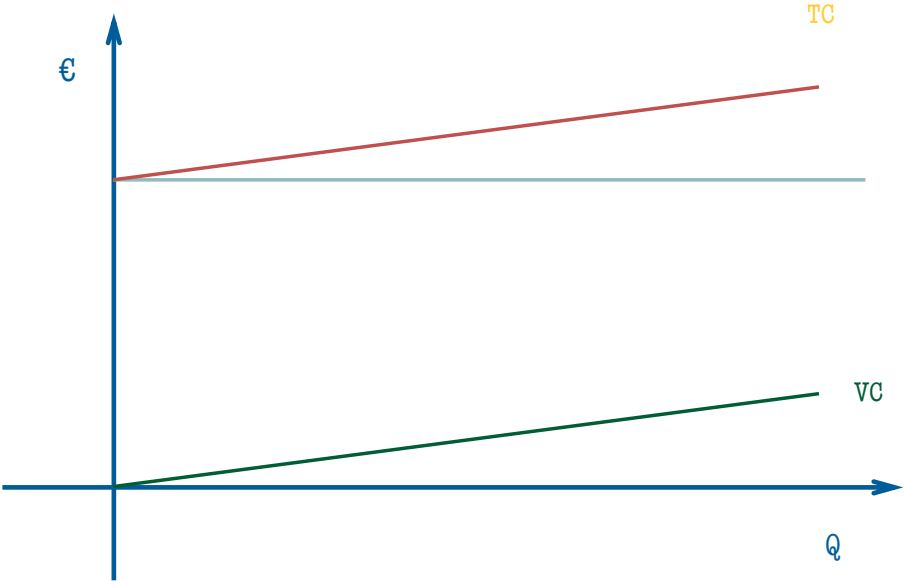
COMPANY «X»



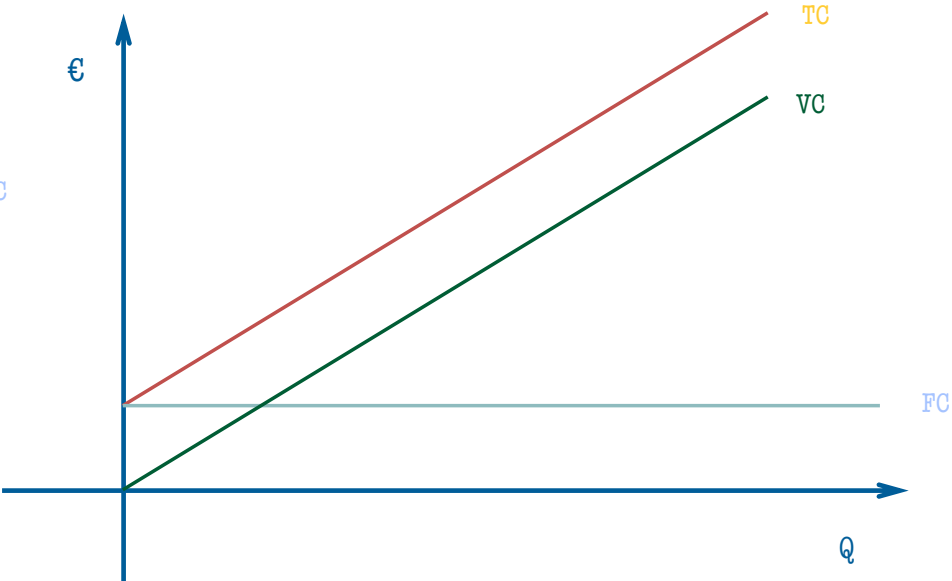
COMPANY «Y»



A COMPARISON



Cheese Maker



Shoes Manufacturer

SENSITIVITY MEASURES

This term is used to refer to that set of indicators that allow the measurement of the change in results or other financial values when one or more variables change, without prejudice to all others.

Thus, these are simple metrics that make possible the concrete implementation of sufficiently simple forms of “what if” type analysis. They make it possible, therefore, to assess, in advance, the effect that a change in a hypothesis – concerning the magnitude assumed by a variable that is considered significant for the purposes of the analysis – could cause on the economic variable linked to it.

Insofar as they are expressive of the variability of the economic outcome with respect to one or more economic entities they are, evidently, tools for analyzing the risk associated with the concrete trends of those entities.



COST ELASTICITY

Cost elasticity (also called cost-output elasticity) measures the responsiveness of total cost to changes in output.

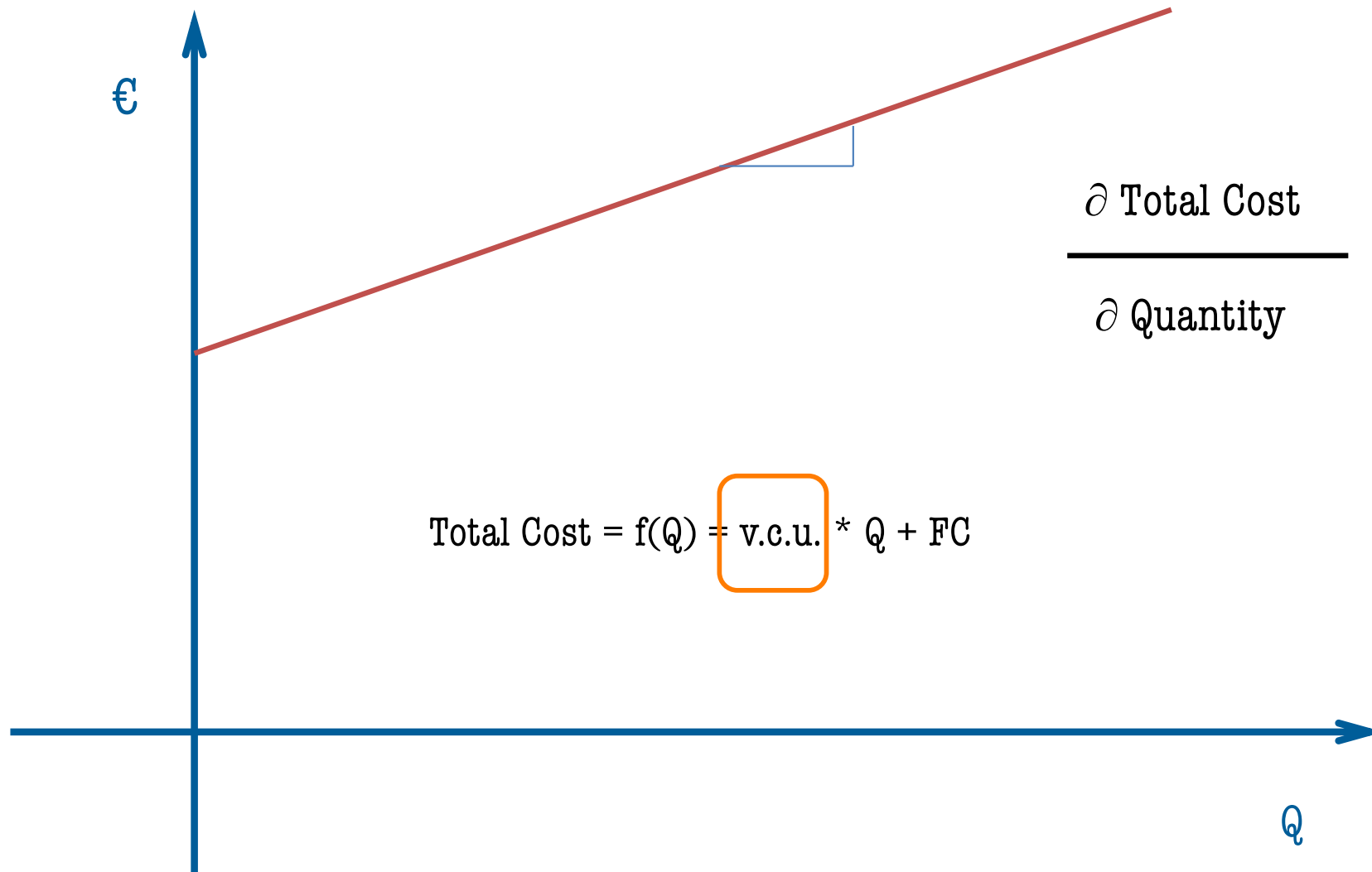
It is calculated by dividing the percentage change in cost with percentage change in output. A cost elasticity value of less than 1 means that economies of scale exists.

$$\text{Cost Elasticity} = \frac{\frac{\partial \text{Total Cost}}{\text{Total Cost}}}{\frac{\partial \text{Quantity}}{\text{Quantity}}}$$

$$= \frac{\partial \text{Total cost}}{\partial \text{Quantity}} * \frac{\text{Quantity}}{\text{Total Cost}}$$

first derivative of the total cost function in respect to the quantity

IF CVP ASSUMPTIONS APPLY



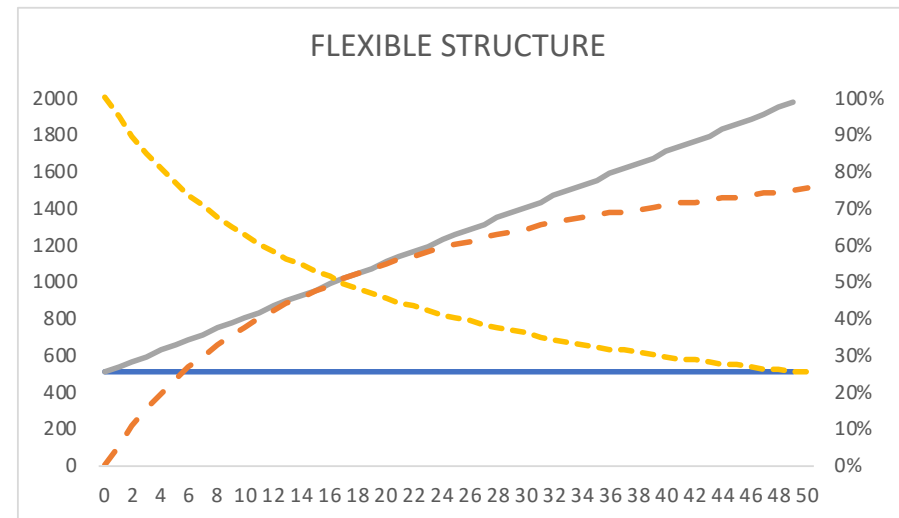
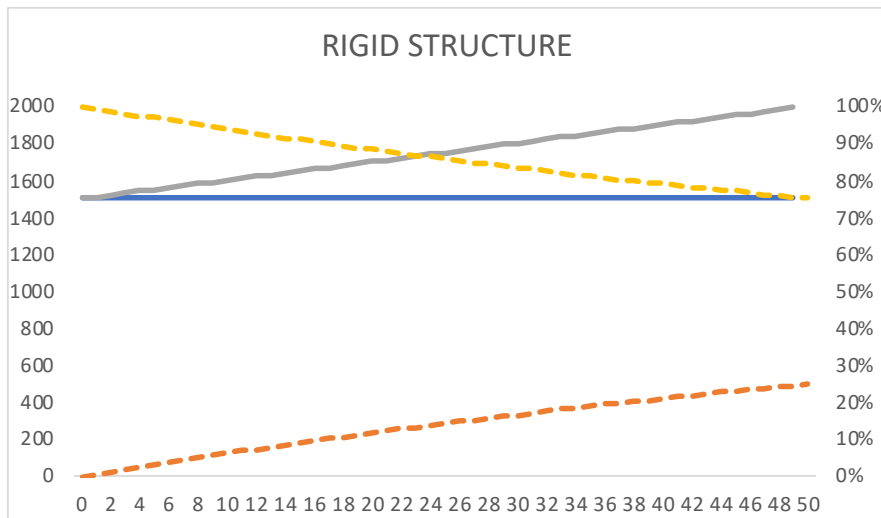
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$$\begin{aligned}
 \text{Cost Elasticity} &= \frac{\frac{\partial \text{Total Cost}}{\text{Total Cost}}}{\frac{\partial \text{Quantity}}{\text{Quantity}}} \\
 &= \frac{\partial \text{Total cost}}{\partial \text{Quantity}} * \frac{\text{Quantity}}{\text{Total Cost}} = \frac{\overbrace{\text{v.c.u.} * \text{Quantity}}^{\text{Variable Cost}}}{\text{Total Cost}}
 \end{aligned}$$

COST ELASTICITY AND COST RIGIDITY: A COMPARISON

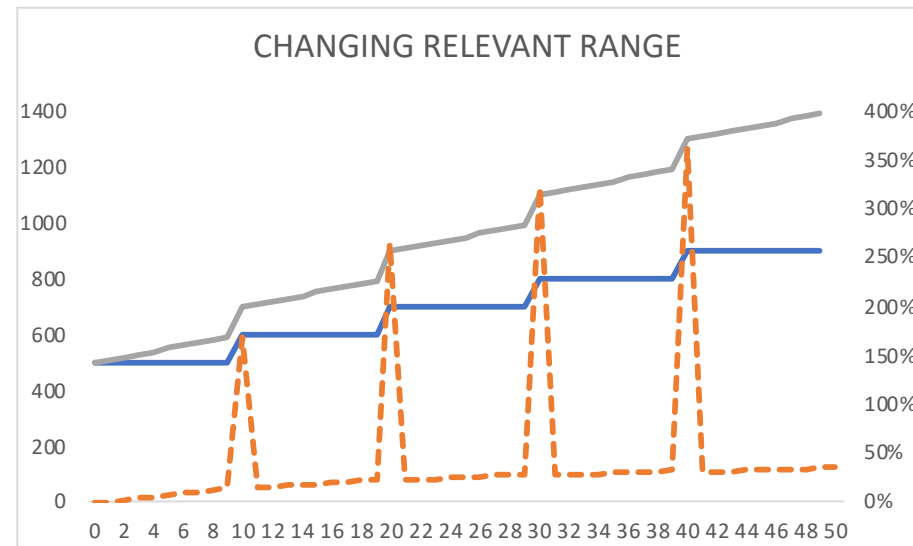
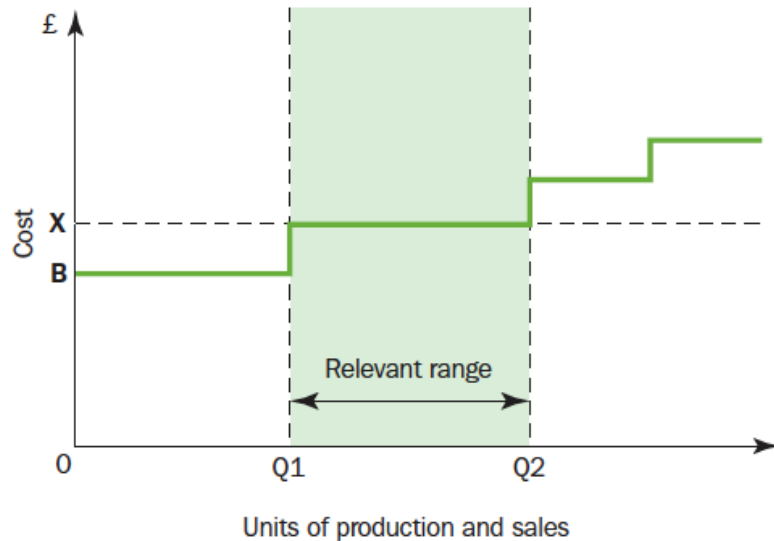


----- Cost Elasticity = $\frac{\text{Variable Cost}}{\text{Total Cost}}$

----- Cost Rigidity = $1 - \frac{\text{Variable Cost}}{\text{Total Cost}} = \frac{\text{Fixed Cost}}{\text{Total Cost}}$



COST ELASTICITY AND ECONOMIES OF SCALE



Within the relevant range the phenomenon of economies of scale always exists, in the sense that if the maximum production value limiting the range is not reached the fixed costs associated with that level of capacity have not been fully exploited. Increases within the interval allow, therefore, the exploitation of existing economies. When one wants to move to a higher capacity level the inevitable increase in fixed costs brings the cost elasticity above one signaling that the cost increase is more than proportional to the increase in output achieved.

OPERATING LEVERAGE

A lever is a tool for multiplying force. Using a lever, a massive object can be moved with only a modest amount of force. In business, *operating leverage* serves a similar purpose.

Operating leverage is a measure of how sensitive net operating income is to a given percentage change in **volume**. Operating leverage acts as a multiplier. If operating leverage is high, a small percentage increase in sales (lead by an increase in the quantity sold) can produce a much larger percentage increase in net operating income.



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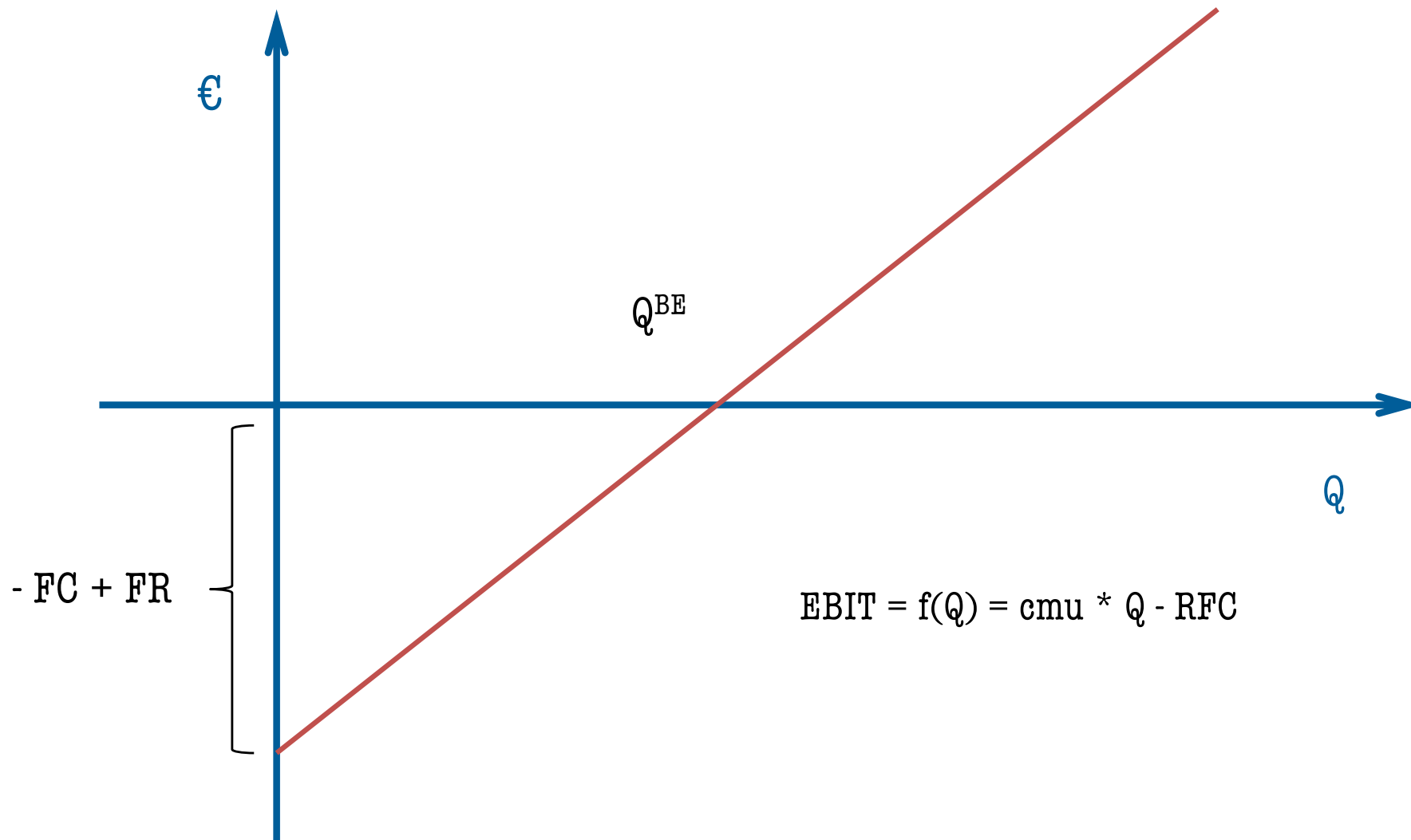
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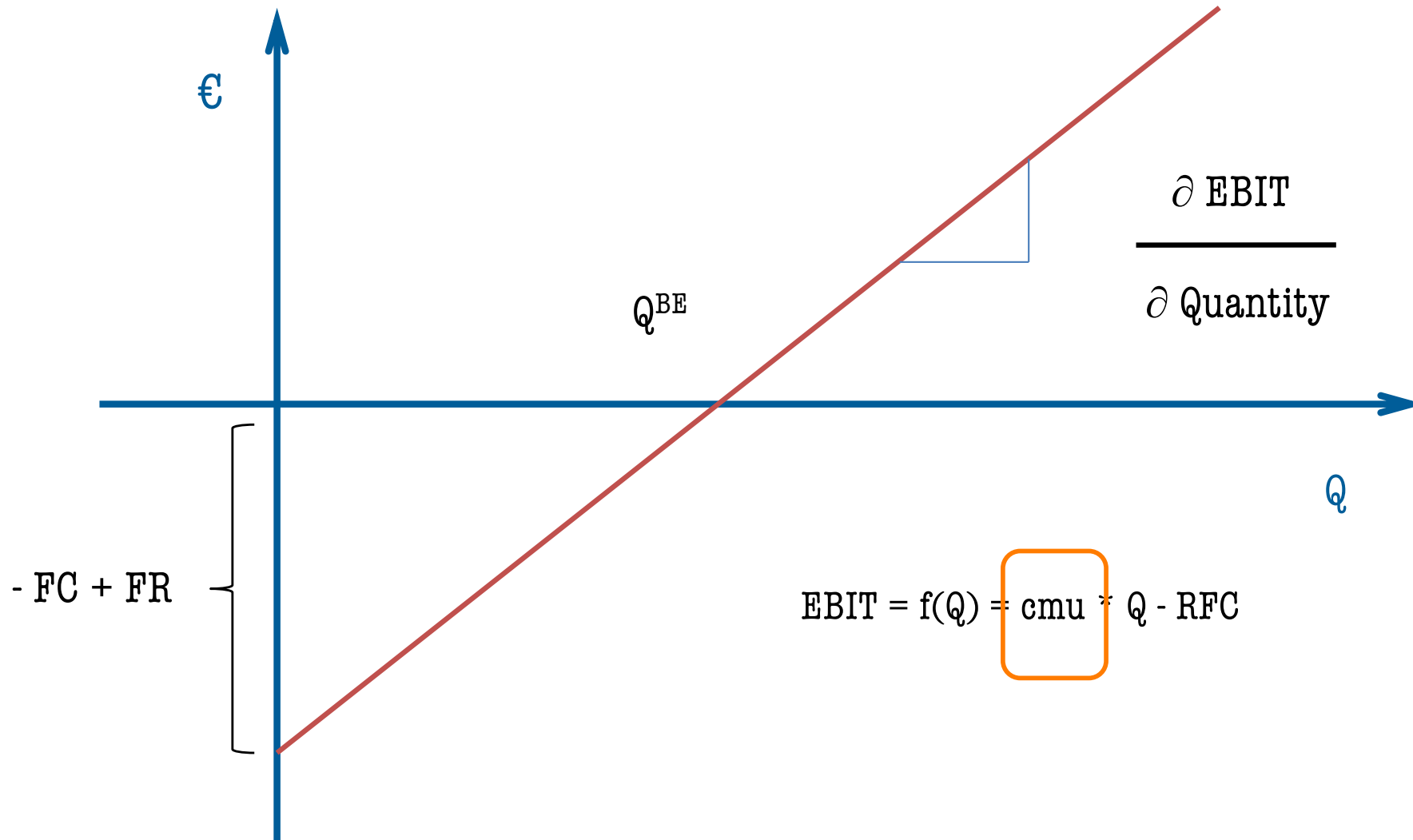
DEGREE OF OPERATING LEVERAGE

$$\begin{aligned}
 \text{Operating leverage} &= \frac{\frac{\partial \text{ EBIT}}{\text{ EBIT}}}{\frac{\partial \text{ Quantity}}{\text{ Quantity}}} \\
 &= \frac{\partial \text{ EBIT}}{\partial \text{ Quantity}} * \frac{\text{ Quantity}}{\text{ EBIT}} = \frac{\overbrace{\text{ cmu * Quantity}}^{\text{TCM}}}{\text{ EBIT}}
 \end{aligned}$$

IF CVP ASSUMPTIONS APPLY



THE SLOPE OF THE EBIT FUNCTION



TWO DIFFERENT LEVERS

$$\text{Pricing leverage} = \frac{\frac{\partial \text{EBIT}}{\text{EBIT}}}{\frac{\partial \text{Average unit price}}{\text{Average unit price}}} = \frac{\overbrace{\text{Average unit price} * \text{Quantity}}^{\text{Sales Revenues}}}{\text{EBIT}}$$

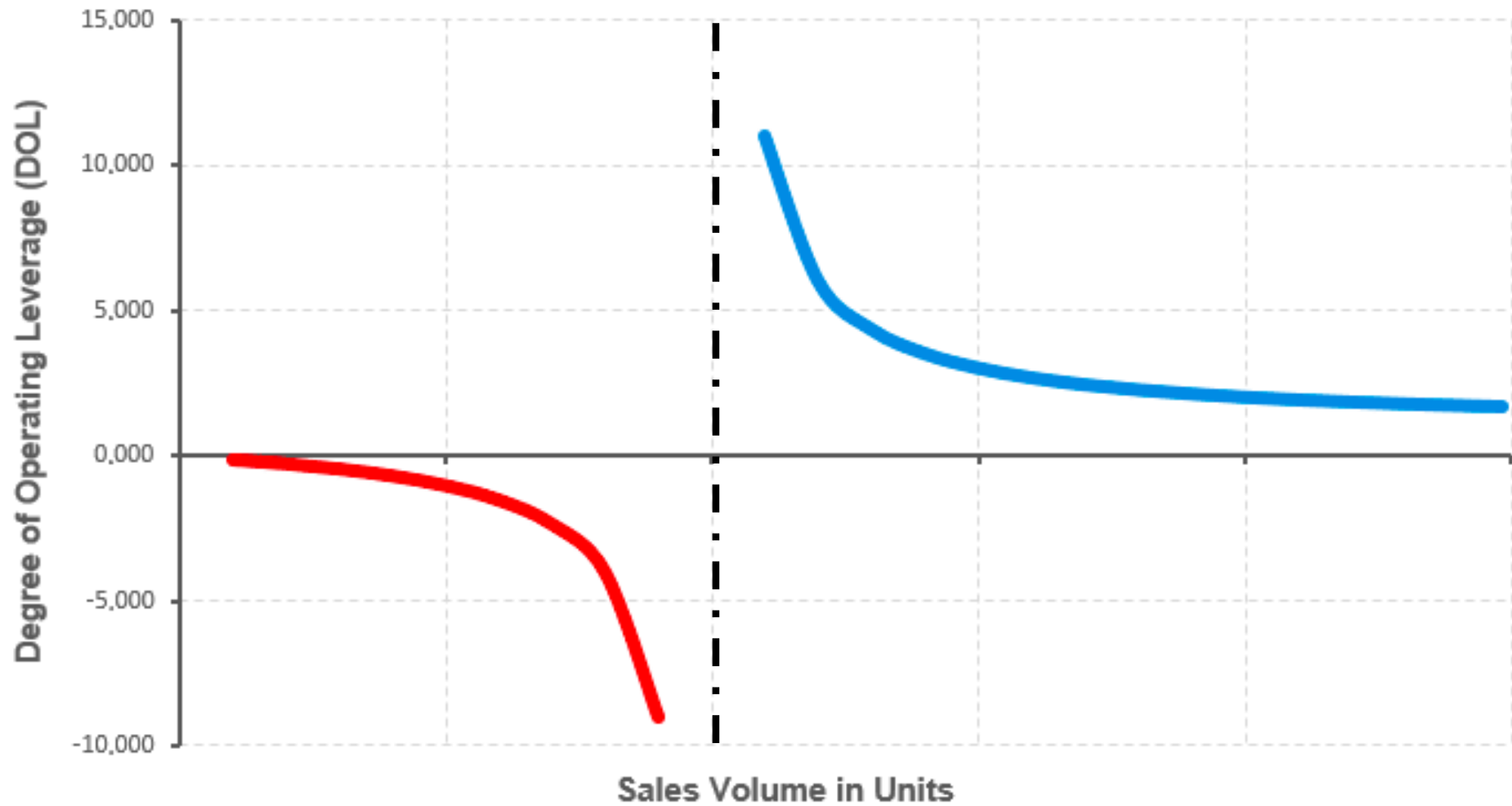
$$\text{Variable cost leverage} = \frac{\frac{\partial \text{EBIT}}{\text{EBIT}}}{\frac{\partial \text{Variable cost per unit}}{\text{Variable cost per unit}}} = \frac{- \overbrace{\text{Variable cost per unit} * \text{Quantity}}^{\text{- Total Variable Costs}}}{\text{EBIT}}$$

TWO DIFFERENT COMPANIES

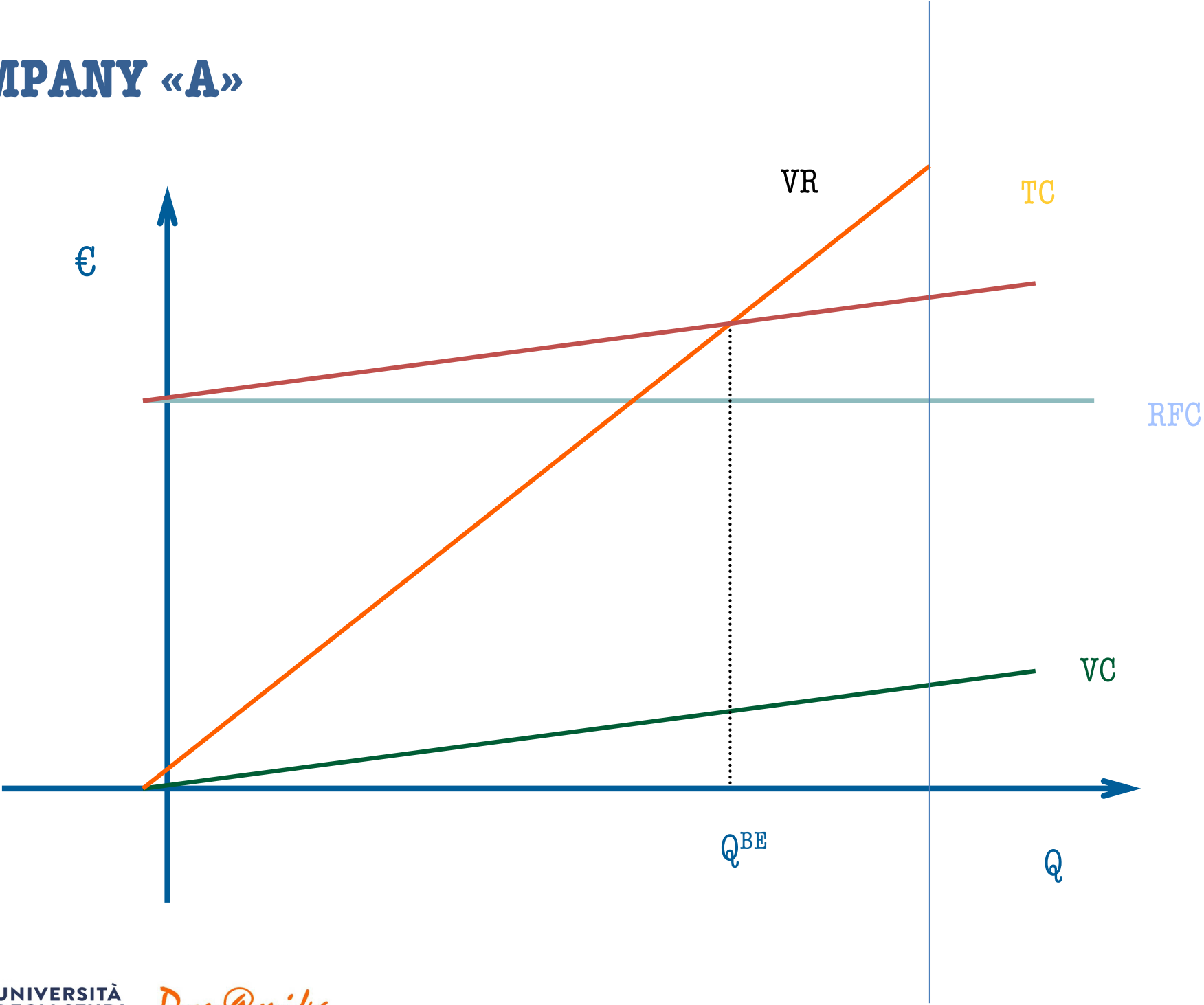
	Lo-Lev Company (1,000,000 units)		Hi-Lev Company (1,000,000 units)	
	Amount	Percentage	Amount	Percentage
Sales	\$1,000,000	100	\$1,000,000	100
Variable costs	<u>750,000</u>	75	<u>250,000</u>	25
Contribution margin . .	\$ 250,000	25	\$ 750,000	75
Fixed costs	<u>50,000</u>	5	<u>550,000</u>	55
Operating profit	<u><u>\$ 200,000</u></u>	20	<u><u>\$ 200,000</u></u>	20
Break-even point . . .	200,000 units		733,334 units	
Contribution margin per unit	\$0.25		\$0.75	



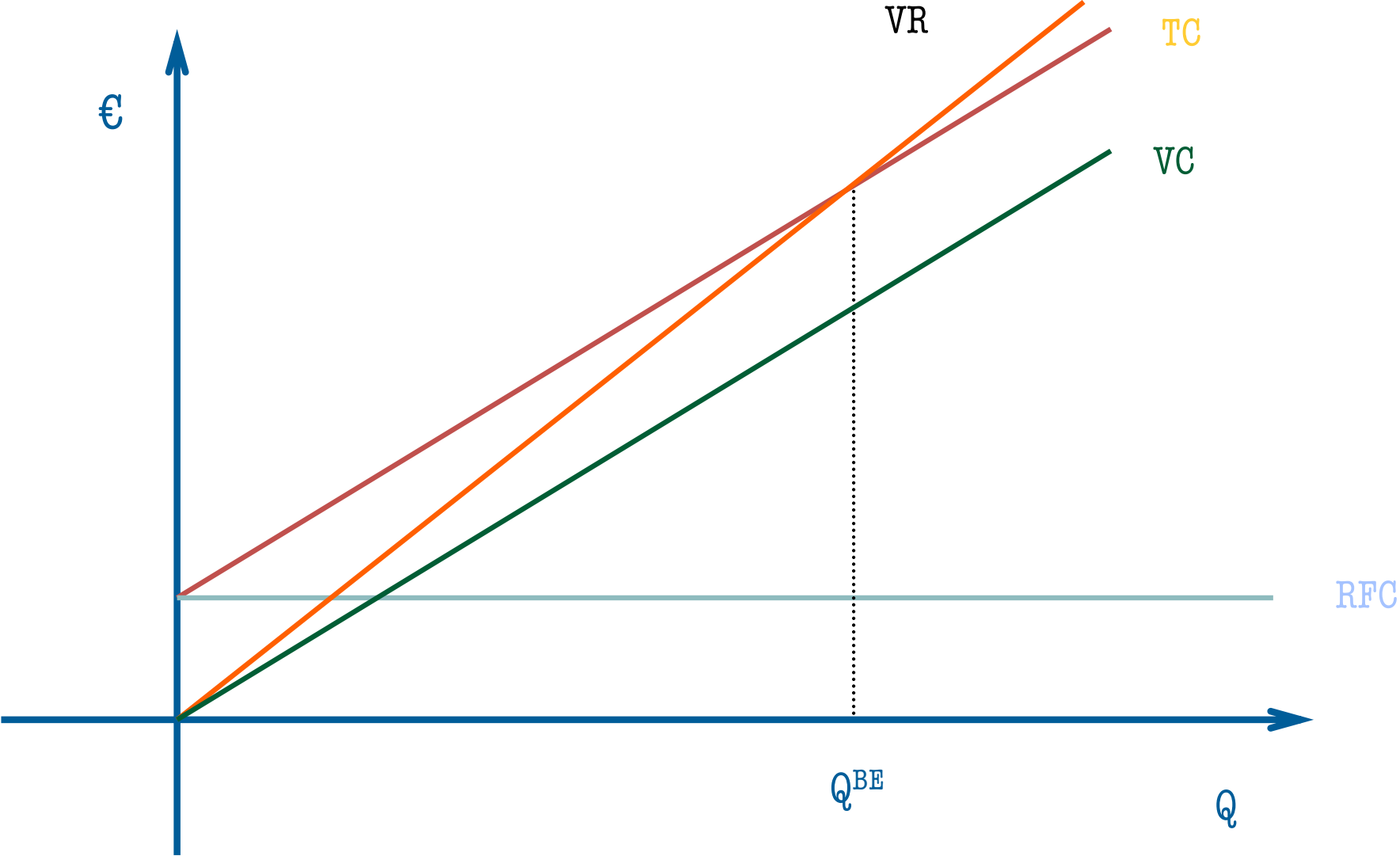
THE GRAPH OF DOL FUNCTION



COMPANY «A»



COMPANY «B»



OPERATING LEVERAGE

The operating data for two different companies follows:

	- Digir Co.-	- Xibleflex Co. -
Sales units	20,000	20,000
Average unit price	€600	€200
Variable unit cost	€100	€150
Fixed costs	€6,000,000	€800,000

Required:

- Compute the break-even point of both companies in sales dollars and units.
- Determine the degree of operating leverage for each company.
- Calculate the margin of safety for both Digir and Xibleflex.



SOLUTIONS

	(in thousands)	(in thousands)
Sales revenues	€12.000	€4.000
- COGS (@ variable)	€2.000	€3.000
=Total Contribution Margin	€10.000	€1.000
-Residual Fixed Costs	€6.000	€800
= EBIT	€4.000	€200
B.E.P.	12.000	16.000
Degree of Operating Leverage	2,5	5
Margin of Safety	40%	20%



MARGIN OF SAFETY

The so-called "margin of safety" is composed of the amount of sales (current or budgeted) that can theoretically be lost (imagining the constancy of the average price and all other relevant variables) without the firm incurring an operating loss. Since the constancy of the average unit price is assumed, it can be calculated by taking into account both quantities and sales revenues

