

VBA APPLICATIONS

Prices, transfers and compensation

Automated Decision Making in Business and Economics

Before we start

We will work with two files:

wholesaler_data.xlsx

EmployeeData_OilCompany.xlsx

1. Open each file and use **File** → **Save As** to save a working copy as an **Excel Macro-Enabled Workbook (.xlsm)**.
2. In that copy, open **Developer** → **Visual Basic**. Select its **VBAProject**, then **Insert** → **Module**.
3. Paste the relevant complete procedures into that module. Keep the original worksheet names: **Sheet 1** for the wholesaler, **Sheet1** for the employees.

Preparation

Use **Formulas** → **Calculation Options** → **Automatic**. To enable Developer on Mac: **Excel** → **Settings/Preferences** → **Ribbon & Toolbar**; on Windows: **File** → **Options** → **Customize Ribbon**. Tick **Developer**.

The wholesaler: what do the data describe?

wholesaler_data.xlsx

A wholesaler sells **14 types of goods**. The worksheet contains **2,000 sales records**; the same good appears in several rows. Each row gives a selling price, a unit cost and a quantity.

From inputs to results

Price, unit cost and quantity are inputs. Excel calculates the money received, the cost of the goods sold and the difference between them.

The owner wants to test a pricing strategy for **Chicken** and **Pasta**. We must compare the resulting **total net revenue** with its original value.

The wholesaler: cells and formulas

Sheet 1!A1:G2001: headers in row 1; data in rows 2–2001.

Column	Content	Type	Formula in row 2
A	Good	Input	—
B	Price (\$ per unit)	Input	—
C	Cost (\$ per unit)	Input	—
D	Quantity	Input	—
E	Total Income (\$)	Formula	=B2*D2
F	Total Cost (\$)	Formula	=C2*D2
G	Net Revenue (\$)	Formula	=E2-F2

What are we measuring?

Net Revenue = (Price – Unit Cost) × Quantity.

This is the workbook's margin on goods sold, before any other expenses.

Reading two actual sales records

		Row 7	Row 9
A	Good	Pasta	Chicken
B	Price	1.80	3.40
C	Unit cost	1.10	2.00
D	Quantity	19	25
E	Total Income	34.20	85.00
F	Total Cost	20.90	50.00
G	Net Revenue	13.30	35.00

Follow the dependency

For Chicken, $85 - 50 = (3.40 - 2.00) \times 25 = 35$. Changing either B9 or D9 changes the formulas in E9:G9. We do not need to rewrite those formulas in VBA.

Exercise 1: a pricing strategy

THE PROPOSED CHANGES

- ▶ **Chicken:** increase price by **50%**; assume that quantity sold decreases by **20%**.
- ▶ **Pasta:** decrease price by **50%**; assume that quantity sold increases by **20%**.

Unit costs and all other goods remain as in the dataset.

1. Does **total net revenue** increase?
2. How does net revenue change for Chicken and Pasta separately?
3. What are the answers to questions 1 and 2 if we apply the strategy **twice consecutively**?

Save the original comparison

1. Select **A1:G2001** on **Sheet 1**. Choose **Insert** → **PivotTable** → **New Worksheet**.
2. Put **Good** in **Rows** and **Net Revenue** in **Values**. In Value Field Settings, choose **Sum**.
3. Copy the complete PivotTable and use **Paste Special** → **Values** in an empty area. Label this fixed comparison **Original**.

Check before running the macro

Original total net revenue: **\$53,626.60**.

Chicken: **\$3,584.00**; Pasta: **\$1,366.40**.

Copy *values*, so that this comparison does not change when the PivotTable is refreshed.

Reading the row with Offset

The loop reads the name of the good in column A.

VBA expression	Column	Meaning
<code>cell.Value</code>	A	Good
<code>cell.Offset(0, 1).Value</code>	B	Price
<code>cell.Offset(0, 2).Value</code>	C	Unit cost
<code>cell.Offset(0, 3).Value</code>	D	Quantity

Two coordinates

`Offset(0, 3)` means: stay on the **same row** and move **three columns to the right**. From A9, this points to D9.

Build the loop and select Chicken

```
Sub shock()  
    Dim cell As Range  
  
    For Each cell In _  
        ThisWorkbook.Worksheets("Sheet 1").Range("A2:A2001")  
  
        If cell.Value = "Chicken" Then  
            'Change the price and quantity here.  
        End If  
  
    Next cell  
End Sub
```

- ▶ cell is one cell of the range at a time.
- ▶ ThisWorkbook is the workbook containing this macro.
- ▶ The underscore continues the instruction on the following line.

Change the price and quantity

Inside the **Chicken** branch:

```
cell.Offset(0, 1).Value = cell.Offset(0, 1).Value _  
                        + 0.5 * cell.Offset(0, 1).Value  
cell.Offset(0, 3).Value = cell.Offset(0, 3).Value _  
                        - 0.2 * cell.Offset(0, 3).Value
```

New price = $1.5 \times$ old price, new quantity = $0.8 \times$ old quantity.

Inside the **Pasta** branch:

```
cell.Offset(0, 1).Value = cell.Offset(0, 1).Value _  
                        - 0.5 * cell.Offset(0, 1).Value  
cell.Offset(0, 3).Value = cell.Offset(0, 3).Value _  
                        + 0.2 * cell.Offset(0, 3).Value
```

New price = $0.5 \times$ old price, new quantity = $1.2 \times$ old quantity.

The complete macro: shock

```
Sub shock()  
    Dim cell As Range  
    For Each cell In _  
        ThisWorkbook.Worksheets("Sheet 1").Range("A2:A2001")  
        If cell.Value = "Chicken" Then  
            cell.Offset(0, 1).Value = cell.Offset(0, 1).Value _  
                + 0.5 * cell.Offset(0, 1).Value  
            cell.Offset(0, 3).Value = cell.Offset(0, 3).Value _  
                - 0.2 * cell.Offset(0, 3).Value  
            If cell.Offset(0, 3).Value < 0 Then  
                cell.Offset(0, 3).Value = 0  
            End If  
        ElseIf cell.Value = "Pasta" Then  
            cell.Offset(0, 1).Value = cell.Offset(0, 1).Value _  
                - 0.5 * cell.Offset(0, 1).Value  
            cell.Offset(0, 3).Value = cell.Offset(0, 3).Value _  
                + 0.2 * cell.Offset(0, 3).Value  
        End If  
    Next cell  
    Application.Calculate  
End Sub
```

Paste this complete procedure once in the wholesaler workbook's module.

What happens at the next click?

Each run changes the **current** inputs. The second run therefore applies the same percentages to the values produced by the first run.

	Original	After one run	After two runs
Chicken price	3.40	5.10	7.65
Chicken quantity (row 9)	25	20	16
Pasta price	1.80	0.90	0.45
Pasta quantity (row 7)	19	22.8	27.36

Assumptions of this exercise

Quantities are treated as continuous scenario values, without rounding. For nonnegative inputs, multiplying quantity by 0.8 or price by 0.5 cannot make them negative. The Chicken guard is retained in the code.

Run, refresh and compare

1. On the data sheet, use **Developer** → **Button** (or **Insert** → **Button (Form Control)**). Draw the button, assign **shock** and label it **Apply strategy**.
2. Click **once**. The worksheet formulas recalculate.
3. Click inside the PivotTable and choose **Data** → **Refresh** (or **PivotTable Analyze** → **Refresh**).
4. Copy the updated PivotTable and **Paste Special** → **Values** beside Original. Label it **After one shock**.
5. Click the button **one more time**, refresh and save another values-only comparison: **After two shocks**.

Two different updates

Recalculating worksheet formulas and refreshing a PivotTable are different operations. Complete both before comparing the totals.

Net revenue: the complete comparison

Good	Original	One shock	Two shocks
Bread	1,932.80	1,932.80	1,932.80
Carrots	1,806.70	1,806.70	1,806.70
Chicken	3,584.00	6,348.80	9,256.96
Eggs	3,435.20	3,435.20	3,435.20
Fresh Vegetable	4,581.00	4,581.00	4,581.00
Frozen Fish	5,522.50	5,522.50	5,522.50
Frozen Vegetable	16,552.80	16,552.80	16,552.80
Milk	1,818.60	1,818.60	1,818.60
Mozzarella	1,893.60	1,893.60	1,893.60
Pasta	1,366.40	-468.48	-1,827.07
Rice	1,680.60	1,680.60	1,680.60
Sugar	1,107.90	1,107.90	1,107.90
Turkey	4,924.50	4,924.50	4,924.50
Water	3,420.00	3,420.00	3,420.00
Total (\$)	53,626.60	54,556.52	56,106.09

Amounts displayed to two decimals; calculations use unrounded values.

Is the strategy successful?

According to the stated objective: yes

Total net revenue increases by **\$929.92** after one shock and by **\$2,479.49** after two shocks, relative to the original data.

- ▶ Chicken's higher margin more than offsets its lower quantity.
- ▶ Pasta's price falls **below its unit cost**: $0.90 < 1.10$ after the first shock. Selling more Pasta then increases the loss on that product.
- ▶ The conclusion depends on the assumed quantity responses. These are scenario assumptions, not estimates from the data.

After two shocks the unrounded total is \$56,106.088.

The oil company: what do the data describe?

EmployeeData_OilCompany.xlsx

The file describes **1,000 employees**, each identified by an anonymous EmployeeID. There are four roles and nine countries.

Why some cells contain formulas

The country determines a risk factor. Role, risk and gender determine the model's employment cost. A separate compensation amount is added to that cost.

We first measure the current workforce and costs. Then we evaluate **a transfer policy** and, after those transfers, **a compensation policy**.

The employee worksheet

Sheet1!A1:G1001: one employee per row, rows 2–1001.

Column	Content	Meaning and origin
A	EmployeeID	Anonymous identifier; input.
B	Position	Engineer, Manager, Supervisor or Technician; input.
C	Country	Employee's work location; input.
D	RiskFactor	Formula based on Country; from 0 to 10.
E	Gender	Input used in the supplied cost model.
F	Total Annual Cost	Formula using B, D, E and G; dollars.
G	Compensation	Extra payment; input, initially zero for everyone.

Changing **C** recalculates **D** and then **F**. Changing **G** recalculates **F** directly.

How the annual cost is calculated

In the supplied model, with risk factor r ,

$$\text{Annual cost} = b \left(1 + \frac{r}{d} \right) m + \text{Compensation}.$$

Position	Base amount b (\$)	Divisor d
Engineer	80,000	20
Manager	100,000	15
Supervisor	70,000	22
Technician	60,000	25

Here $m = 1.2$ for Male and $m = 1$ for Female. These are assumptions encoded in this teaching dataset.

Example: EMP0004, row 5

Female Supervisor in the USA: $r = 4$, compensation = 0.

$$70,000 \left(1 + \frac{4}{22} \right) \times 1 + 0 = \$82,727.27.$$

Country and risk

Country	RiskFactor
Norway	0
Canada	1
UK	2
USA	4
Greenland	5
Saudi Arabia	6
Nigeria	8
Congo	9
Yemen	10

Read the formula bar

Select D2: nested IF functions map Country to RiskFactor. Select F2: the final +G2 adds Compensation. The country scores belong to this exercise's model.

Exercise 2: understand the current workforce

BEFORE CHANGING THE DATA

1. Compute the company's total annual cost.
2. How many Supervisors work in Canada?
3. What is the total annual cost of Engineers working in the UK?

Build the PivotTable

Select A1:G1001, then **Insert** → **PivotTable**.

- ▶ **Rows:** Country.
- ▶ **Columns:** Position.
- ▶ **Values:** Sum of Total Annual Cost; Count of Position.

The original workforce: results

Position	Employees	Total Annual Cost (\$)
Engineer	231	25,717,600.00
Manager	247	35,685,333.33
Supervisor	256	24,074,272.73
Technician	266	21,077,760.00
Total	1,000	106,554,966.06

Answers from the Country–Position table

28 Supervisors work in Canada.

Engineers in the UK cost **\$2,692,800.00** per year.

Copy the original PivotTable and **Paste Special** → **Values** before applying the first policy.

A transfer policy: the business problem

Managers can perform their duties remotely. The company considers moving all Managers based in **Nigeria** to **Norway**.

Two effects on the same employee

The risk factor falls from **8 to 0**, reducing the cost calculated in column F. Each transferred employee also receives a **\$15,000 compensation**, entered in column G.

The number of employees is unchanged. We need to establish whether the reduction in risk-related costs outweighs the compensation.

Exercise 2a: transfer the Managers

EVALUATE THE POLICY

Transfer every employee satisfying both conditions:

- ▶ Position is **Manager**;
- ▶ Country is **Nigeria**.

Set Country to **Norway** and Compensation to **\$15,000**.

1. Does the company's total annual cost decrease?
2. What is its percentage change?
3. What is the percentage change in total annual cost for the **Manager** category alone?

For both percentages, use the corresponding **original cost** as the denominator.

The complete macro: transfer

```
Sub transfer()  
    Dim cell As Range  
    For Each cell In _  
        ThisWorkbook.Worksheets("Sheet1").Range("B2:B1001")  
        If cell.Value = "Manager" And _  
            cell.Offset(0, 1).Value = "Nigeria" Then  
            cell.Offset(0, 1).Value = "Norway"  
            cell.Offset(0, 5).Value = 15000  
        End If  
    Next cell  
    Application.Calculate  
End Sub
```

Starting from **B**, **Offset(0, 1)** is Country in **C**, and **Offset(0, 5)** is Compensation in **G**.

Assign **transfer** to a button in the employee workbook, run it once and refresh the PivotTable. Save the result as **After transfer**.

The transfer policy: results

21 Managers are transferred: 10 Female and 11 Male.

Annual cost (\$)	Company	Managers only
Original	106,554,966.06	35,685,333.33
After transfer	105,632,632.73	34,763,000.00
Change	-922,333.33	-922,333.33
Percentage change	-0.8656%	-2.5846%

$$\% \text{ change} = \frac{\text{Cost after} - \text{Cost before}}{\text{Cost before}} \times 100.$$

Answer

Yes. The company's cost decreases even after including the $21 \times \$15,000 = \$315,000$ compensation.

A compensation policy: the business problem

The transfers have been completed. The company now introduces an additional policy for Female employees with a relatively low annual cost.

The point in time matters

Eligibility is assessed using Total Annual Cost **after the transfer policy and before the new compensation.**

Compensation in column G is included in the formula in column F. Once we change G, the annual cost displayed in F immediately changes. We will need to distinguish the **eligibility value** from the **resulting value**.

Exercise 2b: compensation

APPLY THE SECOND POLICY

For each **Female** employee whose current Total Annual Cost is **at most \$90,000**, set Compensation to **\$10,000**.

1. Which role contributes the most to the cost of this policy:
Engineer, Manager, Supervisor or Technician?
2. What is the percentage change in total annual cost for **Engineers**?

The correct comparison

Compare **After compensation** with **After transfer**. For the Engineers' percentage change, the denominator is the Engineers' cost *after transfer*.

The complete macro: equalopp

```
Sub equalopp()  
    Dim cell As Range  
    Application.Calculate  
    For Each cell In _  
        ThisWorkbook.Worksheets("Sheet1").Range("E2:E1001")  
        If cell.Value = "Female" And _  
            cell.Offset(0, 1).Value <= 90000 Then  
            cell.Offset(0, 2).Value = 10000  
        End If  
    Next cell  
    Application.Calculate  
End Sub
```

Starting from **E**, `Offset(0, 1)` reads cost in **F**; `Offset(0, 2)` writes compensation in **G**.

All eligible employees have zero compensation before this policy. The transferred Managers are above the threshold, so their \$15,000 compensation is preserved.

The compensation policy: results

Run `equalopp` once, refresh the PivotTable and compare with the saved **After transfer** values.

Position	Recipients	Added cost (\$)	Change in role cost
Engineer	32	320,000	+1.2443%
Manager	0	0	0.0000%
Supervisor	97	970,000	+4.0292%
Technician	146	1,460,000	+6.9267%
Total	275	2,750,000	+2.6034%

Answers

Technicians contribute the most to the added cost. Engineers' cost rises from \$25,717,600 to \$26,037,600: $320,000/25,717,600 = 1.2443\%$.

Why do some recipients now exceed \$90,000?

These are actual records from the file; the costs are in dollars.

EmployeeID	Cost before	Compensation	Cost after
EMP0004	82,727.27	10,000	92,727.27
EMP0005	76,363.64	10,000	86,363.64
EMP0008	84,000.00	10,000	94,000.00
EMP0012	80,000.00	10,000	90,000.00
EMP0019	88,000.00	10,000	98,000.00

The condition is checked before the assignment

If the eligible pre-policy cost is x , the final cost is $x + 10,000$. It is above \$90,000 exactly when $x > 80,000$. The upper eligibility limit applies to x , not to the final cost.

Keep the three employee scenarios separate

Scenario	Company's Total Annual Cost (\$)
Original	106,554,966.06
After transfer	105,632,632.73
After transfer and compensation	108,382,632.73

- ▶ The transfer policy saves **\$922,333.33**.
- ▶ The compensation policy then costs **\$2,750,000.00**.
- ▶ Together, the two policies raise costs by **\$1,827,666.67** relative to the original data (**1.7152%**).

Rerunning these macros

transfer finds no Managers still in Nigeria. **equalopp** assigns 10,000 again to any still-eligible rows; it does not add another 10,000. For this dataset, neither repeat changes the final result.

Can we solve both problems without VBA?

Yes: ordinary Excel formulas are sufficient

Use **IF** and **AND** to implement the conditions, retain the existing calculated columns, and compare scenarios with **SUM**, **SUMIF**, **SUMIFS**, **COUNTIFS** or PivotTables.

Start again from the **original .xlsx files**, not from the copies already changed by the macros. Rename the source sheet **Base**.

- ▶ Duplicate sheets to give each scenario its own inputs and outputs.
- ▶ A scenario's input formulas read the **previous scenario**.
- ▶ Keep the original calculated columns: Excel already knows how to compute the results.

Without VBA: the wholesaler, one shock

Duplicate **Base**: right-click its tab, choose **Move or Copy** → **Create a copy**, and name the copy **OneShock**. Replace **only B2 and D2** with the following formulas.

B2: price

```
=IF(Base!A2="Chicken",Base!B2*1.5,  
IF(Base!A2="Pasta",Base!B2*0.5,Base!B2))
```

D2: quantity

```
=IF(Base!A2="Chicken",Base!D2*0.8,  
IF(Base!A2="Pasta",Base!D2*1.2,Base!D2))
```

Select B2:B2001 and use **Home** → **Fill** → **Down**. Repeat for D2:D2001.

Formulas use English function names, decimal points and commas between arguments. In Italian Excel: IF=SE, AND=E; use the local decimal and argument separators.

Without VBA: two shocks and the totals

1. In **OneShock**, keep the copied formulas in **E:G**: **=B2*D2**, **=C2*D2**, **=E2-F2**.
2. Duplicate **OneShock** and name the copy **TwoShocks**.
3. In **TwoShocks!B2** and **TwoShocks!D2**, replace each **Base!** reference with **OneShock!**. Fill B and D down to row 2001 again.

In an empty cell outside **A:G**, calculate each sheet's total:

```
=SUM(G2:G2001)
```

For Chicken and Pasta, respectively:

```
=SUMIF(A2:A2001,"Chicken",G2:G2001)  
=SUMIF(A2:A2001,"Pasta",G2:G2001)
```

The totals are exactly the same as in the VBA comparison. Italian names:

SUM=SOMMA, **SUMIF=SOMMA.SE**.

Without VBA: the employee transfer

In a fresh employee workbook, rename the original sheet **Base**. Duplicate it and name the copy **Transfer**.

In **Transfer!C2**, calculate the new country:

```
=IF(AND(Base!B2="Manager",Base!C2="Nigeria"),  
    "Norway",Base!C2)
```

In **Transfer!G2**, calculate compensation:

```
=IF(AND(Base!B2="Manager",Base!C2="Nigeria"),  
    15000,Base!G2)
```

Fill **C2:C1001** and **G2:G1001** down separately.

Reuse the existing formulas

Keep **D** and **F** exactly as copied. On this sheet, **D** reads the new country in **C**; **F** uses the recalculated risk and the new compensation in **G**.

Without VBA: the compensation policy

Duplicate **Transfer** and name the copy **Equality**. Replace **G2 only** with:

```
=IF(AND(Transfer!E2="Female",Transfer!F2<=90000),  
    10000,Transfer!G2)
```

Fill G2:G1001 down. Leave every other column as copied.

Avoid a circular reference

The eligibility test reads **Transfer!F2**, the cost **before** this policy. It must not read **Equality!F2**, because that cell already includes **Equality!G2**.

The three sheet totals reproduce the macro results:

```
=SUM(Base!F2:F1001)  
=SUM(Transfer!F2:F1001)  
=SUM(Equality!F2:F1001)
```

Without VBA: answer the workforce questions

In unused cells on **Base**, use:

Total annual cost

```
=SUM(F2:F1001)
```

Number of Supervisors in Canada

```
=COUNTIFS(B2:B1001,"Supervisor",C2:C1001,"Canada")
```

Annual cost of Engineers in the UK

```
=SUMIFS(F2:F1001,B2:B1001,"Engineer",C2:C1001,"UK")
```

Results: **\$106,554,966.06, 28, \$2,692,800.00.**

Italian names: COUNTIFS=CONTA.PIÙ.SE, SUMIFS=SOMMA.PIÙ.SE. No recent dynamic-array functions are needed.

Without VBA: compare each role

Create a **Summary** sheet. Put Position, Base, Transfer, Equality in A1:D1, and the four role names in A2:A5.

Enter these formulas in B2, C2 and D2, respectively:

```
=SUMIF(Base!$B$2:$B$1001,$A2,Base!$F$2:$F$1001)
=SUMIF(Transfer!$B$2:$B$1001,$A2,Transfer!$F$2:$F$1001)
=SUMIF(Equality!$B$2:$B$1001,$A2,Equality!$F$2:$F$1001)
```

Fill B2:D5 down. Add these three comparison columns:

Column	Formula in row 2	Meaning
E	$=(C2-B2)/B2$	Transfer change (format as %)
F	$=D2-C2$	Added compensation cost (\$)
G	$=(D2-C2)/C2$	Compensation change (format as %)

Fill E:G down to row 5. The largest value in F identifies **Technician**; the Engineer row in G shows **1.2443%**.