Article

The *Split-Screen* Approach for Project Appraisal (Part II: Spreadsheet Modeling)

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Abstract: This paper employs the newly conceived accounting-and-finance engineering system (AFES) described in a previous paper (Magni 2023, "The Split-Screen Approach for Project Appraisal (Part I: The Theory)"), addressed to the analysis of capital asset investments. In this second part, we show how to implement this theoretical framework onto a spreadsheet software. We guide the analyst step by step, cell by cell, to the creation of the Split-Screen Matrices describing the project film. Because the AFES is based on two arithmetic relations (law of motion and law of conservation), we can use a minimal approach to modeling, with a frugal use of the most common spreadsheet functions (essentially INDEX and MATCH) and no use of the traditional financial functions, yet fulfilling the requisite of clearness, transparency, consistency, and ease of use. Starting from the informal description of the project, we build the model by breaking it down to 7 modules. The spreadsheet model is available online (see link provided in the paper).

Keywords: capital budgeting; engineering economics; project; accounting-and-finance engineering system; spreadsheet modeling; financial model

Introduction

This paper is the second, applicative part of a work addressed to illustrate the accounting-and-finance engineering system (AFES) for project appraisal, developed in Magni (2023). The latter describes the theory underlying the AFES for project appraisal.[1] The AFES is grounded on two principles. First, the Balance Sheet (BS), Income Statement (IS), and Cash Flow Statement (CFS) show, respectively, the capital invested, the income generated, and the cash flow extracted, which are dynamically interconnected by the law of motion $C_t = C_{t-1} + I_t - F_t$; where C, I, and F denote, capital, income, and cash flow, respectively. Second, the BS, IS, and CFS satisfy a law of conservation, according to which the capital in one period must be equal to the financial obligations of the firm towards some capital providers (equityholders and debtholders); the income generated by the investments is equal to the income accrued to the capital providers; the cash flow extracted from (or injected into) some assets is equal to the cash flow distributed to (or raised from) the capital providers. Blending these two laws, the BS, IS, and CFS may be graphically interlinked by a Split-Screen Matrix (SSM) as in Table 1.

Table 1. The Split-Screen Matrix (SSM).

+ BALANCE SHEET$_t$	+ BALANCE SHEET$_{t-1}$	+ INCOME STATEMENT$_t$	+ CASH FLOW STATEMENT$_t$
+ Net Operating Assets$_t$	+ Net Operating Assets$_{t-1}$	+ Operating income$_t$	− Cash flow from operations$_t$
+ Liquid Assets$_t$	+ Liquid Assets$_{t-1}$	+ Interest income$_t$	− Cash flow from liquid assets$_t$
+ Debt$_t$	+ Debt$_{t-1}$	+ Interest expense$_t$	− Cash flow to debt$_t$
+ Equity$_t$	+ Equity$_{t-1}$	+ Net income$_t$	− Cash flow to equity$_t$

where the red (horizontal and vertical) bars represent equality (see Magni 2023). This tabular format enables reading the three financial statements jointly, both horizontally and vertically. Reading it horizontally (dynamic dimension), each component of the BS as of time t is obtained from the same component of the BS as of time $t − 1$ by adding the corresponding component of the IS and subtracting the corresponding component of the CFS (e.g., net operating assets at time t are equal to net operating asset at time $t − 1$ plus the operating income less the cash flow from operations). Reading it vertically (static dimension), the investment components equate the financing components for each financial statement: assets equate financings (BS), income from investments equates income to capital providers (IS), cash flow from investments equates cash flow to capital providers (CFS) (e.g., the sum of operating income and interest income is equal to the interest expense and the net income). The tabular format may be enriched by decomposing each one of the four areas in its constituent assets. For example, breaking down the net operating assets, the SSM is expanded as in Table 2.

Table 2. The Full-Scale Split-Screen Matrix.

+ BALANCE SHEET$_t$	+ BALANCE SHEET$_{t-1}$	+ INCOME STATEMENT$_t$	+ CASH FLOW STATEMENT$_t$
+ Accounts receivable$_t$	+ Accounts receivable$_{t-1}$	+ Sales$_t$	− Cash receipts from customers$_t$
+ Inventory$_t$	+ Inventory$_{t-1}$	+ ΔInventory$_t$	− 0
− Accounts payable$_t$	− Accounts payable$_{t-1}$	− Cost of purchases$_t$	+ Payments to suppliers$_t$
− Salaries and wages$_t$	− Salaries and wages$_{t-1}$	− Labor cost$_t$	+ Payments to employees$_t$
+ Net fixed assets$_t$	+ Net fixed assets$_{t-1}$	− Depreciation$_t$	+ Net asset disposals$_t$
− Taxes payable$_t$	− Taxes payable$_{t-1}$	− Taxes$_t$	+ Payments for income taxes$_t$
+ Liquid Assets$_t$	+Liquid Assets$_{t-1}$	+ Interest income$_t$	− Cash flow from liquid assets$_t$
+ Debt$_t$	+ Debt$_{t-1}$	+ Interest expense$_t$	− Cash flow to debt$_t$
+ Equity$_t$	+ Equity$_{t-1}$	+ Net income$_t$	− Cash flow to equity$_t$

The first six rows represent the net operating assets (i.e., operating assets less operating liabilities). Given an *n*-year project project, there exists a sequence of *n* such SSMs, which give rise to a strip of SSMs. This strip must be built by the modelers on the basis of the assumptions on the input parameters.

As shown in Part I, this very framework may be used for financial evaluation as well. To this end, one builds the strip of SSMs related to the benchmark portfolio. Opposing the two strips (the project's and benchmark portfolio's), the relevant financial metrics are directly computed: economic residual income, net present value, and project's rate of return.

This approach is highly innovative and, while consistent with the traditional capital budgeting theory described in the traditional finance and engineering texts (e.g., Hartman 2007; Newnan et al. 2009; Brealey et al. 2011; Ross et al. 2019; Berk and DeMarzo 2019; Park 2019), it integrates the static and dynamic dimension of a project overturning the traditional models from three main points of view:

- the creation of isolated pro forma financial statements derived from the model's assumptions is replaced by the so-called Split-Screen Matrix (SSM) and split-screen film (displayed in different formats);
- the new notion of cash flow from (or to) liquid assets is employed (in addition to the classical operating cash flow, cash flow to debt, and cash flow to equity);

- the role of the payout and financing decisions is made explicit;
- the project's economic profitability, usually based on cash flows and measured by net present value and internal rate of return, is replaced by a set of new, reciprocally consistent measures, which provide deeper information about the project's economic profitability; and
- the model is designed to act as a diagnostic tool for spotting internal inconsistencies.

These features make the AFES radically different from the approaches to project appraisal currently available in applied corporate finance or engineering economics. For this reason, the new approach requires that the association among accounting and financial magnitudes are remodeled; in other words, the AFES asks for a different-from-usual spreadsheet modeling. This paper aims at filling this gap. We provide a complete translation of the theory into spreadsheet modeling for practical applications and offer a detailed step-by-step guide to the AFES construction in spreadsheets, aiming at helping practitioners to employ it in real-life applications. Using a mockup project and following Part I's concepts, notions, formalizations, and algebraic relationships, we build the whole spreadsheet model for the project, starting from the verbal description of it and explaining it in full, cell by cell.[2]

Several organizations propose guidelines in financial modeling with spreadsheets (especially with Microsoft Excel). Two of the most popular guidelines are the *FAST Standard* (FAST Standard Organization 2022), a set of rules on the building spreadsheet-based financial models, developed by a non-profit organization, and *SSRB Best Practice Spreadsheet Modeling Standards* (Spreadsheet Standards Review Board 2016). These standards contain some similar principles and rules, which we have implemented in the methodology used in our workbook (described in this paper); in particular, we use separate worksheets for inputs, calculations, and outputs, avoid circular references and use concise and simple formula. The result is a spreadsheet model that fulfils the requisite for clear and concise communication and transparency. Indeed, using the rigorous-yet-simple structure of the AFES and implementing the worksheet according to the best practices, we establish a "spreadsheet engineering" discipline that, put it in Thorne's (2009) words, mitigates the problem of spreadsheet errors. Several criteria for spreadsheet accuracy are also applied (some suggestions are, for example, in Powell et al. 2008) and, more specifically, the AFES articulation is based on the law of motion and law of conservation, which enables the analyst to spot modeling errors (e.g., if numbers in rows and columns do not match according to the law of motion and law of conservation, there is some inconsistencies in the calculation). This zeroes out possible internal inconsistencies.

Traditional financial modeling is based on a vast number of functions (see Avon 2021, Ch. 11 for a list of the most used ones; see also Benninga 2014, Benninga and Mofkadi 2018). Owing to the AFES design, we propose a more frugal and user-friendly model, based as it is on very few spreadsheet functions, which are most common tools for modelers. Specifically, we use only four functions: the numeric function SUM(...), the reference functions INDEX(...) and MATCH(...), and the logical function IF(...); these functions are available in most spreadsheets (with small syntactic differences). We will also use the text string operator &[3] (and, last but not least, the analyst will not need any of the usual financial functions).

We accompany this paper with its associated Microsoft Excel file, which is available at the following link: https://morespace.economia.unimore.it/carloalbertomagni/spreadsheet-modeling (accessed 18 February 2023). The spreadsheet file, according to best practices described in handbooks (e.g., Swan 2016) and in standard guidelines, has a structure based on separated sheets for inputs and assumptions (inputs), calculations (working sheets), and presentation of the results (outputs).

The analyst must be equipped with a spreadsheet software such as Microsoft Excel, Apple Numbers, Google Sheets, LibreOffice, OpenOffice Calc, or equivalents (tools that any financial analyst knows and daily employs in its work).

To present the model, we assume the role of a financial analyst who oversees the economic analysis of a given capital asset investment. We follow the entire process of the

analyst, starting from the collection of the pieces of information from the various experts (CFO, CEO, CTO, etc.).

The analyst makes explicit all the assumptions obtained from interviews to the firm's experts (CEO, CFO, CTO, marketing experts, etc.). For illustrative purposes, we model the project in Box 1, which has been inspired by an example presented in Magni (2020, Example 4.1).

Box 1. Description of CAD Inc. project.

CAD Inc. project

CAD Inc. faces the opportunity of undertaking a five-year project consisting in the production of a manufactured good. The initial investment in fixed assets is equal to USD 20,000, to be fully paid in year 0. The investment in fixed assets is depreciated with straight-line depreciation.

The sales projection for the first period (year 1) is 6,000 units of product and the sales growth is equal to 10% yearly. The sale price of each unit of the product is USD 10 for each year.

The unit manufacturing costs incurred are

- material used for production: USD 2.5,
- direct and indirect labor: USD 4.

The production department requires that materials inventory at the end of each period should be 25% of the consumption estimated for the next period.

Selling, General & Administrative Expenses (SGA) are composed of

- purchases of non-manufacturing materials, estimated at 15% of sales
- incremental salaries for non-manufacturing activities, estimated at USD 6,000 each year.

Finished goods inventory will be zero (i.e., production will equal sales).

The average number of days to fully collect the payment after a sale is 90. All the purchases of materials (both manufacturing and non-manufacturing) will be cashed out in the year after the one in which they are incurred (except for the last period, when they will be cashed out in that year); salaries and wages will be paid monthly.

The tax rate is $\tau = 30\%$ and taxes are paid within the year in which they are incurred.

The capital expenditure of USD 20,000 in $t = 0$ is sustained by

(i) an equity injection of USD 6,000,
(ii) a loan of USD 10,000 at an interest rate of $i^d = 2.00\%$; the loan is reimbursed with 4 principal repayments of equal amount,
(iii) a withdrawal from liquid assets for the residual amount of USD 4,000.

The interest rate i^l on liquid asset is forecasted to be 3.80%.

CAD Inc. will pay out $\alpha = 20\%$ of the net income to its shareholders in each period from 1 to 4.

The required returns on operating assets, on liquid assets, and on debt are respectively:

$r^o = 15.00\%$ (pre-tax WACC),

$r^l = 1.00\%$,

r^d 3.00%.

We describe the development of the project model step by step, the creation of the benchmark obtained from the market input data, and the fabrication of the (absolute and relative) measures of economic profitability, which will lead to an accept or reject decision.

The model is divided into seven modules (see Figure 1 and Table 3):

Module 1: Extracting the data of the project
Module 2: Building the project split-screen strip
Module 3: Building the strips of other matrix representations
Module 4: Building the benchmark split-screen strip
Module 5: Performing the single-period analysis
Module 6: Reshaping the project split-screen strip
Module 7: Assessing value creation and financial efficiency

Starting from the verbal description of the project presented above (see also "Description" worksheet), Module 1 translates it into formal inputs and assumptions ("Assumptions" worksheet) and carries out the preliminary calculations ("PreCalc" worksheet) that are

necessary for Module 2 ("SplitScreenStrip" worksheet). The latter shows how to build the full-scale project film (split-screen strip). It first carves out the accounting magnitudes for period 0. The formulas for filling the cells in period 0 are in turn divided into: (i) cells whose values are provided by the preliminary calculations, (ii) cells whose values are calculated via the law of motion, (iii) cells whose values are calculated with suitable accounting formulas, and (iv) cells whose values are calculated with the law of conservation. Cells of periods 1 through n are obtained by simply dragging the fill handle right. Module 3 starts from the full-scale strip and, in a top-down approach, builds other lower-scale Matrix representations which show different pieces of information and different classification of costs and cash flows, up to the germ strip, which condenses the capital invested in the project, C_t; the project's return, I_t; and the project's cash flow, F_t. Module 4 creates the benchmark split-screen strip ("SplitScreenStrip" worksheet), which is necessary for valuation and decision-making. In Module 5, we build a menu of SSMs for every period ("SinglePeriod" worksheet) which favors a period analysis. Module 6 shows how to pass from the split-screen film to the project Transposed Matrix and benchmark Transposed Matrix ("TransMatrix" worksheet). In the same module, we show how to pass from the project split-screen film to the standard pro forma financial statements ("ConventionalFinStat" worksheet). The object of Module 7 is to measure value creation ("ValueCreation" worksheet); in it, we derive the set of absolute measures (quantifying the economic value created by the project) and relative measures (quantifying the financial efficiency of the project) that are described in Magni (2023). Some conclusions follow, and a legend of symbols and abbreviations used in this paper is located at the end of the paper, for the benefit of the reader.
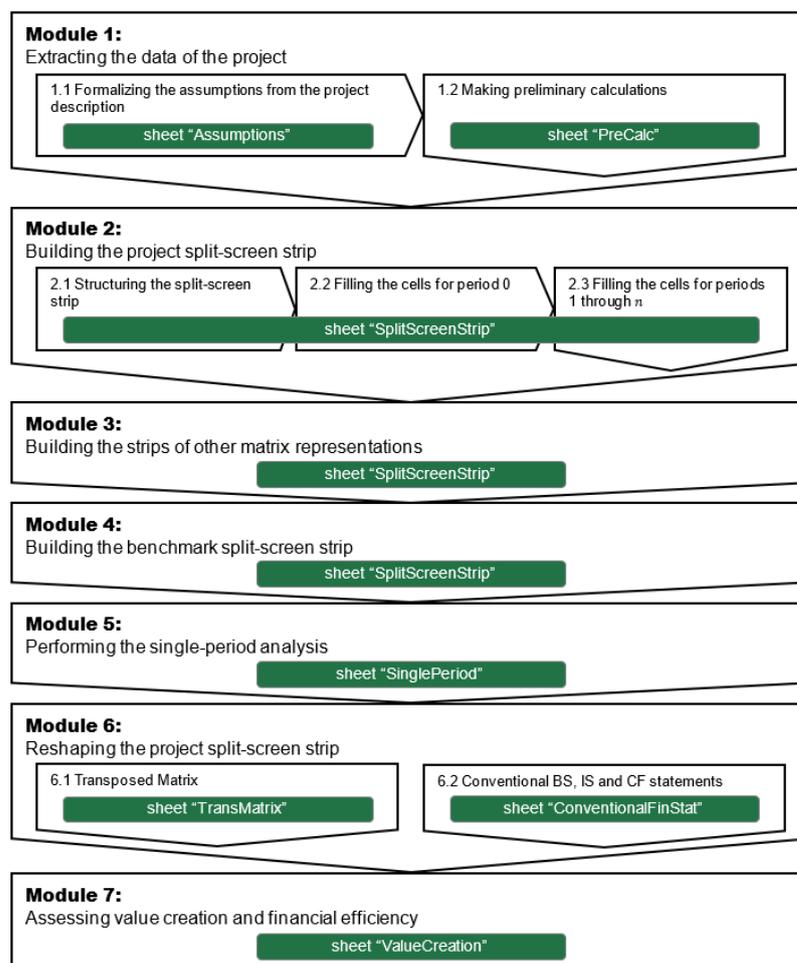

Figure 1. Structure of the paper and of the spreadsheet file.

Table 3. Structure of the paper and of the spreadsheet file.

Module	Worksheet	Section Number	Section Title
1	Assumptions PrelCalc	1	Extracting the data of the project
2	SplitScreenStrip	2	Building the project split-screen strip
3	SplitScreenStrip	3	Building the strips of other matrix representations
4	SplitScreenStrip	4	Building the benchmark split-screen strip
5	SinglePeriod	5	Performing the single-period analysis
6	TransMatrix ConventionalFinStat	6	Reshaping the project split-screen strip
7	Value Creation	7	Assessing value creation and financial efficiency

1. Module 1: Extracting the Data of the Project

1.1. Formalizing the Assumptions from the Project Description

In Module 1, the analyst identifies and formalizes the assumptions and, hence, makes some preliminary calculations, which are necessary for carrying out Module 2. The analyst retrieves all pieces of information regarding the project by the firm's CEO, CFO, CTO, and the marketing experts, and then needs convert them from natural language to figures in order to use them in a financial model that fully describes the project and the relevant relationships. More precisely, the analyst must carve out the figures and the relationships among all the inputs and the resulting accounting and financial magnitudes. As testified by the description above (and explained in detail in Magni 2023),[4] all pieces of information can be classified as capital, income, and cash flow. Furthermore, some of the inputs involve estimation regarding the project (costs, prices, quantities sold, etc.) or the market (required returns on assets, on debt, etc.), some other involve embedded decisions (e.g., the payout policy, the financing policy). The objective of the modeler is to derive, for each magnitude, the capital component, income component, and cash-flow component. Hence, the modeler must derive all the formal links among these basic variables for each area, build the project's SSM for every period, and, therefore, the corresponding split-screen strip.

As a first step of Module 1, the analyst extracts the input variables of the model and the corresponding assumptions from the description conveyed in the natural language. We classify them in project inputs and market inputs:

Project inputs	(verbatim)
Assumption 01	a five-year project
Assumption 02	investment in fixed assets is equal to USD 20,000, to be fully paid in year 0
Assumption 03	the investment in fixed assets is depreciated with straight-line depreciation
Assumption 04	the sales projection for the first period (year 1) is 6,000 units of product
Assumption 05	the sales growth is equal to 10% yearly
Assumption 06	The sale price of each unit of the product is USD 10 for each year
Assumption 07	the unit manufacturing costs incurred are—material used for production: USD 2.5
Assumption 08	the unit manufacturing costs incurred are—direct and indirect labor: USD 4
Assumption 09	the production department requires that materials inventory at the end of each period should be 25% of the consumption estimated for the next period
Assumption 10	purchases of non-manufacturing materials, estimated at 15% of sales
Assumption 11	incremental salaries for non-manufacturing activities, estimated at USD 6,000 each year
Assumption 12	the average number of days to fully collect the payment after a sale is 90
Assumption 13	all the purchases of materials (both manufacturing and non-manufacturing) will be cashed out in the year after the one in which they are incurred (except for the last period, when they will be cashed out in that year)
Assumption 14	salaries and wages will be paid monthly
Assumption 15	the tax rate is $\tau = 30\%$
Assumption 16	taxes are paid within the year in which they are incurred
Assumption 17	the capital expenditure in $t = 0$ is sustained by an equity injection of USD 6,000
Assumption 18	The capital expenditure in $t = 0$ is sustained by a loan of USD 10,000
Assumption 19	at an interest rate of $i^d = 2.00\%$
Assumption 20	the loan is reimbursed with 4 principal repayments of equal amount
Assumption 21	the interest rate i^l on liquid asset is forecasted to be 3.80%

Assumption 22	CAD Inc. will pay out α = 20% of the net income to its shareholders in each period from 1 to 4 and in the last period it will distribute the total amount of the equity
Market inputs	
Assumption 23	r^o = 15.00% (pre-tax WACC)
Assumption 24	r^l = 1.00%
Assumption 25	r^d = 3.00%

The project inputs are in turn divided into estimation variables (assumptions 1–11, 13–16, and 19) and decision variables (assumptions 12, 17, 18, 20, and 22).

The assumptions reported above provide the pieces of information needed for populating the SSM.

CODE INSTRUCTIONS: FORMALIZING ASSUMPTIONS

In a spreadsheet program, the analyst creates a workbook and adds a first sheet in it called "Assumptions", where he collects the assumptions. The analyst can fill the cells of the Assumptions table with the figures extracted from the description of the project. Column G contain the inputs, column H (yellow background) contain the assumptions (Figure 2). In this sheet, each input value is contained only in one single cell: this means that every time an input is used in the calculations ("PreCalc" sheet), the formula captures the content of the input cell. Therefore, the analyst can simulate different scenarios by changing only the contents of the Assumptions sheet.

	A	B C D	E	F	G	H	I
2	assumption				**INPUTS**	**assumptions**	**UoM**
5	01			n	Project length	5	y
6	02		**Fixed Assets**	NFA_0	Investment	20,000	$
7	03				Depreciation	straight-line	
8	04		**Sales**	S_0	Sales projection of the first period	6,000	u
9	05				Growth rate (%/year)	10%	% / y
10	06				Unit Price	10	$ / u
11	07		**Manufacturing Costs (COGS)**	COP^m	Unit Cost of Purchases	2.5	$ / u
12	08			LC^m	Unit Cost of Labor	4.0	$ / u
13	09				Raw Materials Inventory (% of next-period consumption)	25%	%
14	10		**NonManufacturing Costs (SGA)**		Cost of purchases (SGA) (% of Sales)	15%	%
15	11			LC^{nm}	Labor costs (SGA)	6,000	$ / y
16	12		**Operating cycle**		DSO (Days Sales Outstanding)	90	dd
17	13				DPO (Days Payable Outstanding)	365	dd
18	14		**Pay period**		Salaries and Wages will be paid	monthly	
19	15		**Taxes**	τ	Tax Rate	30%	%
20	16				Taxes are paid	yearly	
21	17		**Equity financing**	C_0^e	Capital Payment (period 0)	6,000	$
22	18		**Debt financing**	C_0^l	Loan amount	10,000	$
23	19			i^d	Loan Interest Rate	2.00%	%
24	20				Loan reimbursement periods	4	y
25	21		**Liquid Assets**	i^l	Interest rate on liquid assets	3.80%	%
26	22		**Payout policy**	α	Payout ratio (% Net Income)	20%	%
27	23		**Market data**	r^o	pre-tax WACC	15.00%	%
28	24			r^l	required return on liquid assets	1.00%	%
29	25			r^d	required return on debt	3.00%	%

Figure 2. Inputs and Assumptions ("Assumptions" sheet).

1.2. Making Preliminary Calculations

The objective of the analyst is to feed the Full-scale Matrix (Part I, Equation (33), right matrix) and build the whole strip of SSMs (see Part I, Equation (68)). However, to fill in the cells of each Matrix, preliminary calculations are needed, which make explicit, period by period, the figures already implicit in the assumptions.

More precisely, we highlight in yellow the cells in the full-scale matrix whose values may be obtained from the assumptions via some simple calculations (see Figure 3). We

describe these calculations in this section. The remaining (not highlighted) cells contain amounts that will be calculated in Module 2, as we will see, by making use of the law of motion or the law of conservation or specific accounting formulas.

Full-scale Matrix (compact)

C_t	C_{t-1}	I_t	$-F_t$
$+AR_t$	$+AR_{t-1}$	$+S_t$	$-F_t^{ar}$
$+Inv_t$	$+Inv_{t-1}$	$+\Delta Inv_t$	-0
$-AP_t^m$	$-AP_{t-1}^m$	$-COP_t^m$	$+F_t^{ap,m}$
$-AP_t^{nm}$	$-AP_{t-1}^{nm}$	$-COP_t^{nm}$	$+F_t^{ap,nm}$
$-SWP_t^m$	$-SWP_{t-1}^m$	$-LC_t^m$	$+F_t^{swp,m}$
$-SWP_t^{nm}$	$-SWP_{t-1}^{nm}$	$-LC_t^{nm}$	$+F_t^{swp,nm}$
$+NFA_t$	$+NFA_{t-1}$	$-Dep_t$	$-F_t^{nfa}$
$-TP_t$	$-TP_{t-1}$	$-T_t$	$+F_t^{tp}$
$+C_t^l$	$+C_{t-1}^l$	$+I_t^l$	$-F_t^l$
$+C_t^d$	$+C_{t-1}^d$	$+I_t^d$	$-F_t^d$
$+C_t^e$	$+C_{t-1}^e$	$+I_t^e$	$-F_t^e$

Figure 3. Full-scale matrix (compact form. See also Part I, Equation (33), right matrix). The yellow cells contain values that may be obtained from the assumptions via some simple calculations.

FIXED ASSETS. Assumption 02 regarding the NFA provides the following figures:

Period	0	1	2	3	4	5
$-F_t^{nfa}$	20,000	0	0	0	0	0

Assumption 03 enables calculating the (straight-line) depreciation:

$$\text{Dep}_t = \frac{\text{NFA}_0}{n} = \frac{20{,}000}{5} = 4000$$

Period	0	1	2	3	4	5
$-\text{Dep}_t$	0	−4,000	−4,000	−4,000	−4,000	−4,000

SALES. Assumptions 04, 05, and 06 enable the analyst to calculate the sales for each period:

$$\text{Units sold in } t = (1.1) \cdot \text{Units sold in } t-1$$
$$S_t = \text{Units sold in } t \cdot \text{unit sale price}$$

Units (produced and) sold in the first year = 6,000.
Annual sales growth = 10%.
Unit sale price = USD 10.

Period	0	1	2	3	4	5
Units solid in t	0	6,000	6,600	7,260	7,986	8,785
$+S_t$	0	60,000	66,000	72,600	79,860	87,850

MANUFACTURING COSTS. Assumption 07 enables calculating the material (direct material and overhead) used for production:

$$\text{Material used in } t = \text{units sold in } t \cdot \text{unit cost}$$

Unit cost = USD 2.5

Period	0	1	2	3	4	5
Units sold in t	0	6,000	6,600	7,260	7,986	8,785
−Material used in t	0	−15,000	−16,500	−18,150	−19,965	−21,963

Assumption 09 enables calculating the raw materials inventory:

$$\text{Inv}_t = (\text{Material used in } t + 1) \cdot 25\%$$

Period	0	1	2	3	4	5
Material used in t	0	15,000	16,500	18,150	19,965	21,963
$+\text{Inv}_t$	3,750	4,125	4,538	4,991	5,491	0

The Cost of Purchases for the manufacturing activities (COP^m) is the sum of the Material used for the production and the change in the raw materials inventory:[5]

$$\text{COP}_t^m = \text{Material used in } t + \Delta\text{Inv}_t$$

Period	0	1	2	3	4	5
−Material used in t	0	−15,000	−16,500	−18,150	−19,965	−21,963
$-\Delta\text{Inv}_t$	−3,750	−375	−413	−454	−499	5,491
$-\text{COP}_t^m$	−3,750	−15,375	−16,913	−18,604	−20,464	−16,472

Assumption 08 enables calculating the labor costs for manufacturing activities (LC^m):

$$\text{LC}^m = \text{units sold} \cdot \text{unit labor cost}$$

Unit labor cost = USD 4.

Period	0	1	2	3	4	5
Units sold in t	0	6,000	6,600	7,260	7,986	8,785
$-\text{LC}_t^m$	0	−24,000	−26,400	−29,040	−31,944	−35,140

NON-MANUFACTURING COSTS (SGA). Assumption 10 enables calculating the cost of purchases for the nonmanufacturing activities.

$$\text{COP}_t^{nm} = S_t \cdot 15\%$$

Period	0	1	2	3	4	5
S_t	0	60,000	66,000	72,600	79,860	87,850
$-\text{COP}_t^{nm}$	0	−9,000	−9,900	−10,890	−11,979	−13,178

Assumption 11 enables calculating the cost of labor for the nonmanufacturing activities:

Period	0	1	2	3	4	5
$-\text{LC}_t^{nm}$	0	−6,000	−6,000	−6,000	−6,000	−6,000

OPERATING CYCLE. The next set of information extracted from the interviews to the various firm's experts provides information about the operating cycle of the project. Assumption 12 enables computing the Account Receivables:

$$AR_t = S_t \cdot \frac{90}{365}$$

Period	0	1	2	3	4	5
$+S_t$	0	60,000	66,000	72,600	79,860	87,850
$+AR_t$	0	14,795	16,274	17,901	19,692	0

Assumption 13 enables calculating the Account Payables:

$$AP_t^m = COP_t^m \text{ and } AP_t^{nm} = COP_t^{nm}$$

Period	0	1	2	3	4	5
$-COP_t^m$	–3,750	–15,375	–16,913	–18,604	–20,464	–16,472
$-AP_t^m$	–3,750	–15,375	–16,913	–18,604	–20,464	0

Period	0	1	2	3	4	5
$-COP_t^{nm}$	0	–9,000	–9,900	–10,890	–11,979	–13,178
$-AP_t^{nm}$	0	–9,000	–9,900	–10,890	–11,979	0

PAYROLL PERIOD. Assumption 14 enables calculating the payments to employees:

$$LC_t^m = F_t^{swp,m} \text{ and } LC_t^{nm} = F_t^{swp,nm}$$

Period	0	1	2	3	4	5
$-LC_t^m$	0	–24,000	–26,400	–29,040	–31,944	–35,140
$+F_t^{swp,m}$	0	24,000	26,400	29,040	31,944	35,140

Period	0	1	2	3	4	5
$-LC_t^{nm}$	0	–6,000	–6,000	–6,000	–6,000	–6,000
$+F_t^{swp,nm}$	0	6,000	6,000	6,000	6,000	6,000

TAXES. Assumption 16 enables calculating the Taxes Payable, which will be 0 in each period:

$$T_t = F_t^{tp} \implies TP_t = 0$$

Period	0	1	2	3	4	5
$-TP_t$	0	0	0	0	0	0

DEBT FINANCING. Assumptions 18 enables calculating the debt's principal repayment and the principal outstanding:

$$\text{principal repayment} = C_{t-1}^d - C_t^d = \frac{C_0^d}{4} = \frac{10,000}{4} = 2500$$

whence

$$C_t^d = C_{t-1}^d - 2500$$

Period	0	1	2	3	4	5
−Principal repayments	0	−2,500	−2,500	−2,500	−2,500	0
$+C_t^d$	10,000	7,500	5,000	2,500	0	0

CODE INSTRUCTIONS: PRELIMINARY CALCULATIONS

The analyst adds, in his workbook, a new sheet, named "PreCalc", where he calculates the figures obtained from the assumptions (see Figure 4).

Figure 4. Examples of preliminary calculations ("PreCalc" sheet).

Each column represents one period, and the rows contain the values taken on by the various variables. Columns A:G contain descriptions regarding the variables; column H contains the constant values (i.e., the values that are independent of the period); column I contains the unit of measurement of the variables; columns K to P contain the amounts of periods 0 through $n = 5$ (last period of the project).

Column G contains the labels that describe the variables. Columns D, E, and F report the variables that are expected to be recorded (with proper sign) in the SSM, classified, respectively, as:

capital (AR, Inv, $-AP^m$, $-AP^{nm}$, $-TP$, C^d),
income (S, $-COP^m$, $-COP^{nm}$, $-LC^m$, $-LC^{nm}$, $-Dep$),
cash flow ($F^{swp,m}$, $F^{swp,nm}$, $-F^{nfa}$).

The amounts in the rows with a label in columns D, E, or F, are the ones that will be linked in the SSM in the next steps.

We use different font colors for the cells that are linked to other cells:

- blue for the rows that are linked to rows in the previous sheet, "Assumptions";
- grey for the rows that are linked to other rows in the same sheet;
- red for the cells that will be used for building the SSM and will be linked to cells in the "SplitScreenStrip" sheet.

2. Module 2: Building the Project Split-Screen Strip

2.1. Structuring the Split-Screen Strip

As seen in Part I, four main areas are involved in a project: operating assets, non-operating (i.e., liquid) asset, debt capital, and equity capital. The law of motion holds for each of the four classes and may be represented with the four-area Matrix for each one of the n periods, giving rise to a split-screen film or split-screen strip.

In Figure 5, the project film is displayed in a discrete format (sequence of matrices). Merging the last and first column of any two consecutive matrices, the project film may be reframed in a continuous format (Figure 6):[6]

$$t = 0 \qquad\qquad t = 1 \qquad\qquad t = n$$

C_0^o	$+C_{-1}^o$	$+I_0^o$	$-F_0^o$
C_0^l	$+C_{-1}^l$	$+I_0^l$	$-F_0^l$
C_0^d	$+C_{-1}^d$	$+I_0^d$	$-F_0^d$
C_0^e	$+C_{-1}^e$	$+I_0^e$	$-F_0^e$

C_1^o	$+C_0^o$	$+I_1^o$	$-F_1^o$
C_1^l	$+C_0^l$	$+I_1^l$	$-F_1^l$
C_1^d	$+C_0^d$	$+I_1^d$	$-F_1^d$
C_1^e	$+C_0^e$	$+I_1^e$	$-F_1^e$

$\cdots$

C_n^o	$+C_{n-1}^o$	$+I_n^o$	$-F_n^o$
C_n^l	$+C_{n-1}^l$	$+I_n^l$	$-F_n^l$
C_n^d	$+C_{n-1}^d$	$+I_n^d$	$-F_n^d$
C_n^e	$+C_{n-1}^e$	$+I_n^e$	$-F_n^e$

Figure 5. The split-screen film or strip (discrete format) (reprinted from Part I, Equation (66)).

$$t = 0 \qquad\qquad t = 1 \qquad\qquad t = n$$

C_{-1}^o	$+I_0^o$	$-F_0^o$	C_0^o
C_{-1}^l	$+I_0^l$	$-F_0^l$	C_0^l
C_{-1}^d	$+I_0^d$	$-F_0^d$	C_0^d
C_{-1}^e	$+I_0^e$	$-F_0^e$	C_0^e

C_0^o	$+I_1^o$	$-F_1^o$	C_1^o
C_0^l	$+I_1^l$	$-F_1^l$	C_1^l
C_0^d	$+I_1^d$	$-F_1^d$	C_1^d
C_0^e	$+I_1^e$	$-F_1^e$	C_1^e

$\cdots$

C_{n-1}^o	$+I_n^o$	$-F_n^o$	C_n^o
C_{n-1}^l	$+I_n^l$	$-F_n^l$	C_n^l
C_{n-1}^d	$+I_n^d$	$-F_n^d$	C_n^d
C_{n-1}^e	$+I_n^e$	$-F_n^e$	C_n^e

Figure 6. The split-screen film or strip (continuous format) (reprinted from Part I, Equation (67)).

This compact representation of the film of split-screen matrices in a continuous format is particularly convenient for spreadsheet modeling. The assumptions and the preliminary calculations enable building the project film in full scale—that is, the strip of the n full-scale split-screen matrices (Figure 7).

0	$+S_0$	$-F_0^{ar}$	$+AR_0$	$+S_1$	$-F_1^{ar}$	$+AR_1$		$+S_n$	$-F_n^{ar}$	0
0	$+\Delta Inv_0$	$+0$	$+Inv_0$	$+\Delta Inv_1$	$+0$	$+Inv_1$		$+\Delta Inv_n$	$+0$	0
0	$-COP_0^m$	$+F_0^{ap,m}$	$-AP_0^m$	$-COP_1^m$	$+F_1^{ap,m}$	$-AP_1^m$		$-COP_n^m$	$+F_n^{ap,m}$	0
0	$-COP_0^{nm}$	$+F_0^{ap,nm}$	$-AP_0^{nm}$	$-COP_1^{nm}$	$+F_1^{ap,nm}$	$-AP_1^{nm}$		$-COP_n^{nm}$	$+F_n^{ap,nm}$	0
0	$-LC_0^m$	$+F_0^{swp,m}$	$-SWP_0^m$	$-LC_1^m$	$+F_1^{swp,m}$	$-SWP_1^m$		$-LC_n^m$	$+F_n^{swp,m}$	0
0	$-LC_0^{nm}$	$+F_0^{swp,nm}$	$-SWP_0^{nm}$	$-LC_1^{nm}$	$+F_1^{swp,nm}$	$-SWP_1^{nm}$	$\ldots\ldots$	$-LC_n^{nm}$	$+F_n^{swp,nm}$	0
0	$-Dep_0$	$-F_0^{nfa}$	$+NFA_0$	$-Dep_1$	$-F_1^{nfa}$	$+NFA_1$		$-Dep_n$	$-F_n^{nfa}$	0
0	$-T_0$	$+F_0^{tp}$	$-TP_0$	$-T_1$	$+F_1^{tp}$	$-TP_1$		$-T_n$	$+F_n^{tp}$	0
0	$+I_0^l$	$-F_0^l$	$+C_0^l$	$+I_1^l$	$-F_1^l$	$+C_1^l$		$+I_n^l$	$-F_n^l$	0
0	$+I_0^d$	$-F_0^d$	$+C_0^d$	$+I_1^d$	$-F_1^d$	$+C_1^d$		$+I_n^d$	$-F_n^d$	0
0	$+I_0^e$	$-F_0^e$	$+C_0^e$	$+I_1^e$	$-F_1^e$	$+C_1^e$		$+I_n^e$	$-F_n^e$	0

Figure 7. The full-scale strip (reprinted from Part I, Equation (68)).

CODE INSTRUCTIONS: STRUCTURE OF THE SPLIT-SCREEN STRIP
The analyst adds, in his workbook, a new sheet—named "SplitScreenStrip"—where he lays out a range of cells with the structure of the previous table (see Figure 8).

Figure 8. Structure of the full-scale strip in the spreadsheet ("SplitScreenStrip" sheet).

The table has a first group of columns representing a generic full-scale SSM: column D, E, and F report, respectively, the capital amounts, incomes, and cash flows.[7] The following columns (from column G on) will contain the figures of the project, starting from period $t = -1$, before the beginning of the project. The total number of columns containing numerical values is $(3 \cdot (n+1) + 1)$. Each value is 0 in column G since the project has not started yet ($C_{-1} = 0$).

Row 8 describes the kind of column (C, I or F) and row 9 contains the periods. Row 12 contains the labels of the columns, with specification of the category to which they belong (C, I, or F) and of the period $(-1, 0, \ldots, n)$. Each cell is identified by the labels. For example, cell K13 will contain the sales (S) of period 1; cell M13 will contain the Accounts Receivable (AR) of period 1 (see Figure 9).

Figure 9. Cell M13 will contain the Accounts Receivable at $t = 1$ ("SplitScreenStrip" sheet).

To build the whole split-screen film, one must follow two steps:

Step 1. The analyst fills in the cells of array H13:J23, which contain the values of all the 33 accounting and financial magnitudes that refer to period 0. These cells may be divided into four classes:

- Cells whose values are provided in "PreCalc" (step 1a)
- Cells whose values are calculated with the law of motion (step 1b)
- Cells whose values are calculated with suitable formulas (step 1c)
- Cells whose values are calculated with the law of conservation (step 1d)

We describe the calculations for all these cells in Section 2.2.

Step 2. The analyst fills the whole strip by copying the range H13:J23, which refer to the remaining periods (periods 1 to *n*). This is completed in few seconds by copying and

pasting it in the adjacent ranges, or by dragging the fill handle (we show the procedure in Section 2.3).

2.2. Filling the Cells for Period 0 (Step 1)

2.2.1. Cells Whose Values Are Provided in "PreCalc" (Step 1a)

Preliminary calculations feed into the split-screen strip. To fill the cells of array H13:J23, the analyst should use nested functions INDEX and MATCH.[8] This function is necessary because it makes the formulas parameterized and dependent on the cell where they are (using the references to the row and column labels): it will enable the analyst to drag and fill the whole strip, thereby completing the project film in few seconds (see Section 3.3).

In the code instructions below, we first provide the code for the general formula and then show how to use it for each one of the three economic elements: capital, income, and cash flow. For those who are not familiar with spreadsheet formulas, we suggest reading the online support pages of the software employed.

There are 15 cells to be filled (highlighted with yellow background in Figure 3): six of them are capital amounts, six are incomes, and three are cash flows (see Table 4).

Table 4. Cells whose values are provided in "PreCalc" (yellow cells).

Cell	Symbol	Magnitude	Type
H13	$+ S_0$	Sales	Income
J13	$+ AR_0$	Accounts Receivable	Capital
J14	$+ Inv_0$	Inventory	Capital
H15	$- COP_0^m$	$-$ Cost of Purchases (manufacturing)	Income
J15	$- AP_0^m$	$-$ Accounts Payable (manufacturing)	Capital
H16	$- COP_0^{nm}$	$-$ Cost of Purchases (nonmanufacturing)	Income
J16	$- AP_0^{nm}$	$-$ Accounts Payable (nonmanufacturing)	Capital
H17	$- LC_0^m$	$-$ Labor costs (manufacturing)	Income
I17	$+ F_0^{swp,m}$	Payments to employees (manufacturing)	Cash flow
H18	$- LC_0^{nm}$	Labor costs (nonmanufacturing)	Income
I18	$+ F_0^{swp,nm}$	Payments to employees (nonmanufacturing)	Cash flow
H19	$- Dep_0$	$-$ Depreciation	Income
I19	$- F_0^{nfa}$	$-$ Asset disposals (net of capital expenditures)	Cash flow
J20	$- TP_0$	$-$ Taxes Payable	Capital
J22	$+ C_0^d$	Debt	Capital

CODE INSTRUCTIONS: CELLS WHOSE VALUES ARE PROVIDED IN "PreCalc"
The analyst must pick the figures from the "PreCalc" sheet and insert them into the split-screen strip. For this operation, the analyst must use the nested formulas INDEX-MATCH.

The INDEX function

$$INDEX(\,array, row\_num, column\_num)$$

returns the value in the cell of the array at the intersection of row_num and column_num.
The MATCH function

$$MATCH(\,lookup\_value, lookup\_array, match\_type)$$

returns the position of the matched value within lookup_array, finding the first value that is exactly equal to lookup_value, if the optional argument is 0.
Hence, the combined formula

$$INDEX(\,PreCalc!\$K:\$P, MATCH(lookup\_value, lookup\_array, 0), column\_num)$$

returns a value within the range PreCalc!K:P, that is, the columns which contain the amounts preliminarily calculated in "PreCalc" sheet. The row of this value must be the one where the label in columns D, E, or F matches with the corresponding label in the split-screen strip. The column must be the $(t + 1)$-th column, where t is the period (i.e., first column for $t = 0$, second column for $t = 1$, etc.). The formulas are similar for three types of components: capital, income, and cash flow. Following are some examples of spreadsheets codes.

For an income component: lookup_value is the label in column SplitScreenStrip!E and lookup_array is the column PreCalc!E. For example, the code for cell H13 is

$$\text{H13} = \text{INDEX}(\ \underbrace{\text{PreCalc!\$K : \$P}}_{\substack{\text{array :} \\ \text{columns group of the} \\ \text{amounts calculated} \\ \text{in worksheet "PreCalc"}}}\ ,\ \underbrace{\text{MATCH(\$E13, PreCalc!\$E : \$E, 0)}}_{\substack{\text{the result of this formula is the number} \\ \text{of the row in the worksheet "PreCalc" with} \\ \text{the same label of cell E13}}}\ ,\ \underbrace{\text{H\$9 + 1}}_{\substack{\text{the } (t+1) - \text{th column,} \\ \text{where } t \text{ is the period} \\ \text{(first column for period 0)} \\ \text{in the columns group of the} \\ \text{worksheet "PreCalc"}}}\ )$$

(see Figures 10 and 11).

For a cash-flow component: lookup_value is the label in column SplitScreenStrip!F, and lookup_array is the column PreCalc!F. For example, the code for cell I17 is

$$\text{I17} = \text{INDEX}(\text{PreCalc!\$K : \$P, MATCH(\$F17, PreCalc!\$F : \$F, 0), I\$9 + 1})$$
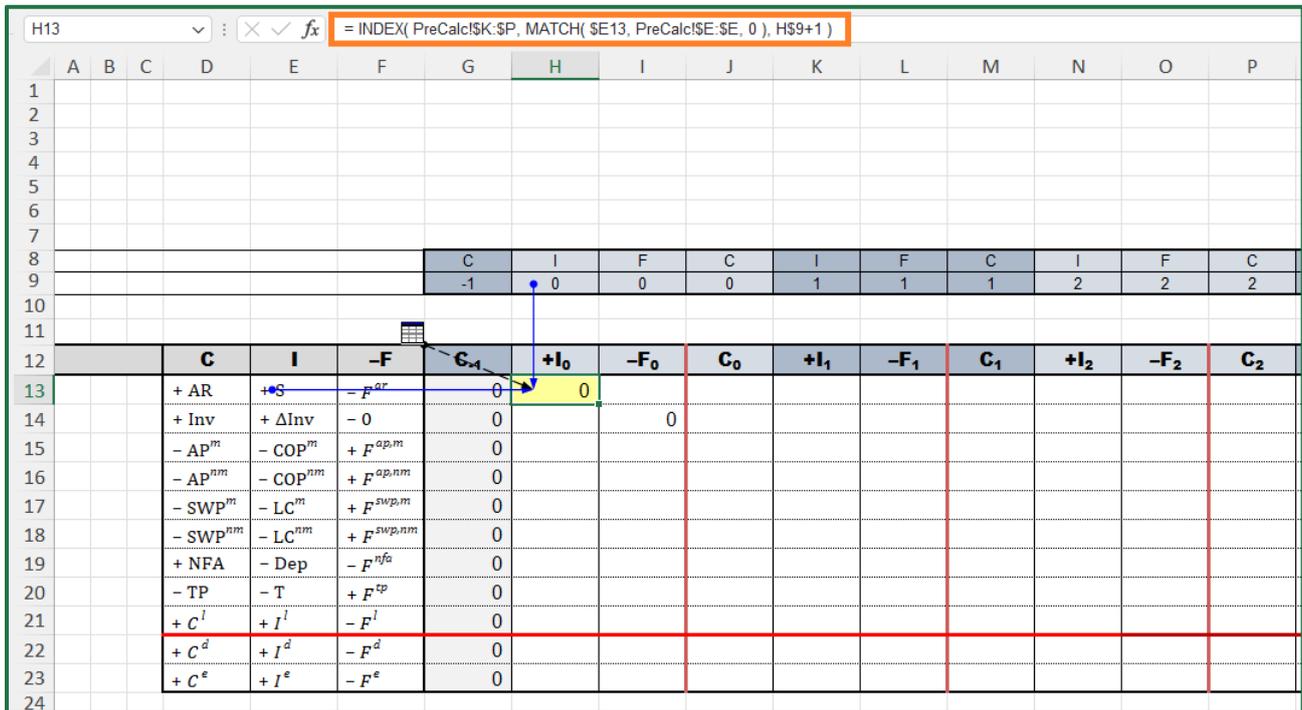
Figure 10. Cell H13 contains the formula for calculating the income component of AR (i.e., sales). Cell I14 is zero, by definition ("SplitScreenStrip" sheet).

Figure 11. Cell K43 contains the value that has the same label of SplitScreenStrip!E13 and that is in the (H\$9 + 1)-th column ("PreCalc" sheet).

For a capital component: lookup_value is the label in column SplitScreenStrip!D, and lookup_array is the column PreCalc!D. For example, the code for cell J15 is

$$J15 = INDEX(PreCalc!\$K : \$P, MATCH(\$D15, PreCalc!\$D : \$D, 0), J\$9 + 1)$$

(see also Figure 12).

Every cell in Table 4 should be filled using the formula INDEX-MATCH. Figure 12 shows the output of this step.

Figure 12. The 15 cells whose values are provided in "PreCalc" are in yellow. Cell J15 calculates the accounts payable for manufacturing activities at $t = 0$ ("SplitScreenStrip" sheet).

2.2.2. Cells Whose Values Are Calculated with the Law of Motion (Step 1b)

The second class of cells in array H13:J23 is the class of those cells which must be filled with the law of motion. To fill in these values, the analyst should use the law of motion for $t = 0$ (see Part I, Equation (2)). Specifically, to find a capital amount, the law of motion is expressed as

$$C_0 = C_{-1} + I_0 - F_0.$$

To find an income amount, the law of motion becomes

$$I_0 = C_0 - C_{-1} + F_0.$$

To find a cash-flow component, the law of motion becomes

$$F_0 = C_0 - C_{-1} + I_0.$$

Applying these laws of motion, the cells of this class are calculated, with their own sign (see Table 5).

Table 5. Cells whose values are calculated with the law of motion (green cells).

Cell	Symbol	Magnitude	Law of Motion	Type
H14	$+ \Delta \mathrm{Inv}_0$	Income from inventory	$+ \Delta \mathrm{Inv}_0 = \mathrm{Inv}_0 - \mathrm{Inv}_{-1} + (-0)$	Income
I13	$- F_0^{ar}$	$-$ Cash receipts from customers	$- F_0^{ar} = \mathrm{AR}_0 - \mathrm{AR}_{-1} - S_0$	Cash flow
I15	$+ F_0^{ap,m}$	Payments to suppliers (manufacturing)	$+ F_0^{ap,m} = -\mathrm{AP}_0^m + \mathrm{AP}_{-1}^m + \mathrm{COP}_t^m$	Cash flow
I16	$+ F_0^{ap,nm}$	Payments to suppliers (nonmanufacturing)	$+ F_0^{ap,nm} = -\mathrm{AP}_0^{nm} + \mathrm{AP}_{-1}^{nm} + \mathrm{COP}_0^{nm}$	Cash flow
I20	$+ F_0^{tp}$	Tax payments	$+ F_0^{tp} = -\mathrm{TP}_0 + \mathrm{TP}_{-1} + \mathrm{T}_0$	Cash flow
I22	$- F_0^d$	$-$ Cash flow to debt	$- F_0^d = C_0^d - C_{-1}^d - I_0^d$	Cash flow
J17	$- \mathrm{SWP}_0^m$	$-$ Salaries & Wages Payable (manufacturing)	$- \mathrm{SWP}_0^m = -\mathrm{SWP}_{-1}^m - \mathrm{LC}_0^m + F_0^{swp,m}$	Capital
J18	$- \mathrm{SWP}_0^{nm}$	$-$ Salaries & Wages Payable (nonmanufacturing)	$- \mathrm{SWP}_0^{nm} = -\mathrm{SWP}_{-1}^{nm} - \mathrm{LC}_0^{nm} + F_0^{swp,nm}$	Capital
J19	$+ \mathrm{NFA}_0$	Net Fixed Asset	$+ \mathrm{NFA}_0 = \mathrm{NFA}_{-1} - \mathrm{Dep}_0 + \left(-F_0^{nfa} \right)$	Capital
J21	$+ C_0^l$	Liquid assets	$+ C_0^l = C_{-1}^l + I_0^l - F_0^l$	Capital
J23	$+ C_0^e$	Equity	$+ C_0^e = C_{-1}^e + I_0^e - F_0^e$	Capital

Note that the application of the law of motion for J21 supplies a value equal to zero, because I_0^l and F_0^l (respectively, cell H21 and I21) have not been calculated yet. However, the values of J21 will be automatically updated as soon as H21 and I21 will be calculated in the next steps. The same holds for J23, I20, and I22—cells that temporarily can exhibit an incorrect value—because one of the cells linked in the formula is not yet calculated. The output of this step is displayed in Figure 13 (the cells of the class are highlighted in green).

CODE INSTRUCTIONS: CELLS WHOSE VALUES ARE CALCULATED WITH THE LAW OF MOTION
EXAMPLE OF CAPITAL COMPONENT. The (changed-in-sign) salaries and wages payable at $t = 0$ in cell J17 is obtained as follows:

$$\underbrace{\mathrm{J17}}_{-\mathrm{SWP}_0^m} = \underbrace{\mathrm{G17}}_{-\mathrm{SWP}_{-1}^m} + \underbrace{\mathrm{H17}}_{-\mathrm{LC}_0^m} + \underbrace{\mathrm{I17}}_{+F_0^{swp,m}}$$

(see Figure 13).

The analyst can copy cell J17 and paste it in cells J18, J19, J21, and J23 (the equations share the same structure).

EXAMPLE OF INCOME COMPONENT. The income from inventory in cell H14 is just equal to $\Delta \mathrm{Inv}_0$ (because the cash-flow component of inventory is zero):

$$\underbrace{\mathrm{H14}}_{+\Delta\mathrm{Inv}_0} = \underbrace{\mathrm{J14}}_{+\mathrm{Inv}_0} - \underbrace{\mathrm{G14}}_{+\mathrm{Inv}_{-1}} + \underbrace{\mathrm{I14}}_{-F_0^{Inv}}$$

with $F_0^{Inv} = 0$ (see Figure 14).

Figure 13. The cells whose values are calculated with the law of motion are in green. Cell J17 contains the law of motion for SWP_0^m ("SplitScreenStrip" sheet). (The cells whose values are provided in "PreCalc" are in yellow and the cells whose values are calculated with the law of motion are in green).

Figure 14. Cell H14 contains the law of motion for ΔInv_0 ("SplitScreenStrip" sheet). (The cells whose values are provided in "PreCalc" are in yellow and the cells whose values are calculated with the law of motion are in green).

EXAMPLE OF CASH-FLOW COMPONENT. The (changed-in-sign) cash receipts from customers $-F_0^{ar}$ in cell I13 are obtained as follows:

$$\underbrace{\text{I13}}_{-F_0^{ar}} = \underbrace{\text{J13}}_{+AR_0} - \underbrace{\text{G13}}_{+AR_{-1}} - \underbrace{\text{H13}}_{+S}$$

(see Figure 15).

Figure 15. Cell I13 contains the law of motion for the cash receipts from customers ("SplitScreenStrip" sheet). (The cells whose values are provided in "PreCalc" are in yellow and the cells whose values are calculated with the law of motion are in green).

The analyst can copy cell I13 and paste it in cells I15, I16, I20, and I22 (the equations share the same structure).

2.2.3. Cells Whose Values Are Calculated with Suitable Formulas (Step 1c)

The third class of cells consists of those cells that can be calculated via suitable, specific formulas. These are the taxes, interest income, interest expenses, and CFE (see Table 6 and description below).

Table 6. Cells whose values are calculated via suitable formulas (blue cells).

Cell	Symbol	Magnitude	Formula	Type
H20	T_t	Taxes	$T_t = EBT_t \cdot \tau$	Income
H21	I_t^l	Interest income	$I_t^l = C_{t-1}^l \cdot i^l$	Income
H22	I_t^d	Interest expenses	$I_t^d = C_{t-1}^d \cdot i^d$	Income
I23	F_t^e	Cash flow to equity	depends on the period	Cash flow

TAXES. The amount of Taxes (T_t) is not known, but the assumptions provide the necessary information for calculating it. The tax amount is computed applying the tax rate to earnings before taxes (EBT):

$$T_t = EBT_t \cdot \tau$$

where τ is the tax rate, equal to 30% (by Assumption 15) and EBT is equal to $\text{EBT}_t = \text{EBIT}_t + I_t^l - I_t^d$, so that

$$T_t = \left(\text{EBIT}_t + I_t^l - I_t^d\right) \cdot \tau$$

where EBIT_t is obtained as $\text{EBIT}_t = S_t - \text{COGS}_t - \text{SGA}_t - \text{Dep}_t$ (Part I, Equation (47)). Hence,

$$T_t = (S_t - \overbrace{(\text{COP}_t^m + \text{LC}_t^m - \Delta\text{Inv}_t)}^{\text{COGS}_t} - \overbrace{(\text{COP}_t^{nm} + \text{LC}_t^{nm})}^{\text{SGA}_t} - \text{Dep}_t + I_t^l - I_t^d) \cdot \tau$$

(see also Part I, footnote 7). All the values in this formula have already been computed or will be computed in the next steps (i.e., I_t^l and I_t^d).

CODE INSTRUCTIONS: TAXES
The tax rate τ is recorded in "Assumption" sheet: the analyst can show it in a cell above the Matrix in the "SplitScreenStrip" sheet (e.g., in cell D3) and then use it in the formulas (see Figure 16).
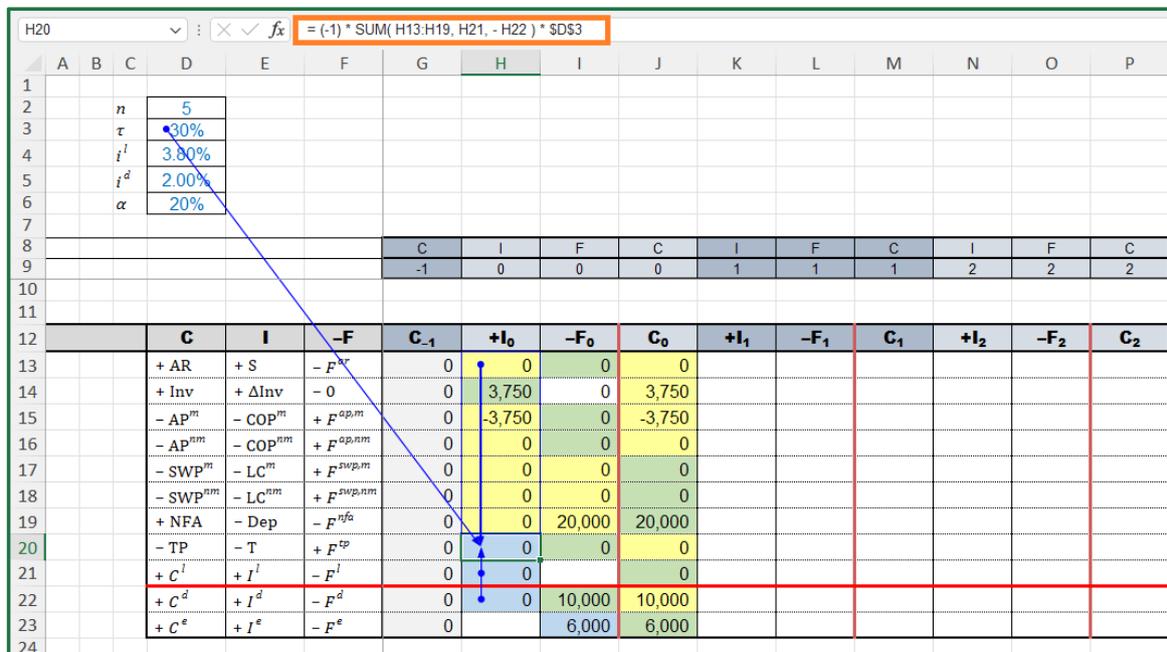
Figure 16. The cells whose values are calculated with suitable formulas are shown in blue. Cell H20 contains the specific formula for calculating the taxes ("SplitScreenStrip" sheet). (The cells whose values are provided in "PreCalc" are in yellow, the cells whose values are calculated with the law of motion are in green, and the cells whose values are calculated via suitable formulas are in blue).

Cell D3 is linked to the cell that contains the value of τ with the formula

$$D3 = \text{Assumptions!\$F\$19}.$$

The (changed-in-sign) taxes, $-T_t$, are calculated in cell H20:

$$H20 = (-1) * \text{SUM}(\ \underbrace{H13:H19}_{\substack{+S_0 + \Delta\text{Inv}_0 \\ -\text{COP}_0^m - \text{COP}_0^{nm} \\ -\text{LC}_0^m - \text{LC}_0^{nm} \\ -\text{Dep}_0}}, \underbrace{H21}_{+I_0^l}, \underbrace{-H22}_{-(+I_0^d)}) * \underbrace{\$D\$3}_{\tau}.$$

$$\underbrace{}_{-T_0}$$

while the equation is correct, the value obtained in H20 is not yet the correct one, because cells H21 ($+I_0^l$) and H22 ($-I_0^d$) have not yet been occupied by formulas; however, they will be filled with the amounts of interest income and expenses in the next step, and the value taken on by cell H20 will be automatically updated (see Figure 16).

INTEREST INCOME. The amounts of interest expenses (I_t^l) are not known, but the assumptions provide sufficient information for calculating it by applying the interest rate to the beginning-of-period balance of liquid assets:

$$I_t^l = C_{t-1}^l \cdot i^l$$

where i^l is the interest rate on liquid assets, equal to 3.80% (by assumption 21).

CODE INSTRUCTIONS: INTEREST INCOME
The interest rate i^l is recorded in the "Assumption" sheet. The analyst can show it in a cell above the Matrix in the "SplitScreenStrip" sheet (e.g., in cell D4) and then use it in the formulas (see Figure 15). Cell D4 is linked to the cell that contains the value of interest rate i^l with the formula

$$D4 = \text{Assumptions!}\$F\$25$$

The interest income I_t^l is calculated in cell H22:

$$\underbrace{H21}_{+I_1^l} = \underbrace{G21}_{+C_0^l} * \underbrace{\$D\$4}_{i^l}$$

(see Figure 17).
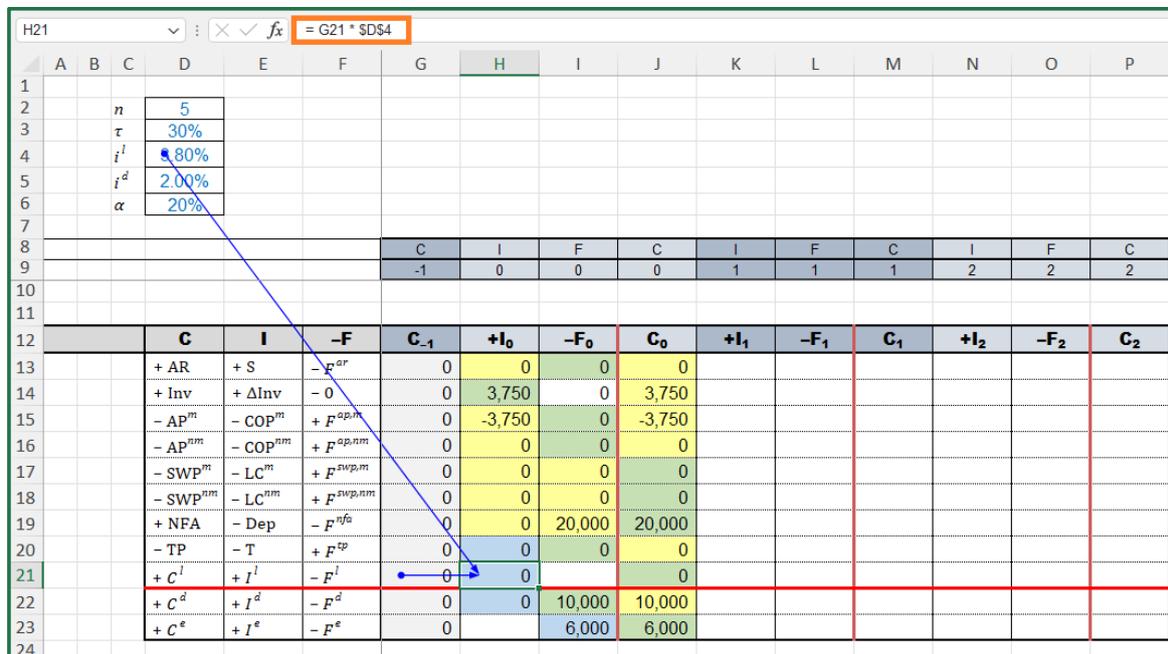
Figure 17. Cell H21 contains the specific formula for calculating the interest income ("SplitScreenStrip" sheet). (The cells whose values are provided in "PreCalc" are in yellow, the cells whose values are calculated with the law of motion are in green and the cells whose values are calculated via suitable formulas are in blue).

INTEREST EXPENSES. The amounts of interest expenses (I_t^d) are not known, but the assumptions provide sufficient information for calculating it by applying the interest rate to the beginning-of-period principal outstanding:

$$I_t^d = C_{t-1}^d \cdot i^d$$

where i^d is the interest rate of the loan, equal to 2% (by assumption 19).

CODE INSTRUCTIONS: INTEREST EXPENSES
The interest rate i^d is recorded in the "Assumption" sheet: the analyst can show it in a cell above the Matrix in the "SplitScreenStrip" sheet (e.g., in cell D5) and then use it in the formulas (see Figure 18). Cell D5 is linked to the cell that contains the value of interest rate i^d with the formula

$$D5 = \text{Assumptions!\$F\$23}.$$

The interest expenses I_t^d is calculated in cell H22:

$$\underbrace{\text{H22}}_{+I_1^d} = \underbrace{\text{G22}}_{+C_0^d} * \underbrace{\text{\$D\$5}}_{i^d}$$

(see Figure 18).

Figure 18. Cell H22 contains the interest expenses ("SplitScreenStrip" sheet). (The cells whose values are provided in "PreCalc" are in yellow, the cells whose values are calculated with the law of motion are in green and the cells whose values are calculated via suitable formulas are in blue).

CASH FLOW TO EQUITY. For simplifying the spreadsheet calculation for the CFE (F_t^e), it is convenient to break down the CFE into three categories (equity financing, interim payout, and liquidation dividend) and, hence, build the stream of cash flows for each such category. Equity financing is equal to USD 6,000 for $t = 0$ (i.e., the cash flow initially contributed by shareholders is $F_0^e = -6,000$) and equal to 0 for $t > 0$ (the firm's shareholders will not be required to make any other contribution) (assumption 17). The interim payout distributions are equal to $\alpha = 20\%$ of the project's net income for $1 < t < 5$ (assumption 22). As shown in Part I, the liquidation dividend, F_5^e, may be obtained as the sum of the equity at time $t = 4$ and the net income at time $t = 5$ (Part I, Equation (62)), as displayed in Table 7.

Alternatively, one can calculate it as the sum of FCFE and the last non-operating cash flow (see Part I, Equation (61) and Section 4.1 below).

It is worth noting here that the interim payout is a decision variable which affects the project's value and, as such, the project's economic profitability. Such a variable is often neglected in traditional financial modeling, where the project's value is not calculated by discounting the actual project CFEs but calculated by discounting the project FCFEs. However, this boils down to assuming that the payout ratio is 100% and that such a ratio is applied to FCFE. In real life, the payout ratio may be different (even 0%) and may be applied, commonly, to the net income, the FCFE, or other bases (see the Appendix A; see also Part I, Section 9).

Table 7. Breakdown of CFE (payout ratio = 20% of net income).

	TIME	0	1	2	3	4	5
CASH FLOW TO EQUITY (F_t^e)	Shareholders' investment	$-6{,}000$	0	0	0	0	0
	Interim payout (20% of net income)	0	$0.2 \cdot I_1^e$	$0.2 \cdot I_2^e$	$0.2 \cdot I_3^e$	$0.2 \cdot I_4^e$	0
	Liquidation dividend	0	0	0	0	0	$C_4^e + I_5^e$

CODE INSTRUCTIONS: CASH FLOW TO EQUITY

The analyst must fill cell I23 with a single formula that should consider that, depending on time t, either of the three categories of CFE applies. The project length and the payout ratio are recorded in the "Assumption" sheet: the analyst can show it in a cell above the Matrix in the "SplitScreenStrip" sheet (e.g., cell D2 and cell D6) and then use it in the formulas (see Figure 19). Cells D2 and D6 are linked to the cells that contain the values of project length and payout ratio with the respective formulas = Assumptions!$F$5 and = Assumptions!$F$26.
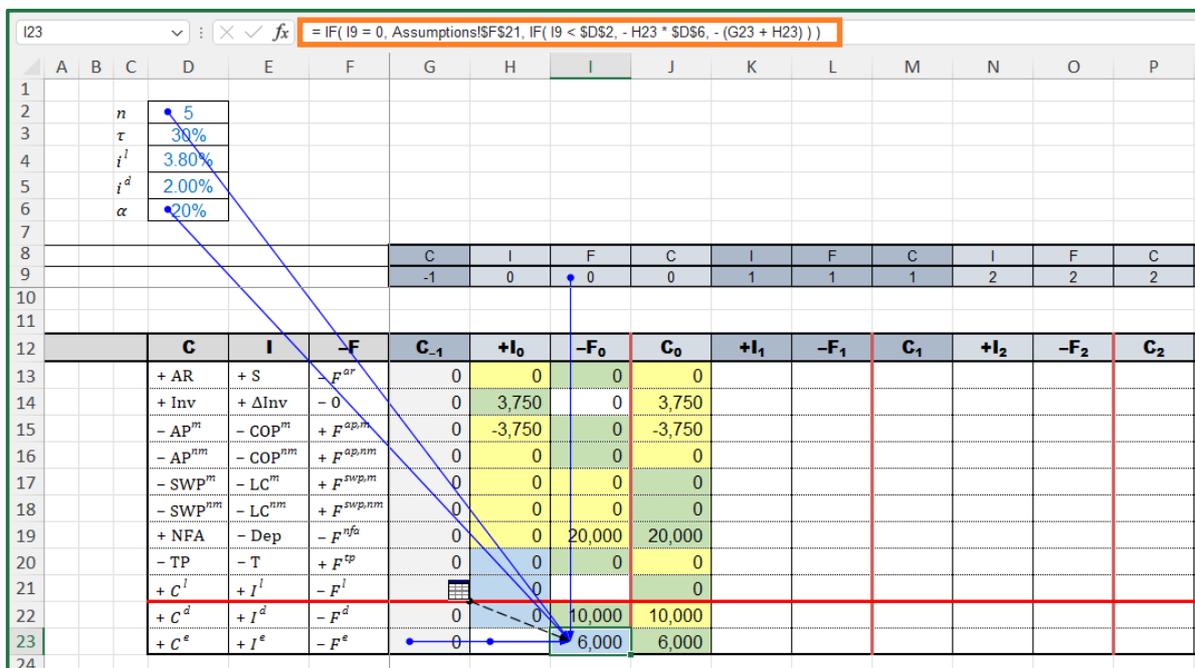

Figure 19. Cell I23 reports the cash flow to equity ("SplitScreenStrip" sheet). (The cells whose values are provided in "PreCalc" are in yellow, the cells whose values are calculated with the law of motion are in green, and the cells whose values are calculated via suitable formulas are in blue).

The spreadsheet code for I23 is:

$$
\overbrace{\text{I23}}^{-F_0^e} = \text{IF}(\ \overbrace{\text{I9}}^{\text{period}}\ = 0, \underbrace{\overbrace{\text{Assumptions!\$H\$21}}^{\text{equity financing}}}_{\text{case } t=0}, \text{IF}(\ \overbrace{\text{I9}}^{\text{period}}\ < \overbrace{\text{\$D\$2}}^{n}, \underbrace{\overbrace{-\text{H23} * \text{\$D\$6}}^{\text{interim payout}}, \overbrace{-(\text{G23} + \text{H23})}^{\text{liquidation dividend}}}_{\substack{\text{case } 0<t<n \qquad\qquad \text{case } t=n \\ \text{case } t\neq 0}}))
$$

The payout is calculated as a function of the net income. However, as shown in Part I, other schemes are possible. For example, the payout may be a fraction of the FCFE or a fraction of the minimum between net income and FCFE. In Appendix A of this paper, we show how to cope with these alternative schemes.

2.2.4. Cells Whose Values Are Calculated with the Law of Conservation (Step 1d)

The fourth class of cells in array H13:J23 consists of those cells which can be calculated by means of the law of conservation. These are the net income and the cash flow from non-operating (liquid) assets (see Table 8).

Table 8. Cells whose values are calculated with the law of conservation (pink orange cells).

Cell	Symbol	Magnitude	Law of Conservation	Type
H20	I_t^e	Net Income	$I_t^e = I_t^o + I_t^l - I_t^d$	Income
H21	$-F_t^l$	$-$ Cash flow from liquid assets	$-F_t^l = F_t^o - F_t^d - F_t^e$	Cash flow

NET INCOME

Owing to the law of conservation, $I_t^o + I_t^l = I_t^d + I_t^e$ (see Part I, Equation (10)) or, breaking down the after-tax operating profit,

$$
\overbrace{S_t + \Delta\text{Inv}_t - \text{COP}_t^m - \text{COP}_t^{nm} - \text{LC}_t^m - \text{LC}_t^{nm} - \text{Dep}_t - T_t}^{I_t^o} + I_t^l = +I_t^d + I_t^e
$$

(see also Part I, Equation (15)), whence

$$
I_t^e = +S_t + \Delta\text{Inv}_t - \text{COP}_t^m - \text{COP}_t^{nm} - \text{LC}_t^m - \text{LC}_t^{nm} - \text{Dep}_t - T_t + I_t^l - I_t^d
$$

CODE INSTRUCTIONS: NET INCOME
Net Income I_t^e is calculated in cell H23:

$$
\underbrace{\text{H23}}_{I_0^e} = \text{SUM}(\ \underbrace{\text{H13 : H21}}_{\substack{+S_0 + \Delta\text{Inv}_0 \\ -\text{COP}_0^m - \text{COP}_0^{nm} \\ -\text{LC}_0^m - \text{LC}_0^{nm} \\ -\text{Dep}_0 - T_0 + I_0^l}}\ , \underbrace{-\text{H22}}_{I_0^d})
$$

(see Figure 20).

CASH FLOW FROM LIQUID ASSETS. Owing to the law of conservation (see Part I, Equation (11)), $F_t^o + F_t^l = F_t^d + F_t^e$ or, breaking down the operating cash flow,

$$
\overbrace{-F_t^{ar} - 0 + F_t^{ap,m} + F_t^{ap,nm} + F_t^{swp,m} + F_t^{swp,nm} - F_t^{nfa} + F_t^{tp}}^{-F_t^o} - F_t^l = -F_t^d - F_t^e
$$

(see also Part I, Equation (16)), whence

$$
-F_t^l = \left(F_t^{ar} - F_t^{ap,m} - F_t^{ap,nm} - F_t^{swp,m} - F_t^{swp,nm} + F_t^{nfa} - F_t^{tp} \right) - F_t^d - F_t^e.
$$

CODE INSTRUCTIONS: CASH FLOW FROM LIQUID ASSETS

Here is an example of how to calculate the cash flow from/to liquid assets F_t^l in cell I21:

$$\underbrace{I21}_{-F_0^l} = -SUM(\ \underbrace{I13:I20}_{\substack{-F_0^{ar} + F_0^{ap,m} \\ +F_0^{ap,nm} + F_0^{swp,m} \\ +F_0^{swp,nm} - F_0^{nfa} \\ +F_0^{tp}}}\ ) + \underbrace{I22}_{-F_0^d} + \underbrace{I23}_{-F_0^e}$$

(see Figure 21).

Figure 20. The cells whose values are calculated with the law of conservation are shown in pink orange. Cell H23 reports the net income ("SplitScreenStrip" sheet). (The cells whose values are provided in "PreCalc" are in yellow, the cells whose values are calculated with the law of motion are in green, the cells whose values are calculated via suitable formulas are in blue, and the cells whose values are calculated with the law of conservation are in pink orange).

Figure 21. Cell I21 contains the cash flow from/to liquid assets ("SplitScreenStrip" sheet). (The cells whose values are provided in "PreCalc" are in yellow, the cells whose values are calculated with the law of motion are in green, the cells whose values are calculated via suitable formulas are in blue, and the cells whose values are calculated with the law of conservation are in pink orange).

2.3. Filling the Cells for Periods 1 through n (Step 2)

The law of motion and the law of conservation hold for all $t = 0, 1, \ldots, n$: the structure of all the SSMs is the same. Hence, once the cells for period 0 have been filled, it suffices to extend the same formulas for periods 1 through n to complete the project split-screen film.

CODE INSTRUCTIONS: FROM THE MATRIX TO THE STRIP

The analyst can copy the range H13:J23 and paste it in the ranges K13:Y23. Alternatively, one can copy the formulas into adjacent cells by using the fill handle. This technique works properly because the formulas do not contain embedded data or constants (the formulas must contain the links to the cells in the "Assumptions" or in "PreCalc" sheet, and they must be parameterized using the labels of row and of column). Operationally, the analyst can proceed as follows:

1. Select the range of cells H13:J23
2. Hover your cursor over the lower-right corner so that it turns into a plus sign (+) (the "fill handle")
3. Drag the fill handle right to cover all the cells up to column Y
4. Let it go and the formulas are automatically filled in the other columns of the split-screen strip

(see Figure 22).

Figure 22. Drag the fill handle to fill the strip ("SplitScreenStrip" sheet).

The result of this step is the whole strip of the project, populated with the correct figures (Figure 23).

Figure 23. Full-scale project strip with all the figures ("SplitScreenStrip" sheet).

3. Module 3: Building the Strips of Other Matrix Representations

Once constructed the full-scale strip, more compact representations of the strip can be drawn from it to act as summarized statements highlighting specific accounting and/or financial magnitudes that may be of interest to the analyst. It suffices to use the split-screen technique described in Part I, Section 4. Among the many framings that the SSM can take, we only focus on the SSM with costs classified by nature, SSM with costs classified by function, SSM showing the net operating liabilities, and SSM showing the net operating working capital (see also Part I for a detailed description). These framings are easily obtained via consolidation of rows (Rule 5 of the split-screen technique).

3.1. Expanded Matrices

If the analyst wants to build an expanded matrix and the related strip, it suffices to consolidate the relevant items of the full-scale matrix and related strip. Alternatively, the analyst may start from some other (higher-scale) matrix representation to obtain the same result.

THE EXPANDED MATRIX BY NATURE. Suppose the analyst wants to build the expanded matrix by nature and the associated strip (see Part I, Equation (33)). To do so, it suffices to consolidate, respectively, the rows pertaining to the firm's suppliers and the rows pertaining to the firm's employees (see Figure 24).

CODE INSTRUCTIONS: FROM FULL-SCALE MATRIX TO EXPANDED MATRIX (BY NATURE)
The analyst lays out a range of cells in the "SplitScreenStrip" sheet (rows 25:35) with the structure of the full-scale matrix (rows 11:23), but with fewer rows. More precisely, on one hand, the analyst merges the rows pertaining to the suppliers (rows 15:16) into one row (row 29); on the other hand, the analyst merges the rows pertaining to the employees (rows 17:18) into one row (row 30) by means of a simple sum of the relevant items.

Operationally, one first fills column G (cells G27:G35). To do so, one consolidates the manufacturing and nonmanufacturing AP:

$$\underbrace{\text{G29}}_{-\text{AP}_{-1}} = \underbrace{\text{G15}}_{-\text{AP}^m_{-1}} + \underbrace{\text{G16}}_{-\text{AP}^{nm}_{-1}}$$

and the manufacturing and nonmanufacturing SWP:

$$\underbrace{\text{G30}}_{-\text{SWP}_{-1}} = \underbrace{\text{G17}}_{-\text{SWP}^m_{-1}} + \underbrace{\text{G18}}_{-\text{SWP}^{nm}_{-1}}$$

The remaining cells of column G remain unvaried, so one just need to add the proper link. For example, as regards the AR,

$$\underbrace{\text{G27}}_{\text{AR}_{-1}} = \underbrace{\text{G13}}_{\text{AR}_{-1}}.$$

Once column G has been filled, the analyst needs only copy and paste (or drag the fill handle) to fill the cells of all periods (see Figure 25).

THE EXPANDED MATRIX BY FUNCTION. Suppose the analyst wants to build the expanded matrix and the associated strip by function (see Part I, Equation (36)). To do so, it suffices to consolidate the rows pertaining to the manufacturing items and the rows pertaining to the nonmanufacturing items (see Figure 26).

Full-Scale Matrix

Expanded Matrix (by Nature)

Figure 24. From full-scale matrix to expanded matrix by nature (see Part I, Equation (33)). The rows with the same color in the Full-Scale Matrix are consolidated into one row of the same color in the Expanded Matrix.

Figure 25. The strip of expanded matrices (by nature) ("SplitScreenStrip" sheet). The rows with the same color in the Full-scale Matrix are consolidated into one row of the same color in the Expanded Matrix.

Full-Scale Matrix

$\mathbf{C_t}$	$\mathbf{C_{t-1}}$	$\mathbf{+I_t}$	$\mathbf{-F_t}$
$+AR_t$	$+AR_{t-1}$	$+S_t$	$-F_t^{ar}$
$+Inv_t$	$+Inv_{t-1}$	$+\Delta Inv_t$	-0
$-AP_t^m$	$-AP_{t-1}^m$	$-COP_t^m$	$+F_t^{ap,m}$
$-AP_t^{nm}$	$-AP_{t-1}^{nm}$	$-COP_t^{nm}$	$+F_t^{ap,nm}$
$-SWP_t^m$	$-SWP_{t-1}^m$	$-LC_t^m$	$+F_t^{swp,m}$
$-SWP_t^{nm}$	$-SWP_{t-1}^{nm}$	$-LC_t^{nm}$	$+F_t^{swp,nm}$
$+NFA_t$	$+NFA_{t-1}$	$-Dep_t$	$-F_t^{nfa}$
$-TP_t$	$-TP_{t-1}$	$-T_t$	$+F_t^{tp}$
$+C_t^l$	$+C_{t-1}^l$	$+I_t^l$	$-F_t^l$
$+C_t^d$	$+C_{t-1}^d$	$+I_t^d$	$-F_t^d$
$+C_t^e$	$+C_{t-1}^e$	$+I_t^e$	$-F_t^e$

$\Rightarrow$

Expanded Matrix (by Function)

$\mathbf{C_t}$	$\mathbf{C_{t-1}}$	$\mathbf{+I_t}$	$\mathbf{-F_t}$
$+AR_t$	$+AR_{t-1}$	$+S_t$	$-F_t^{ar}$
$-NOL_t^m$	$-NOL_{t-1}^m$	$-COGS_t$	$+F_t^{cogs}$
$-NOL_t^{nm}$	$-NOL_{t-1}^{nm}$	$-SGA_t$	$+F_t^{swp}$
$+NFA_t$	$+NFA_{t-1}$	$-Dep_t$	$-F_t^{nfa}$
$-TP_t$	$-TP_{t-1}$	$-T_t$	$+F_t^{tp}$
$+C_t^l$	$+C_{t-1}^l$	$+I_t^l$	$-F_t^l$
$+C_t^d$	$+C_{t-1}^d$	$+I_t^d$	$-F_t^d$
$+C_t^e$	$+C_{t-1}^e$	$+I_t^e$	$-F_t^e$

Figure 26. From full-scale Matrix to expanded Matrix by function (see Part I, Equation (36)). The rows with the same color in the Full-scale Matrix are consolidated into one row of the same color in the Expanded Matrix.

CODE INSTRUCTIONS: FROM FULL-SCALE MATRIX TO EXPANDED MATRIX (BY FUNCTION)

The analyst prepares a range of cells in the "SplitScreenStrip" sheet (rows 37:46) with the structure of the full-scale Matrix (rows 11:23), but with fewer rows. More precisely, on one hand, the analyst merges the inventory and the manufacturing costs (rows 14, 15, and 17) into one row (row 40); on the other hand, the analyst merges the nonmanufacturing costs (rows 16 and 18) into one row (row 41). Consolidation is obtained by means of a simple sum of the relevant items. Operationally, one first fills column G (cells G39:G46). To do so, one consolidates the manufacturing book values,

$$\underbrace{G40}_{-NOL_{-1}^m} = \underbrace{G14}_{Inv_{-1}} + \underbrace{G15}_{-AP_{-1}^m} + \underbrace{G17}_{-SWP_{-1}^m}$$

and the nonmanufacturing book values,

$$\underbrace{G41}_{-NOL_{-1}^{nm}} = \underbrace{G16}_{-AP_{-1}^{nm}} + \underbrace{G18}_{-SWP_{-1}^{nm}}$$

The remaining cells of column G remain unvaried, so one just needs to add the proper link. For example, as regards the AR,

$$\underbrace{G39}_{AR_{-1}} = \underbrace{G13}_{AR_{-1}}$$

Once columns G is filled, the analyst needs only copy and paste (or drag the fill handle) to fill the cells of all periods (see Figure 27).

Figure 27. The strip of expanded matrices (by function) ("SplitScreenStrip" sheet). The rows with the same color in the Full-scale Matrix are consolidated into one row of the same color in the Expanded Matrix.

3.2. NOL-Framed and NOWC-Framed Matrices

THE NOL-FRAMED MATRIX. If one wants to build a NOL-framed matrix and associated strip, one may simply aggregate the items of the manufacturing and nonmanufacturing NOL obtained in the expanded matrix (Figure 27, rows 40 and 41; also see Part I, Equation (39)). Alternatively, starting from the full-scale matrix, one consolidates the rows pertaining to the net operating liabilities.

CODE INSTRUCTIONS: FROM EXPANDED MATRIX (BY FUNCTION) TO NOL-FRAMED MATRIX

The analyst lays out a range of cells in the "SplitScreenStrip" sheet (rows 48:56) with the structure of the expanded matrix (by function) (rows 37:46), but with fewer rows. Specifically, the analyst merges the rows pertaining to the net operating liabilities (rows 40:41) into one single row (row 51). Consolidation is obtained by means of a simple sum of the relevant items. Operationally, one proceeds as made for the previous matrix representations by first filling column G (cells G50:G56). To do so, one consolidates the rows of the expanded matrix (by function) that form the group of net operating liabilities:

$$\underbrace{G51}_{-\text{NOL}_{-1}} = \text{SUM}(\ \underbrace{G41:G42}_{-\text{NOL}^m_{-1}-\text{NOL}^{nm}_{-1}}\ )$$

The remaining cells of column G remain unvaried, so one just needs to add the proper links. For example, as regards the AR,

$$\underbrace{G50}_{AR_{-1}} = \underbrace{G39}_{AR_{-1}}$$

Once column G has been filled, the analyst needs only copy and paste (or drag the fill handle) to fill the cells of all periods (see Figure 28).

Figure 28. The strip of NOL-framed matrices ("SplitScreenStrip" sheet). The rows with the same color in the Expanded Matrix are consolidated into one row of the same color in the NOL-framed Matrix.

THE NOWC-FRAMED MATRIX. If one wants to build a NOWC-framed matrix and the corresponding strip, one may simply aggregate the relevant rows starting from the NOL-framed matrix. This result in a five-area matrix (see Part I, Equation (50)).

CODE INSTRUCTIONS: FROM NOL-FRAMED MATRIX TO NOWC-FRAMED MATRIX

The analyst lays out a range of cells structure of the NOL-framed matrix (rows 48:56), but with fewer rows. Specifically, the analyst merges the rows pertaining to net operating working capital (rows 50:51 and 53) into one single row (row 60). Consolidation is obtained by means of a simple sum of the relevant items. Operationally, one proceeds as made for the previous matrix representations by first filling column G (cells G60:G64). To do so, one consolidates the rows in the full-scale matrix which form the group net operating working capital:

$$\underbrace{G60}_{+NOWC_{-1}} = SUM(\underbrace{G50:G51, G53}_{AR_{-1}-NOL_{-1}-TP_{-1}})$$

The remaining cells of column G remain unvaried, so one just needs to add the proper links. For example, as regards NFA,

$$\underbrace{G61}_{\text{NFA}_{-1}} = \underbrace{G52}_{\text{NFA}_{-1}}$$

Once column G is filled, the analyst needs only copy and paste (or drag the fill handle) to fill the cells of all periods (see Figure 29).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2			n	5											
3			τ	30%											
4			i^l	3.80%											
5			i^d	2.00%											
6			α	20%											
7															
8							C	I	F	C	I	F	C	I	F
9							-1	0	0	0	1	1	1	2	2
48		**NOL-framed Matrix**													
49			**C**	**I**	**–F**	C_{-1}	$+I_0$	$-F_0$	C_0	$+I_1$	$-F_1$	C_1	$+I_2$	$-F_2$
50			+ AR	+ S	$-F^{ar}$	0	0	0	0	60,000	-45,205	14,795	66,000	-64,521
51			– NOL	+ OpC	$+F^{nol}$	0	0	0	0	-54,000	33,750	-20,250	-58,800	56,775
52			+ NFA	– Dep	$-F^{nfa}$	0	0	20,000	20,000	-4,000	0	16,000	-4,000	0
53			– TP	– T	$+F^{tp}$	0	0	0	0	-494	494	0	-959	959
54			$+c^l$	$+I^l$	$-F^l$	0	0	-4,000	-4,000	-152	8,030	3,878	147	3,689
55			$+c^d$	$+I^d$	$-F^d$	0	0	10,000	10,000	200	-2,700	7,500	150	-2,650
56			$+c^e$	$+I^e$	$-F^e$	0	0	6,000	6,000	1,154	-231	6,923	2,238	-448
57															
58		**NOWC-framed Matrix**													
59			**C**	**I**	**–F**	C_{-1}	$+I_0$	$-F_0$	C_0	$+I_1$	$-F_1$	C_1	$+I_2$	$-F_2$
60			+ NOWC	+ EBITDA–T	$-F^{nowc}$	0	0	0	0	5,506	-10,961	-5,455	6,241	-6,786
61			+ NFA	– Dep	$-F^{nfa}$	0	0	20,000	20,000	-4,000	0	16,000	-4,000	0
62			$+c^l$	$+I^l$	$-F^l$	0	0	-4,000	-4,000	-152	8,030	3,878	147	3,689
63			$+c^d$	$+I^d$	$-F^d$	0	0	10,000	10,000	200	-2,700	7,500	150	-2,650
64			$+c^e$	$+I^e$	$-F^e$	0	0	6,000	6,000	1,154	-231	6,923	2,238	-448
65															

Figure 29. The strip of NOWC-framed matrices ("SplitScreenStrip" sheet). The rows with the same color in the NOL-framed Matrix are consolidated into one row of the same color in the NOWC-framed Matrix.

3.3. Four-Area and Germ Matrices

It is possible to further shrink the strip and have more compact forms. For example, to favor a synthetic analysis of the project, the analyst may be willing to build a four-area matrix and corresponding strip, where one only the elements related to operating assets, non-operating assets, debt, and equity are reported (Part I, right matrix in Equation (12)). Furthermore, merging the two classes of assets and the two classes of financings, one may even build the germ strip, where all the accounting and financial items of the project are aggregated (Part I, right matrix in Equation (8)).

THE FOUR-AREA MATRIX. To build the four-area matrix and corresponding strip, it suffices to sum the relevant items from some higher-scale matrix (NOWC-framed strip, NOL-framed matrix, expanded matrix, full-scale matrix).

CODE INSTRUCTIONS: FROM NOWC-FRAMED MATRIX TO FOUR-AREA MATRIX
The analyst lays out in the "SplitScreenStrip" sheet a range of cells (rows 66:71) with the structure of the NOWC-framed matrix (rows 58:64), but with only four rows, one for each area: operations, liquidity, debt, and equity. The analyst proceeds as in the previous matrices by filling the cells of column G and then copy and paste for the whole strip. The operating capital is obtained as

$$\underbrace{G68}_{+C^o_{-1}} = \text{SUM}(\ \underbrace{G60:G61}_{\text{NOWC}_{-1}+\text{NFA}_{-1}}\ )$$

For the three remaining cells of column G, it suffices to provide the proper links (see Figure 30).

Figure 30. Four-area matrix ("SplitScreenStrip" sheet). The rows with the same color in the NOWC-framed Matrix are consolidated into one row of the same color in the Four-area Matrix.

THE GERM MATRIX. The germ matrix is easily built, as usual, by consolidating the rows from some higher-scale matrix.

CODE INSTRUCTIONS: FROM FOUR-AREA MATRIX TO GERM MATRIX

The analyst sets up a range of cells (rows 73:76) in the "SplitScreenStrip" sheet with the same structure of the four-area matrix (rows 66:71), but with only two rows, one for each area: investment and financing. The analyst proceeds as in the previous matrices and fill the cells of column G by aggregation. Specifically, the two cells of column G of the germ matrix are calculated as follows:

$$\underbrace{G75}_{C^{\text{inv}}_{-1}} = \text{SUM}(\underbrace{G68:G69}_{C^o_{-1}+C^l_{-1}}) \quad \underbrace{G76}_{C^{\text{fin}}_{-1}} = \text{SUM}(\underbrace{G70:G71}_{C^d_{-1}+C^e_{-1}})$$

Then, one copies and paste to fill the whole strip (see Figure 31).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1																
2			n	5												
3			τ	30%												
4			i^l	3.80%												
5			i^d	2.00%												
6			α	20%												
7																
8							C	I	F	C	I	F	C	I	F	C
9							-1	0	0	0	1	1	1	2	2	2
65																
66		**Four-area Matrix**														
67			**C**	**I**	**–F**	**C_{-1}**	**$+I_0$**	**$–F_0$**	**C_0**	**$+I_1$**	**$–F_1$**	**C_1**	**$+I_2$**	**$–F_2$**	**C_2**
68			$+C^o$	$+I^o$	$-F^o$	0	0	20,000	20,000	1,506	-10,961	10,545	2,241	-6,786	5,999
69			$+C^l$	$+I^l$	$-F^l$	0	0	-4,000	-4,000	-152	8,030	3,878	147	3,689	7,714
70			$+C^d$	$+I^d$	$-F^d$	0	0	10,000	10,000	200	-2,700	7,500	150	-2,650	5,000
71			$+C^e$	$+I^e$	$-F^e$	0	0	6,000	6,000	1,154	-231	6,923	2,238	-448	8,713
72																
73		**Germ Matrix**														
74			**C**	**I**	**–F**	**C_{-1}**	**$+I_0$**	**$–F_0$**	**C_0**	**$+I_1$**	**$–F_1$**	**C_1**	**$+I_2$**	**$–F_2$**	**C_2**
75			$+C^{inv}$	$+I^{inv}$	$-F^{inv}$	0	0	16,000	16,000	1,354	-2,931	14,423	2,388	-3,098	13,713
76			$+C^{fin}$	$+I^{fin}$	$-F^{fin}$	0	0	16,000	16,000	1,354	-2,931	14,423	2,388	-3,098	13,713
77																

Figure 31. Germ matrix ("SplitScreenStrip" sheet). The rows with the same color in the Four-area Matrix are consolidated into one row of the same color in the Germ Matrix.

4. Module 4: Building the Benchmark Split-Screen Strip

Project appraisal requires the comparison of the project with a benchmark which collects the values, the profits, and the cash flows of the benchmark portfolio. This module is precisely devoted to building the benchmark film (or strip) from the market input data (see Part I, Equation (88)). The mathematical relations are equivalent to the ones used for the project four-area matrix and strip, but, in this case, we need to flesh out the benchmark values from the prospective cash flows (which are just equal to the project's cash flows), so we use backward induction (see Part I).

4.1. Benchmark Four-Area Matrix

To design the benchmark Matrix, the analyst requires the MARRs as well as the cash flows. Specifically, the economic value of each area may be calculated with the backward formula

$$V_{t-1}^j = \frac{V_t^j + F_t^{Vj}}{1 + r_t^j}, \quad j = o, l, d, \quad t = 1, \dots, n$$

with $V_n^o = V_n^l = V_n^d = 0$ and where $F_0^{Vj} = -V_0^j$ and $F_0^{Vj} = F_t^j$ for $t \geq 1$ (see Part I, Equation (77)). The economic value of the equity can be calculated via the law of conservation: $V_t^e = V_t^o + V_t^l - V_t^d$. The cash flows in the benchmark Matrix are the same as in the project matrix, except for period 0. The column of benchmark profits is calculated as

$$I_t^{Vj} = r^j \cdot V_{t-1}^j, \quad j = o, l, d$$

for the of operating assets, the non-operating assets, and the debt (see Part I, Equation (80)). The benchmark profit for the equity can be calculated with the law of conservation as a residual amount: $I_t^{Ve} = I_t^{Vo} + I_t^{Vl} - I_t^{Vd}$. The operating cash flows can be obtained as sum of the cash-flow components of the operating area in some higher-scale matrix and the other cash flows are merely linked from some other higher-scale matrix.

CODE INSTRUCTIONS: BENCHMARK MATRIX SCHEME
The analyst prepares a table in a range of cells (rows 81:86) in the "SplitScreenStrip" sheet having the structure of the project four-area matrix (rows 66:71). The rates r^o, r^l, and r^d are

recorded in the "Assumption" sheet. The analyst can position them in a space above the full-scale matrix (cells F3:F5) in the "SplitScreenStrip" sheet and use them in the relevant formulas. Cells F3:F5 are linked to the cells that contain the value of r^o, r^l, and r^d with the formulas $=$ Assumptions!\$F\$27, $=$ Assumptions!\$F\$28, and $=$ Assumptions!\$F\$29.

CODE INSTRUCTIONS: ECONOMIC VALUES IN THE BENCHMARK MATRIX
For the operating class, the analyst starts by inserting the value 0 for V_5^o, V_5^l, V_5^d, and V_5^e; then, the analyst calculates the economic value of AR as of period $t = n - 1 = 4$ with the backward formula:

$$\underbrace{V83}_{V_4^o} = (\underbrace{Y83}_{V_5^o} - \underbrace{X83}_{-F_5^{Vo}(=-F_5^o)})/(1 + \underbrace{\$F\$3}_{r^o})$$

(see Figure 32). For the liquid assets and the debt, the analogous backward formula applies:

$$\underbrace{V84}_{V_4^l} = (\underbrace{Y84}_{V_5^l} - \underbrace{X84}_{-F_5^{Vl}(=-F_5^l)})/(1 + \underbrace{\$F\$4}_{r^l})$$
$$\underbrace{V85}_{V_4^d} = (\underbrace{Y85}_{V_5^d} - \underbrace{X85}_{-F_5^{Vd}(=-F_5^d)})/(1 + \underbrace{\$F\$5}_{r^d})$$

The equity value is calculated with the law of conservation:

$$\underbrace{V86}_{V_4^e} = \underbrace{V83}_{V_4^o} + \underbrace{V84}_{V_4^l} - \underbrace{V85}_{V_4^d}$$

while the equations are correct, the values obtained in the cell range V83:V86 are not yet the correct ones, because cells X83:X86 have not yet been occupied by formulas; however, they will be filled with the amounts of cash flows in the next steps, and the values taken on by cells V83:V86 will be automatically updated.
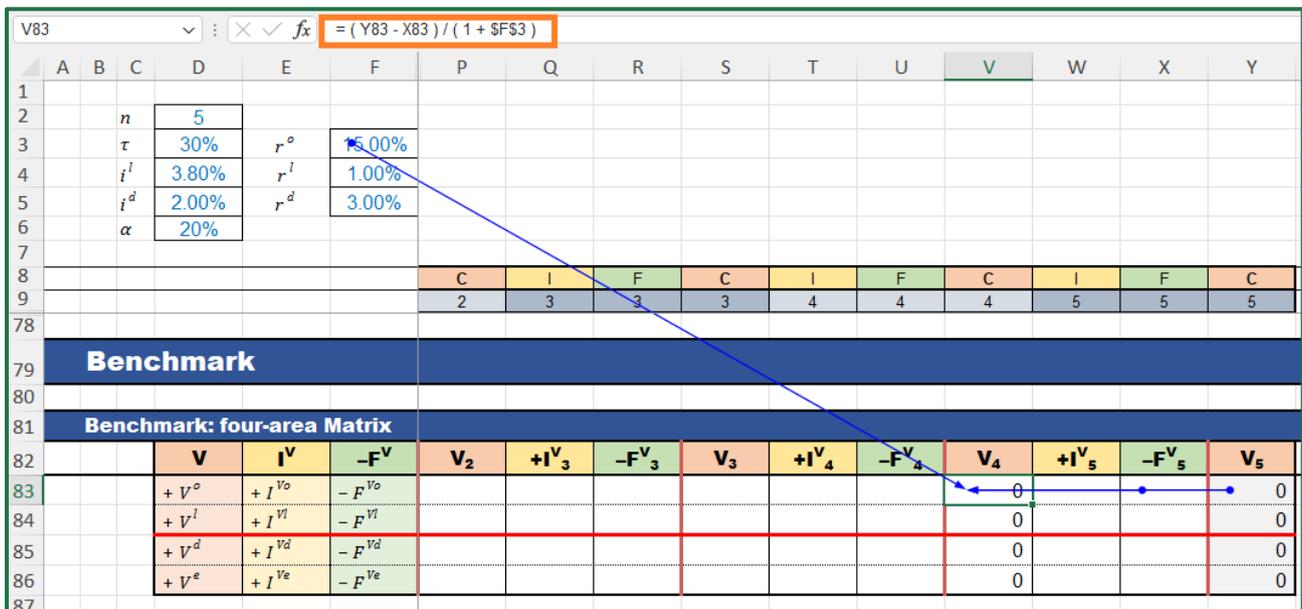
Figure 32. Cell V83 contains the formula for calculating the economic value V_4^o as a function of next-period value V_5^o and cash flow F_5^o ("SplitScreenStrip" sheet).

CODE INSTRUCTIONS: INCOMES IN THE BENCHMARK MATRIX.
The analyst may start from the operating area and, in particular, from cell W83:

$$\underbrace{W83}_{I_4^{Vo}} = \underbrace{V83}_{V_4^o} * \underbrace{\$F\$3}_{r^o}$$

(see Figure 33).
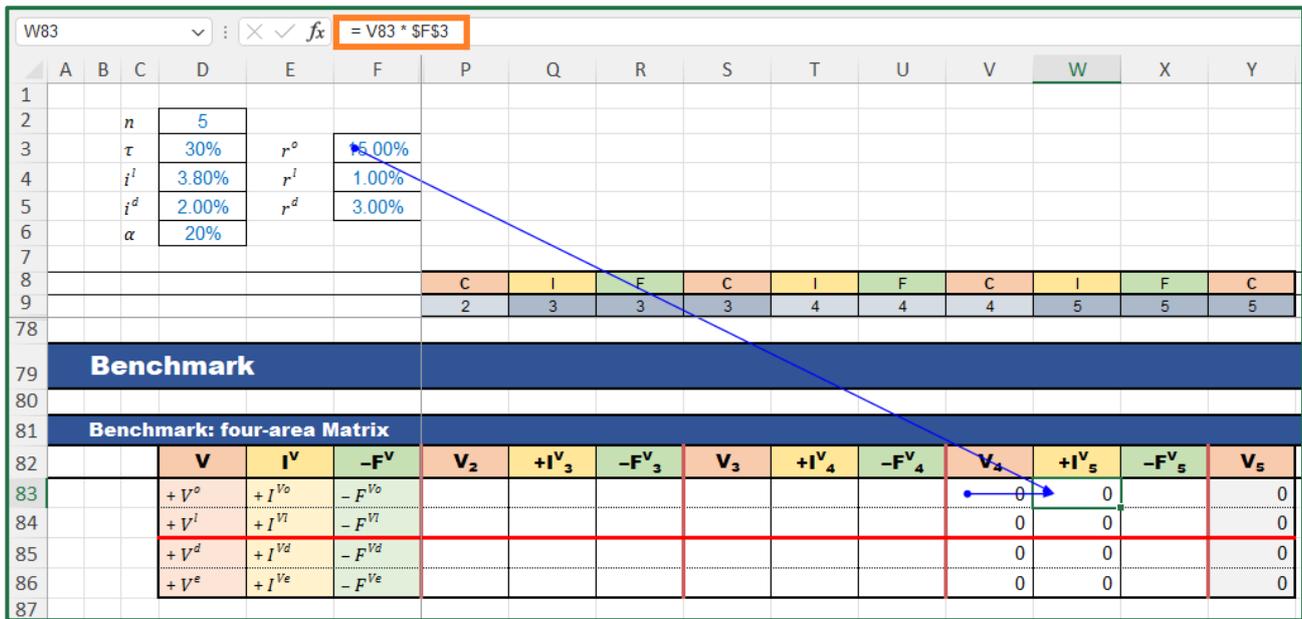
Figure 33. Cell W83 contains the formula for calculating the benchmark profit ("SplitScreenStrip" sheet).

For the non-operating area and the debt area, respectively, one uses

$$\underbrace{W84}_{I_4^{Vl}} = \underbrace{V84}_{V_4^l} * \underbrace{\$F\$4}_{r^l} \quad \text{and} \quad \underbrace{W85}_{I_4^{Vd}} = \underbrace{V85}_{V_4^d} * \underbrace{\$F\$5}_{r^d}$$

The cash flow of the equity area can be calculated via the law of conservation:

$$\underbrace{W86}_{I_4^{Ve}} = \underbrace{W83}_{I_4^{Vo}} + \underbrace{W84}_{I_4^{Vl}} - \underbrace{W85}_{I_4^{Vd}}$$

while the equations are correct, the values obtained in the cell range W84:W86 are not yet the correct ones, because cells X83:X86 have not yet been occupied by formulas; however, they will be filled with the amounts of cash flows in the next steps, and the values taken on by cells W84:W86 will be automatically updated.

CODE INSTRUCTIONS: CASH FLOWS IN THE BENCHMARK MATRIX
The (changed-in-sign) cash flow may be grabbed by the split-screen strip for $t > 0$, whereas it is equal to the economic value for $t = 0$. Therefore, the analyst may use the following formula for cell X83:

$$\underbrace{X83}_{-F_4^{Vo}} = \text{IF}(\underbrace{X\$9}_{\text{period}} = 0, \underbrace{Y83}_{V_5^o}, \underbrace{X68}_{-F_4^o})$$

(in such a way, the analyst may later copy and paste the formula to complete the whole strip).

The analyst then copies the formula in X83 and paste it in cell X84 (the non-operating area) and in cell X85 (the debt area):

$$\underbrace{X84}_{-F_4^{Vl}} = IF(\ \underbrace{X\$9}_{period}\ = 0,\ \underbrace{Y84}_{V_5^l};\ \underbrace{X69}_{-F_4^l})\ \text{and}\ \underbrace{X85}_{-F_4^{Vd}} = IF(\ \underbrace{X\$9}_{period}\ = 0,\ \underbrace{Y85}_{V_5^d},\ \underbrace{X70}_{-F_4^d})$$

The (changed-in-sign) CFE can be calculated with the same formula or via the law of conservation:

$$\underbrace{X86}_{-F_4^{Ve}} = \underbrace{X83}_{-F_4^{Vo}} + \underbrace{X84}_{-F_4^{Vl}} - \underbrace{X85}_{-F_4^{Vd}}$$

(see Figure 34).

Figure 34. Cell X83 contains the formula for calculating the CFO ("SplitScreenStrip" sheet).

The analyst can now copy the cell range V83 : X86 and paste it in the cell range G83 : U86 (or, more simply, use the fill handle backwards).

4.2. Benchmark Germ Matrix

Just as with the project matrix, it is possible to construct the benchmark germ matrix.

CODE INSTRUCTIONS: FROM BENCHMARK FOUR-AREA MATRIX TO BENCHMARK GERM MATRIX
The analyst lays out a range of cells (rows 88:91) in the "SplitScreenStrip" sheet with the structure of the project germ matrix (rows 73:76). The formulas for producing the benchmark germ matrix are trivial:

$$\underbrace{G90}_{V_{-1}^{inv}} = SUM(\underbrace{G83 : G84}_{V_{-1}^o + V_{-1}^l}) \qquad \underbrace{G91}_{V_{-1}^{fin}} = SUM(\underbrace{G85 : G86}_{V_{-1}^d + V_{-1}^e})$$

whence the whole strip is obtained by copying and pasting (or, more simply, use the fill handle).

4.3. Market Value Added Matrix

The analyst can build the Market Value Added (MVA) matrix and the related strip by computing the differences between the profits of the project and the benchmark profits (see Part I, Equations (91) and (92)).

CODE INSTRUCTIONS: MVA FOUR-AREA MATRIX
The analyst prepares a cell range (rows 96:101) in the "SplitScreenStrip" sheet with the structure of the four-area matrices and fills each cell of it with the differences between the corresponding cells of the benchmark four-area matrix (rows 83:86) and the project four-area matrix (rows 68:71). For example, starting from the first cell of the table,

$$\text{G98} = \underbrace{\text{G83}}_{V^o_{-1}} - \underbrace{\text{G68}}_{C^o_{-1}}, \qquad \text{G99} = \underbrace{\text{G84}}_{V^l_{-1}} - \underbrace{\text{G69}}_{C^l_{-1}}$$

$$\text{G100} = \underbrace{\text{G85}}_{V^d_{-1}} - \underbrace{\text{G70}}_{C^d_{-1}}, \qquad \text{G101} = \underbrace{\text{G86}}_{V^e_{-1}} - \underbrace{\text{G71}}_{C^e_{-1}}$$

Then, it suffices to copy G98:G101 and paste for the whole strip H98:Y101 (or, more simply, use the fill handle).

As the reader can see, the range I98:I101 shows the NPV for the various areas: $\text{NPV}^o = \text{USD5,622}$, $\text{NPV}^l = \text{USD1,025}$, $\text{NPV}^d = -\text{USD236}$, and $\text{NPV}^e = \text{USD6,882}$.

All the cells reporting the difference $I^{Vj}_t - I^j_t$ (H98:H101, K98:K101, N98:N101, Q98:Q101, T98:T101, W98:W101) give voice to the economic residual income (ERI) changed in sign (see next section for details).

CODE INSTRUCTIONS: MVA GERM MATRIX
The analyst prepares a range of cells (rows 103:106) in the "SplitScreenStrip" sheet with the structure of the germ matrices. To obtain the two values, one merely turns to the MVA four-area matrix and sums:

$$\underbrace{\text{G105}}_{\text{MVA}^{\text{inv}}_{-1}} = \text{SUM}(\ \underbrace{\text{G98}:\text{G99}}_{\text{MVA}^o_{-1}+\text{MVA}^l_{-1}}\ )$$

$$\underbrace{\text{G106}}_{\text{MVA}^{\text{fin}}_{-1}} = \text{SUM}(\ \underbrace{\text{G100}:\text{G101}}_{\text{MVA}^d_{-1}+\text{MVA}^e_{-1}}\ )$$

Then, it suffices to copy G105:G106 and paste for the whole strip H105:Y106 (or, more simply, use the fill handle) (see Figure 35).

Figure 35. Market value added: four-area matrix and germ matrix ("SplitScreenStrip" sheet).

5. Module 5: Performing the Single-Period Analysis

The whole project is described in detail in the split-screen film. However, a convenient representation of it is possible which favors the detailed analysis of a single period. One creates a worksheet named "SinglePeriod" where the matrix will be located. In it, one can use the preferred framing of the SSM. For example, we propose a framing where the BS at a given date is illustrated and one where the CFS is illustrated. The former facilitates the comprehension of how the project's book value is apportioned across the various areas (customers, suppliers, employees, etc.) and how it is affected diachronically by the income components and the cash-flow components; the latter facilitates the comprehension of how the project's cash flow is apportioned across the various areas and how it is diachronically determined by income and change of book values. These configurations turn the project's split-screen strip into a sequence of snapshots describing the accounting and financial magnitudes and their relationships for one period.

CODE INSTRUCTIONS: BUILDING THE SET OF MATRICES FOR SINGLE-PERIOD ANALYSIS

The analyst builds the structure of two split-screen matrices, in the configuration of full-scale matrix and in the form of BS and CFS (see Figure 36). Cell E2 indicates the period. The analyst can apply the Data Validation to restrict the values to the periods of the project, allowing only the values that are in the list "0, 1, 2, 3, 4, 5" or creating a drop-down list with these values. Some spreadsheets software allow to use a range as source list, even if it is in another worksheet: in this case, it is possible to use the range "=PreCalc!$K$2:$P$2". Three columns on the left (columns D, E, and F, same as in the sheets "PreCalc" and "SplitScreenStrip") contain the labels of the rows ("+AR", "+Inv", etc.). Below the structure of the matrix, a row (row 4) contains the descriptor of the column content. This content is C for Capital, I for Income, and F for Cash Flow. It is variable and depends on the value of cell E2: "C-1", "+I0", "−F0", and "C0" if number 0 is selected for cell E2; "C0", "+I1", "−F1", and "C1" if number 1 is selected for cell E2, and so on.

$$I4 = \text{"C"} \& (\$E\$2 - 1)$$
$$J4 = \text{" + I"} \& \$E\$2$$
$$K4 = \text{"–F"} \& \$E\$2$$
$$L4 = \text{"C"} \& \$E\$2$$

(see Figure 36).
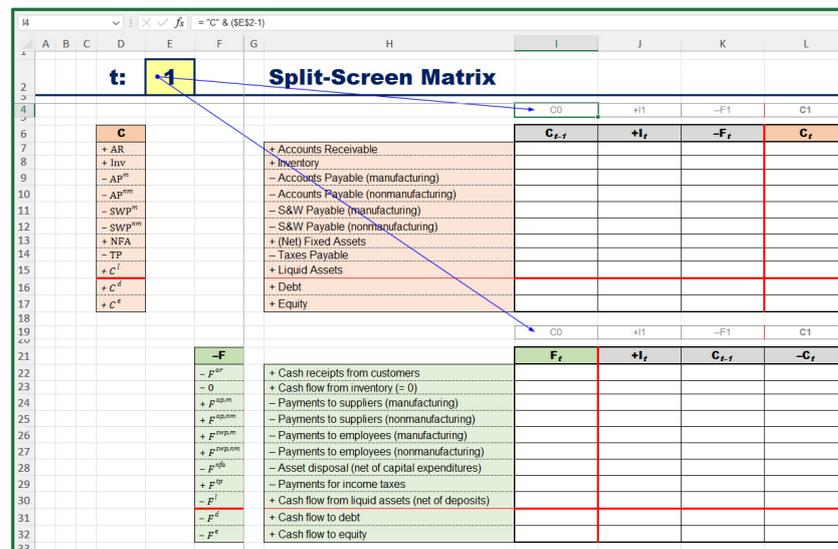
Figure 36. Cell I4 depends on cell E2: if E2 value is t, then I4 value is Ct-1 (e.g., if E2 = 1, then I4 is "C0"). Analogous code for row 19 ("SinglePeriod" sheet).

To fill the cells of the matrix, we again employ the INDEX and MATCH combination. The technique is like the one described in Section 2.2, used in the split-screen strip for picking the amounts from the "PreCalc" worksheet.

The more external formula is:

$$\text{INDEX}(\,\text{FullScaleStrip}, \text{row\_num}, \text{column\_num})$$

where

"FullScaleStrip" is the range of cells where the full-scale strip is located (i.e. the range SplitScreenStrip!$13:$23);

"row_num" is the row-number of the range "FullScaleStrip" where the item that contains the sought value is located: it can be selected by matching the label of the row in the Matrix and the label in the split-screen strip, using the function MATCH;

"column_num" is the column-number of the range "FullScaleStrip" where the category (capital, income, or cash flow) and the period that contains the sought value are indicated: it can be selected by matching the label of the column in the matrix and the labels in the split-screen strip, using the function MATCH.

One starts from cell I7:

$$
\begin{aligned}
\text{I7} = \text{INDEX}(\quad &\text{SplitScreenStrip!}\$13:\$23, \\
&\underbrace{\text{MATCH}(\$D7, \text{SplitScreenStrip!}\$D\$13:\$D\$23, 0)}\quad , \\
&\text{the result of this formula is the nnmber of the row in the} \\
&\text{four-area strip that has the same label as cell \$D7 ("+AR")} \\
&\underbrace{\text{MATCH}(\text{I}\$4, \text{SplitScreenStrip!}\$12:\$12, 0)} \\
&\text{the result of this formula is the number of the column in} \\
&\text{the four-area strip that has the same label as cell I\$4 ("C0")} \\
&)
\end{aligned}
$$

(see Figures 37 and 38).
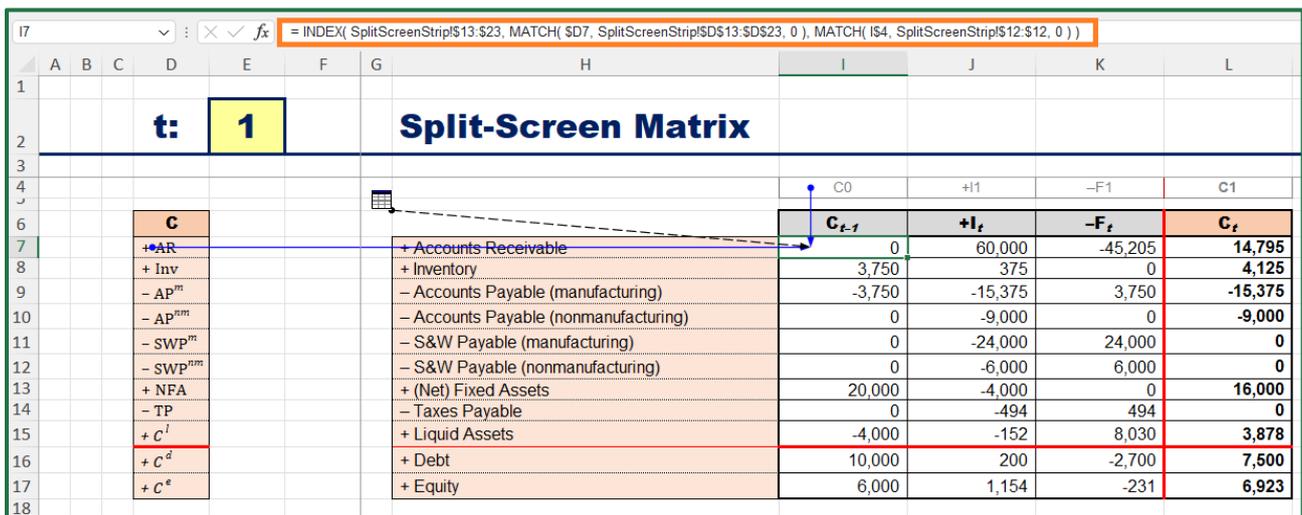
Figure 37. Cell I7 contains the formula for picking up the Account Receivable AR as of period $t = 0$ ("SinglePeriod" sheet).

The formula written for cell I7 can then be used for cells J7 and K7 as well:

$$
\begin{aligned}
J7 = \text{INDEX}(\quad & \text{SplitScreenStrip!\$13 : \$23,} \\
& \text{MATCH(\$D7, SplitScreenStrip!\$D\$13 : \$D\$23, 0),} \\
& \text{MATCH(J\$4, SplitScreenStrip!\$12 : \$12, 0)} \\
&)
\end{aligned}
$$

The analyst can then copy cell I7 and paste it in cells J7 and K7. Cell L7 contains the formula that applies the law of motion:

$$
C_t = C_{t-1} + I_t - F_t
$$

$$
\underbrace{L7}_{AR_t} = \underbrace{I7}_{AR_{t-1}} + \underbrace{J7}_{S_t} + \underbrace{K7}_{-F_t^{ar}}
$$

The analyst can copy range I7:L7 and paste it in range I8:L17 (or drag the fill handle).

Figure 38. Cell J13 contains the value that has the same row-label as SiglePeriod!D7 (+AR) and the same column-label as SiglePeriod!I4 C_0 ("SplitScreenStrip" sheet).

The realization of the matrix where CFS statement is illustrated is analogous to the one described above. The labels of the rows are in column F (column of cash-flow labels) and the labels of the columns are in row 19. The figures of the matrix are grabbed from the full-scale strip with the formulas:

$$
\begin{aligned}
J22 = \text{INDEX}(\quad & \text{SplitScreenStrip!\$13 : \$23,} \\
& \text{MATCH(\$F22, SplitScreenStrip!\$F\$13 : \$F\$23, 0),} \\
& \text{MATCH(J\$19, SplitScreenStrip!\$12 : \$12, 0)} \\
&)
\end{aligned}
$$

$$
\begin{aligned}
K22 = \text{INDEX}(\quad & \text{SplitScreenStrip!\$13 : \$23,} \\
& \text{MATCH(\$F22, SplitScreenStrip!\$F\$13 : \$F\$23, 0),} \\
& \text{MATCH(K\$19, SplitScreenStrip!\$12 : \$12, 0)} \\
&)
\end{aligned}
$$

$$
\begin{aligned}
L22 = (-1) * \text{INDEX}(\quad & \text{SplitScreenStrip!\$13 : \$23,} \\
& \text{MATCH(\$F22, SplitScreenStrip!\$F\$13 : \$F\$23, 0),} \\
& \text{MATCH(K\$19, SplitScreenStrip!\$12 : \$12, 0)} \\
&)
\end{aligned}
$$

Cell I22 contains the formula that applies the law of motion:

$$
F_t = I_t + C_{t-1} - C_t
$$

$$
\underbrace{L22}_{F_t^{ar}} = \underbrace{J22}_{S_t} + \underbrace{K22}_{AR_{t-1}} + \underbrace{L22}_{-AR_t}
$$

The analyst can copy range I22:L22 and paste it in range I23:L32 (or drag the fill handle).

The analyst can build in the same way any preferred framing of the SSM, with higher or lower scale, depending on the objective of the analysis.

6. Module 6: Reshaping the Project Split-Screen Strip

The model's main purpose is to communicate the result of the numeric analysis: the recipients of the reports can include readers that are not familiar with the compact structure of the split-screen strip. The Transposed Matrix (Part I, Section 10.2) and a set of standard financial statements may be easily extracted from the split-screen strip.

6.1. Reshaping the Strip as a Transposed Matrix

The Transposed Matrix, presented in Part I, Section 10.2, is a compact form of the project strip which provides an intuitive picture of the whole project in terms of three submatrices, respectively reporting the book values (C_t), the incomes (I_t), and the cash flows (F_t), each one divided into the main four areas (operating, non-operating, debt, and equity) (see also Figure 39):

Symbol	Description
$+C^o$	+ Operating assets
$+C^l$	+ Liquid assets
$C^{\mathbf{inv}}$	**Investments**
$+C^d$	+ Debt
$+C^e$	+ Equity
$C^{\mathbf{fin}}$	**Financings**
$+I^o$	+ Operating income
$+I^l$	+ Interest income
$+I^{\mathbf{inv}}$	**Income from assets**
$+I^d$	+ Interest expenses
$+I^e$	+ Net Income
$I^{\mathbf{fin}}$	**Income to capital providers**
$+F^o$	+ CFO (cash flow from operations)
$+F^l$	+ CFL (cash flow from/to non-operating assets)
$F^{\mathbf{inv}}$	**Cash flow from assets**
$+F^d$	+ CFD (cash flow to debtholders)
$+F^e$	+ CFE (cash flow to equity)
$F^{\mathbf{fin}}$	**Cash flow to capital providers**

Figure 39. Structure of a column of the Transposed Matrix: capital amounts, incomes, and cash flows are in vertical format (symbol on the left, description on the right; see also Part I, Section 10.2).

CODE INSTRUCTIONS: STRUCTURE OF TRANSPOSED MATRIX

The analyst adds, in his workbook, a new worksheet—"TransMatrix"—and creates three ranges of cells representing the three submatrices presented in Part I, Equation (70) (see also Figure 40 below).

Each row of the Transposed Matrix contains the label of the corresponding row in the four-area matrix (SplitScreenStrip!D68:F71): columns D, E, and F report the labels that pertains, respectively, to capital, income and cash flow.

CODE INSTRUCTIONS: FILLING THE CAPITAL SUBMATRIX OF TRANSPOSED MATRIX

We employ again the INDEX and MATCH combination. The technique is like the one described in Section 2.2, used in the split-screen strip for picking the amounts from the "PreCalc" worksheet.

Figure 40. Structure of the Transposed Matrix ("TransMatrix" sheet).

The more external formula is:

$$\text{INDEX}(\text{FourAreaStrip}, \text{row\_num}, \text{column\_num})$$

where
    "FourAreaStrip" is the range of cells where the four-area Matrix is located (i.e. the range SplitScreenStrip!$G$68:$Y$71);
    "row_num" is the row-number of the range "FourAreaStrip" where the item that contains the sought value is located: it can be selected by matching the label of the row in the Transposed Matrix and the label in the split-screen strip, using the function MATCH;
    "column_num" is the column-number of the range "FourAreaStrip" where the category (capital, income, or cash flow) and the period that contains the sought value are indicated: it can be selected by matching the label of the column in the Transposed Matrix and the labels in the split-screen strip, using the function MATCH. One starts from cell I6:

$$I6 = \text{INDEX}(\quad \text{SplitScreenStrip}!\$G\$68 : \$Y\$71,$$
$$\underbrace{\text{MATCH}(\$D6, \text{SplitScreenStrip}!\$D\$68 : \$D\$71, 0)}_{} \quad ,$$

the result of this formula is the number of the row in the four-area strip that has the same label as cell $\$D6$ ("$+C^o$")

$$\underbrace{\text{MATCH}(I\$4, \text{SplitScreenStrip}!\$G\$67 : \$Y\$67, 0)}_{}$$

the result of this formula is the number of the column in the four-area strip that has the same label as cell $I\$4$ ("C_0")
)

The formula written for cell I6 can then be used for cells I7, I10, and I11 as well. Rows 8 and 12 contain the sums of the previous rows:

$$\underbrace{I8}_{C_0^{inv}} = \text{SUM}(\underbrace{I6 : I7}_{C_0^o + C_0^l}) \qquad \underbrace{I12}_{C_0^{fin}} = \text{SUM}(\underbrace{I10 : I11}_{C_0^d + C_0^e})$$

Hence, the analyst can copy the range of cells I6 : I12 and paste it in the range J6 : N12 (or, more simply, use the fill handle), see Figures 41 and 42.

Figure 41. Cell I6 contains the formula for picking up the operating capital C^o as of period $t = 0$; cells I8:N8 and I12:N12 contain the sums of the two rows above ("TransMatrix" sheet).

Figure 42. Cell J68 contains the value that has the same row-label as TransMatrix!D6 ($+C_0$ and the same column-label as TransMatrix!I4 (C_0) ("SplitScreenStrip" sheet).

CODE INSTRUCTIONS: FILLING THE INCOME SUBMATRIX OF TRANSPOSED MATRIX

The technique useful for filling the cells of the income submatrix is the same employed for the capital submatrix. The only difference in the formula is in the column where the row-labels are reported: the column of incomes is E. Cell I16 is calculated as follows:

$$\text{I16} = \text{INDEX}(\quad \text{SplitScreenStrip!}\$G\$68:\$Y\$71,$$
$$\underbrace{\text{MATCH}(\$E16, \text{SplitScreenStrip!}\$E\$68:\$E\$71, 0)}\quad ,$$

the result of this formula is the number of the row in the four-area strip that has the same label as cell $\$E11 ("+I^o")$

$$\underbrace{\text{MATCH}("+"\&I\$14, \text{SplitScreenStrip!}\$G\$67:\$Y\$67, 0)}$$

the result of this formula is the number of the column in the four-area strip that has the same label (preceded by "+") as cell I\$14 ($"+I_0"$)

$$)$$

(see Figure 43).

I16				f_x	= INDEX(SplitScreenStrip!$G$68:$Y$71, MATCH($E16, SplitScreenStrip!$E$68:$E$71, 0), MATCH("+"&I$14, SplitScreenStrip!$G$67:$Y$67, 0))											
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1																
2					C	I	F			2022	2023	2024	2025	2026	2027		
3																
14									I_0	I_1	I_2	I_3	I_4	I_5		ΣI_t
16					$+I^o$			$+I^o$	0	1,506	2,241	3,106	4,053	5,091		15,997
17					$+I^l$			$+I^l$	0	-152	147	293	473	691		1,453
18								$+I^{inv}$	0	1,354	2,388	3,399	4,527	5,783		17,450
20					$+I^d$			$+I^d$	0	200	150	100	50	0		500
21					$+I^e$			$+I^{fin}$	0	1,154	2,238	3,299	4,477	5,783		16,950
22								$+I^{fin}$	0	1,354	2,388	3,399	4,527	5,783		17,450
23																

Figure 43. Cell I16 contains the formula for picking the operating income I^o as of period $t = 0$; cells I18:N18 and I22:N22 contain the sums of the two rows above ("TransMatrix" sheet).

The operator "&" joins the text strings, so the formula "+"&I\$16 returns the symbol "+" alongside the content of cell I16, that is, it returns the value $+I_0$. This operation is necessary, because the labels in the "TransMatrix" sheet are "I_0", "I_1", "I_2", "I_3", "I_4", and "I_5", but the labels in the "SplitScreenStrip" sheet are "$+I_0$", "$+I_1$", "$+I_2$", "$+I_3$", "$+I_4$", and "$+I_5$".[9]

The formula written for cell I16 can be used for I17, I20, and I21 as well. Rows 18 and 22 contain the sums of the previous rows:

$$\underbrace{\text{I18}}_{I_0^{inv}} = \text{SUM}(\underbrace{\text{I16}:\text{I17}}_{I_0^o + I_0^l}) \qquad \underbrace{\text{I22}}_{I_0^{fin}} = \text{SUM}(\underbrace{\text{I20}:\text{I21}}_{I_0^d + I_0^e})$$

The analyst can then copy the cell range of cells I16 : I22 and paste it in the range J16 : N22 (or, more simply, use the fill handle. See Figure 43).

CODE INSTRUCTIONS: FILLING THE CASH-FLOW SUBMATRIX OF TRANSPOSED MATRIX

The technique useful for filling the cells of the cash-flow submatrix is the same employed for the capital submatrix and the income submatrix. The column where the row-labels are is column F. In the "TransMatrix" sheet, the rows of cash flows have positive sign; whereas, in the four-area matrix in the "SplitScreenStrip" sheet, they have negative sign. For this

reason, when we pick the value from the four-area Matrix, we must change it in sign (i.e., one multiplies by -1). One starts from the CFO, in cell I26:

$$\text{I26} = (-1) * \text{INDEX}(\ \underbrace{\text{SplitScreenStrip!\$G\$68} : \$Y\$71,}_{}$$
$$\underbrace{\text{MATCH}(\$F26, \text{SplitScreenStrip!\$F\$68} : \$F\$71, 0)}_{}\ ,$$

the result of this formula is the number of the row in the four-area strip that has the same label as cell \$F26 ("$-F^o$")

$$\underbrace{\text{MATCH}("-"\&\text{I\$24}, \text{SplitScreenStrip!\$G\$67} : \$Y\$67, 0)}_{}$$

the result of this formula is the number of the column in the four-area strip that has the same label (preceded by "$-$") as cell I\$24 ("$-F_0$")

$$)$$

(see Figure 44).

Figure 44. Cell I26 contains the formula for picking the operating cash flow F^o as of the period $t = 0$; cells I28:N28 and I32:N32 contain the sums of the two rows above ("TransMatrix" sheet).

The operator "&" joins the text strings, so the formula "$-$"&I\$24 returns the symbol "$-$" alongside the content of the cell I24, i.e., it returns the value $-F_0$: this operation is necessary, because the labels in the "TransMatrix" sheet are "F_0", "F_1", "F_2", "F_3", "F_4", "F_5", but in the "SplitScreenStrip" sheet the labels are "$-F_0$", "$-F_1$", "$-F_2$", "$-F_3$", "$-F_4$", "$-F_5$".

The formula written for the cell I26 can be used for I27, I30, and I31 as well.

Rows 28 and 32 contain the sums of the previous rows:

$$\underbrace{\text{I28}}_{F_0^{\text{inv}}} = \text{SUM}(\underbrace{\text{I26} : \text{I27}}_{F_0^o + F_0^l}) \qquad \underbrace{\text{I32}}_{F_0^{\text{fin}}} = \text{SUM}(\underbrace{\text{I30} : \text{I31}}_{F_0^d + F_0^e})$$

The analyst can then copy the cell range I26 : I32 and paste it in the range J26 : N32 (or, more simply, use the fill handle).

FCFE AND CFL. The CFS in the Transposed Matrix enables the analyst to disclose an important piece of information: the Free Cash Flow to (or from) Equity (FCFE). It is obtained by consolidating the CFO and CFD row (i.e., $\text{FCFE}_t = F_t^o - F_t^d$). A positive FCFE indicates that the operations sustain the debt and leave some extra cash that may be distributed to shareholders or reinvested in liquid assets; a negative FCFE indicates that the operations cannot service the debt, so a financial deficit exists which must be covered either by equity or by liquid assets or by new borrowing (see Figure 45 below. See also Part I, Section 9). In both cases, it is necessary to make a decision on the CFL: if FCFE is positive, it is necessary to make a payout decision (how much will be retained in the firm and how much will be distributed to equityholders?); if FCFE is negative, it is necessary to make a

financing decisions (how much will be financed by cash withdrawals, by issuance of new shares, or by new borrowing?). In other words, CFE is a decision variable from $t = 0$ to $t = n - 1$ (at $t = n$, the project ends and the CFE is equal to the sum of the last FCFE and the end-of-period balance of liquid assets (see Part I, Equations (61) and (62)).

CODE INSTRUCTIONS: FILLING THE CFL STRIP
The FCFE matrix is simply a different representation of the data in the cash-flow submatrix of Transposed Matrix (see Part I, right matrix in Equation (63)). It can be placed in the "TransMatrix" sheet, rows 37:40, below the Transposed Matrix:

$$\underbrace{I38}_{\text{FCFE}_0} = \underbrace{I26}_{F_0^o} - \underbrace{I30}_{F_0^d}$$

$$\underbrace{I39}_{-F_0^e} = (-1) * \underbrace{I31}_{F_0^e}$$

$$\underbrace{I40}_{-F_0^l} = \underbrace{I38}_{\text{FCFE}_0} + \underbrace{I39}_{-F_0^e}$$

(see Figure 45).

M40				fx	= M38 + M39										
						2022	2023	2024	2025	2026	2027				
		C	I	F		F_0	F_1	F_2	F_3	F_4	F_5		ΣF_t		
26			$-F^o$	$+F^o$	20,000	10,961	6,786	7,706	8,714	1,830		15,997		
27			$-F^l$	$+F^l$	4,000	-8,030	-3,689	-4,446	-5,268	18,887		1,453		
28				$+F^{inv}$	16,000	2,931	3,098	3,260	3,445	20,717		17,450		
30			$-F^d$	$+F^d$	10,000	2,700	2,650	2,600	2,550	0		500		
31			$-F^e$	$+F^e$	-6,000	231	448	660	895	20,717		16,950		
32				$+F^{fin}$	16,000	2,931	3,098	3,260	3,445	20,717		17,450		
34				**Cash flow from or to liquid assets**										
36					F_0	F_1	F_2	F_3	F_4	F_5				
38				FCFE	-10,000	8,261	4,136	5,106	6,164	1,830				
39				$-F^e$	6,000	-231	-448	-660	-895	-20,717				
40				$-F^l$	-4,000	8,030	3,689	4,446	5,268	-18,887				

Figure 45. The FCFE at time $t = 4$ (cell M38) is positive and equal to USD 6,164. Part of it is distributed to the firm's shareholders ($F_4^e = $ USD895), the remaining part is retained by the firm and reinvested in liquid assets ($-F_4^l = $ USD5,268). This figure is necessary for calculating C_4^l and, therefore, completing the BS as of period 4. The CFE at time $t = 5$, when the project ends, is $F_5^e = $ USD20,717, equal to the FCFE (USD 1,830) plus the end-of-period balance of liquid assets (USD 18,887).

THE BENCHMARK TRANSPOSED MATRIX. It is convenient to build the Transposed Matrix for the benchmark as well (see Part I, Equation (87)).

It will turn out to be computationally helpful when appraising the project.

CODE INSTRUCTIONS: BUILDING THE BENCHMARK TRANSPOSED MATRIX
The analyst creates, in rows 45:73 of the "TransMatrix" sheet, a structure like the one created for the Transposed Matrix in rows 4:32. Each cell of this new structure contains the same formula as the corresponding cell of transposed matrix, but different in the strip where the amounts are picked up: the source of data of the project Transposed Matrix is the project strip (rows 68:71 of the "SplitScreenStrip" sheet), whereas the source of data of the

benchmark Transposed Matrix is the benchmark strip (rows 83:86 of "SplitScreenStrip" sheet). For example, the value V_0^o in cell I47:

$$\text{I47} = \text{INDEX}(\quad \text{SplitScreenStrip!\$G\$83 : \$Y\$86,}$$
$$\underbrace{\text{MATCH}(\$\text{D47}, \text{SplitScreenStrip!\$D\$83 : \$D\$86, 0)}},$$

the result of this formula is the number of the row in the benchmark four-area strip that has the same label as cell \$D47 ("$+V^o$")

$$\underbrace{\text{MATCH}(\text{I\$45}, \text{SplitScreenStrip!\$G\$82 : \$Y\$82, 0)}}$$

the result of this formula is the number of the column in the benchmark four-area strip that has the same label as cell I\$45 ("V_0")

$$)$$

(see Figure 46).
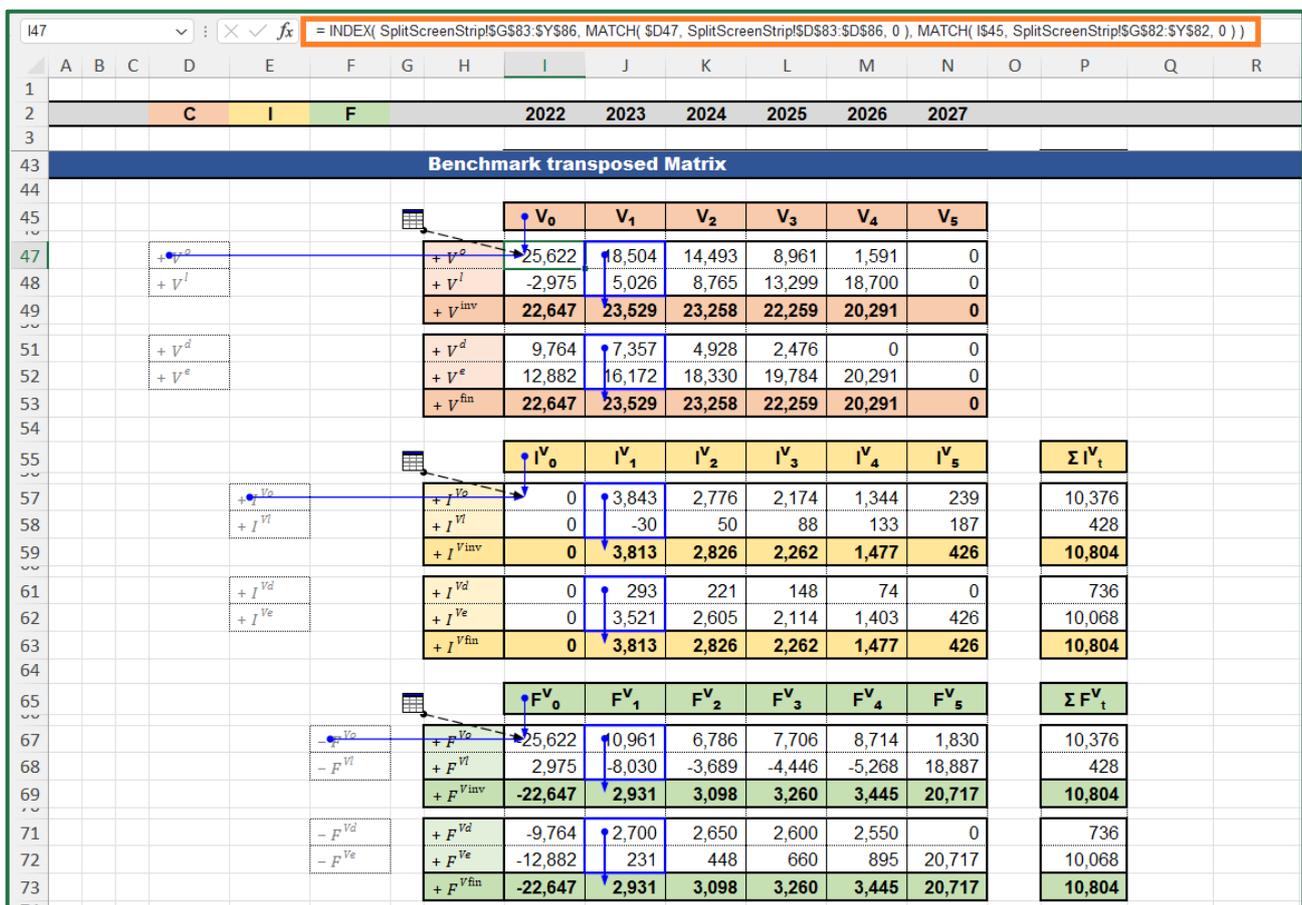
Figure 46. Benchmark Transposed Matrix. Cell I47 contains the formula for picking up the economic value of operating assets V^o as of period $t = 0$ ("TransMatrix" sheet).

The formula written for the cell I47 can be used for I48, I51, and I52 as well. Rows 49 and 53 contain the sums of the previous rows:

$$\underbrace{\text{I49}}_{V_0^{\text{inv}}} = \text{SUM}(\underbrace{\text{I47} : \text{I48}}_{V_0^o + V_0^l}) \qquad \underbrace{\text{I53}}_{V_0^{\text{fin}}} = \text{SUM}(\underbrace{\text{I51} : \text{I52}}_{V_0^d + V_0^e})$$

The value I_0^{Vo} in cell I57 is obtained as

$$I57 = \text{INDEX}(\quad \text{SplitScreenStrip!}\$G\$83:\$Y\$86,$$
$$\text{MATCH}(\$E57, \text{SplitScreenStrip!}\$D\$83:\$D\$86,0),$$
$$\text{MATCH}("+"\&I\$55, \text{SplitScreenStrip!}\$G\$82:\$Y\$82,0)$$
$$)$$

The formula written for cell I57 can be used for I58, I61, and I62 as well. Rows 59 and 63 contain the sums of the previous rows:

$$\underbrace{I59}_{I_0^{V\text{inv}}} = \text{SUM}(\underbrace{I57:I58}_{I_0^{Vo}+I_0^{Vl}}) \quad \underbrace{I63}_{I_0^{V\text{fin}}} = \text{SUM}(\underbrace{I61:I62}_{I_0^{Vd}+I_0^{Ve}})$$

The value F_0^{Vo} in the cell I67 is obtained as

$$I67 = (-1) * \text{INDEX}(\quad \text{SplitScreenStrip!}\$G\$83:\$Y\$86,$$
$$\text{MATCH}(\$F67, \text{SplitScreenStrip!}\$D\$83:\$D\$86,0),$$
$$\text{MATCH}("-"\&I\$65, \text{SplitScreenStrip!}\$G\$82:\$Y\$82,0)$$
$$)$$

The formula written for cell I67 can be used for I68, I71, and I72 as well. Rows 69 and 73 contain the sums of the previous rows:

$$\underbrace{I69}_{F_0^{V\text{inv}}} = \text{SUM}(\underbrace{I67:I68}_{F_0^{Vo}+F_0^{Vl}}) \quad \underbrace{I73}_{F_0^{V\text{fin}}} = \text{SUM}(\underbrace{I71:I72}_{F_0^{Vd}+F_0^{Ve}})$$

The Transposed Matrix makes it easy to calculate the sums of all the rows, which will be employed for computing the measures of worth in Module 7. The analyst uses column P in the "TransMatrix" sheet for calculating the sums of the rows. For example, one can calculate the sum of book values, $C \left(= \sum_{t=0}^{n} C_t\right)$ in cell P6:

$$P6 = \text{SUM}(\underbrace{\underbrace{I6:N6}_{C_0^o, C_1^o, \ldots, C_n^o}}_{\sum_{t=0}^{n} C_t^o})$$

(see Figure 47).

The formula written for cell P6 can be used for P7, P8, P10, P11, and P12 as well. In the same way, the calculation of the sum of incomes and cash flows is possible in the other submatrices of the project (cells P16:P18, P20:P22, P26:P28, and P30:P32) and of the benchmark (cells P57:P59, P61:P63, P67:P69, and P71:P73).

P26   = SUM(I26:N26)

			2022	2023	2024	2025	2026	2027		Σ
C	**I**	**F**								
			C_0	C_1	C_2	C_3	C_4	C_5		ΣC_t
$+C^o$		$+C^o$	20,000	10,545	5,999	1,399	-3,201	0		34,681
$+C^l$		$+C^l$	-4,000	3,878	7,714	12,454	18,195	0		38,242
		$+C^{inv}$	**16,000**	**14,423**	**13,713**	**13,853**	**14,934**	**0**		**72,923**
$+C^d$		$+C^d$	10,000	7,500	5,000	2,500	0	0		25,000
$+C^e$		$+C^e$	6,000	6,923	8,713	11,353	14,934	0		47,923
		$+C^{fin}$	**16,000**	**14,423**	**13,713**	**13,853**	**14,934**	**0**		**72,923**
			I_0	I_1	I_2	I_3	I_4	I_5		ΣI_t
	$+I^o$	$+I^o$	0	1,506	2,241	3,100	4,053	5,091		15,997
	$+I^l$	$+I^l$	0	-152	147	293	473	691		1,453
		$+I^{inv}$	**0**	**1,354**	**2,388**	**3,399**	**4,527**	**5,783**		**17,450**
	$+I^d$	$+I^d$	0	200	150	100	50	0		500
	$+I^e$	$+I^{fin}$	0	1,154	2,238	3,299	4,477	5,783		16,950
		$+I^{fin}$	**0**	**1,354**	**2,388**	**3,399**	**4,527**	**5,783**		**17,450**
			F_0	F_1	F_2	F_3	F_4	F_5		ΣF_t
	$-F^o$	$+F^o$	20,000	10,961	6,786	7,706	8,714	1,830		15,997
	$-F^l$	$+F^l$	4,000	-8,030	-3,689	-4,446	-5,268	18,887		1,453
		$+F^{inv}$	**-16,000**	**2,931**	**3,098**	**3,260**	**3,445**	**20,717**		**17,450**
	$-F^d$	$+F^d$	-10,000	2,700	2,650	2,600	2,550	0		500
	$-F^e$	$+F^e$	-6,000	231	448	660	895	20,717		16,950
		$+F^{fin}$	**-16,000**	**2,931**	**3,098**	**3,260**	**3,445**	**20,717**		**17,450**

Figure 47. Column P contains the sums of the rows ("TransMatrix" sheet).

6.2. Reshaping the Strip as a Set of Conventional Financial Statements

A different representation of the output is in the form of standard financial statements. Using report forms, the BS, IS, and CFS are laid out in report form (see also Part I, Figure 3).

CODE INSTRUCTIONS: STRUCTURE OF FINANCIAL STATEMENTS
The analyst creates, in his workbook, a new sheet — "ConventionalFinStat" — and sets up some ranges of cells to host the pro forma BSs, ISs, and CFs (Figures 48–50).

Each row contains a label in column D, E, or F: they are references of the values in the split-screen strip and report the capital amounts, incomes, and cash flows.

The standard pro forma financial statements are just a different way to show the results of the project. The analyst picks up the values for period 0 from the "SplitScreenStrip" sheet and feeds them into the conventional BS, IS, and CFS. Then, it suffices to copy and paste (or drag the fill handle) to fill the strip of all the project's BSs.

CODE INSTRUCTIONS: FILLING THE BALANCE SHEET
An effective technique for catching the figures from the split-screen strip is the use of the combinate functions INDEX and MATCH. The technique is the same described in the previous sections. For example, the AR are obtained as follows:

$$L11 = \text{INDEX}(\quad \text{SplitScreenStrip!}\$13 : \$23,$$
$$\underbrace{\text{MATCH}(\$D11, \text{SplitScreenStrip!}\$D\$13 : \$D\$23, 0)}_{} \quad ,$$

the result of this formula is the number of the row in the split-screen strip that has the same label as cell \$D11 ("+AR")

$$\underbrace{\text{MATCH}(L\$7, \text{SplitScreenStrip!}\$12 : \$12, 0)}_{}$$

the result of this formula is the number of the column in the split-screen strip that has the same label as cell L\$7 ("C_0")
$$)$$

(see Figure 51).

C	I	F		Financial Statements	UoM	2022	2023	2024	2025	2026	2027
				Balance Sheet		C_0	C_1	C_2	C_3	C_4	C_5
			$+ c^e$	+ Operating Assets	$						
			$+ \mathrm{NOWC}$	+ Net Operating WC	$						
$+ \mathrm{AR}$			$+ \mathrm{AR}$	+ Accounts Receivable	$						
$+ \mathrm{Inv}$			$+ \mathrm{Inv}$	+ Inventory	$						
$- \mathrm{AP}^m$			$- \mathrm{AP}^m$	− Accounts Payable (manufacturing)	$						
$- \mathrm{AP}^{nm}$			$- \mathrm{AP}^{nm}$	− Accounts Payable (nonmanufacturing)	$						
$- \mathrm{SWP}^m$			$- \mathrm{SWP}^m$	− S&W Payable (manufacturing)	$						
$- \mathrm{SWP}^{nm}$			$- \mathrm{SWP}^{nm}$	− S&W Payable (nonmanufacturing)	$						
$- \mathrm{TP}$			$- \mathrm{TP}$	− Taxes Payable	$						
$+ \mathrm{NFA}$			$+ \mathrm{NFA}$	+ (Net) Fixed Assets	$						
$+ c^l$			$+ c^l$	+ Liquid Assets	$						
			$+ c^{inv}$	Investments	$						
$+ c^d$			$+ c^d$	+ Debt	$						
$+ c^e$			$+ c^e$	+ Equity	$						
			$+ c^{fin}$	Financings	$						

Figure 48. Structure of the balance sheets in the spreadsheet ("ConventionalFinStat" sheet).

C	I	F		Financial Statements	UoM	2022	2023	2024	2025	2026	2027
				Income Statement		I_0	I_1	I_2	I_3	I_4	I_5
	$+ S$		$+ S$	+ Sales	$						
			$(-) \mathrm{COGS}$	− Cost Of Goods Sold	$						
	$+ \Delta \mathrm{Inv}$		$+ \Delta \mathrm{Inv}$	+ Income from inventory (Δ Inventory)	$						
	$- \mathrm{COP}^m$		$- \mathrm{COP}^m$	− Cost of Purchases (manufacturing)	$						
	$- \mathrm{LC}^m$		$- \mathrm{LC}^m$	− Labor costs (manufacturing)	$						
				Gross Profit	$						
			$(-) \mathrm{SGA}$	− Selling General and Administrative Expenses	$						
	$- \mathrm{COP}^{nm}$		$- \mathrm{COP}^{nm}$	− Cost of Purchases (nonmanufacturing)	$						
	$- \mathrm{LC}^{nm}$		$- \mathrm{LC}^{nm}$	− Labor costs (nonmanufacturing)	$						
			EBITDA	**Earnings Before Interest, Taxes, Depreciation and Amortization**	$						
	$- \mathrm{Dep}$		$- \mathrm{Dep}$	− Depreciation	$						
			EBIT	**Earnings Before Interest and Taxes**	$						
	$+ I^l$		$+ I^l$	+ Interest income	$						
	$+ I^d$		$- I^d$	+ Interest expenses	$						
			EBT	**Earnings Before Taxes**	$						
	$- T$		$- T$	− Taxes	$						
	$+ I^e$		$+ I^e$	**Net Income**	$						

Figure 49. Structure of the income statements in the spreadsheet ("ConventionalFinStat" sheet).

C	I	F		Financial Statements	UoM	2022	2023	2024	2025	2026	2027
				Statement of cash flows (Direct method)		F_0	F_1	F_2	F_3	F_4	F_5
		$- F^{ar}$	$+ F^{ar}$	+ Cash receipts from customers	$						
	$+ I^l$		$+ I^l$	+ Interest income	$						
		$+ F^{ap,m}$	$- F^{ap,m}$	− Payments to suppliers (manufacturing)	$						
		$+ F^{ap,nm}$	$- F^{ap,nm}$	− Payments to suppliers (nonmanufacturing)	$						
		$+ F^{swp,m}$	$- F^{swp,m}$	− Payments to employees (manufacturing)	$						
		$+ F^{swp,nm}$	$- F^{swp,nm}$	− Payments to employees (nonmanufacturing)	$						
	$+ I^d$		$- I^d$	− Interest expenses	$						
		$+ F^{tp}$	$- F^{tp}$	− Payments for income taxes	$						
			(a)	**Cash flow from operating activities**	$						
		$- F^{nfa}$	$+ F^{nfa}$	+ Asset disposal − Capital expenditures	$						
			(b)	**Cash flow from investing activities**	$						
$+ c^d$			$+ c^d$	+ Debt	$						
			$+ \Delta c^d$	+ New borrowing − Principal repayments	$						
		$- F^e$	$- F^e$	+ Issuance of New stock − Distributions to equityholders	$						
			(c)	**Cash flow from financing activities**	$						
			(a)+(b)+(c)	**Change in cash and cash equivalents (Δc^l)**	$						

Figure 50. Structure of the cash flow statements in the spreadsheet ("ConventionalFinStat" sheet).

Figure 51. Cell L11 contains the formula for picking the Account Receivables (+AR of period $t = 0$ from the split-screen strip ("ConventionalFinStat" sheet).

Every cell of the BS that contains a value calculated in the split-screen strip can be filled using the function INDEX-MATCH: the analyst can copy cell L11 and paste it in cells L12:L19 and L22:L23, as shown in Figure 51.

Other cells are partial sums of the values in the split-screen strip. An example is cell L10, which contains the value of the net operating working capital, NOWC:

$$\underbrace{\text{L10}}_{+\text{NOWC}_0} = \text{SUM}(\underbrace{\text{L11}:\text{L17}}_{+\text{AR}_0+\text{Inv}_0-\text{AP}_0^m-\text{AP}_0^{nm}-\text{SWP}_0^m-\text{SWP}_0^{nm}-\text{TP}_0})$$

or cells L9, L20, and L24:

$$\underbrace{\text{L9}}_{C_0^o} = \underbrace{\text{L10}}_{+\text{NOWC}_0} + \underbrace{\text{L18}}_{+\text{NFA}_0}$$

$$\underbrace{\text{L20}}_{C_0^{inv}} = \underbrace{\text{L9}}_{C_0^o} + \underbrace{\text{L19}}_{C_0^l}$$

$$\underbrace{\text{L24}}_{C_0^{fin}} = \underbrace{\text{L22}}_{C_0^d} + \underbrace{\text{L23}}_{C_0^e}$$

as represented in Figure 52.

Figure 52. Cell L20 contains the formula fur summarizing C^o and C^l, which determine C^{inv} ("ConventionalFinStat" sheet).

Once the BS for $t = 0$ has been completed, the analyst can copy the cell range L9 : L24 and paste it in the cell range M9 : Q24 (or, more simply, use the fill handle).

CODE INSTRUCTIONS: FILLING THE INCOME STATEMENT
The structure of the formula used for filling the BS can be used for filling the IS. An example of the formula is

$$L30 = INDEX(\quad \underbrace{SplitScreenStrip!\$13 : \$23, \\ MATCH(\$E30, SplitScreenStrip!\$E\$13 : \$E\$23, 0)}_{\substack{\text{the result of this formula is the number of the row in the} \\ \text{split-screen strip that has the same label as cell } \$E30 \text{ (``+}\Delta Inv\text{'')}}} \quad ,$$

$$\underbrace{MATCH(\text{``+''}\&L\$26, SplitScreenStrip!\$12 : \$12, 0)}_{\substack{\text{the result of this formula is the number of the column in the} \\ \text{split-screen strip that has the same label (preceded by+) as cell } L\$26 \text{ (``}I_0\text{'')}}}$$
$$)$$

(see Figure 53).

Figure 53. Cell L30 contains the formula for picking the inventory variation, $+\Delta Inv$, of period $t = 0$ ("ConventionalFinStat" sheet).

I^d is a special case, in the sense that, while $+I^d$ is available in the split-screen strip, the value $-I^d = (-1) \cdot I^d$ is actually required in the IS scheme:

$$L41 = \quad (-1) * INDEX(SplitScreenStrip!\$13 : \$23, \\ MATCH(\$E41, SplitScreenStrip!\$E\$13 : \$E\$23, 0), \\ MATCH(\text{``+''}\&L\$26, SplitScreenStrip!\$12 : \$12, 0) \\ )$$

The intermediate components of the income statements are not in the split-screen strip, so the analyst must calculate them in this layout:

$$\underbrace{L29}_{-COGS_0} = SUM(\ \underbrace{L30:L32}_{+\Delta Inv_0 - COP_0^m - LC_0^m}\ )$$

$$\underbrace{L33}_{GrossProfit_0} = \underbrace{L28}_{+Sales_0} + \underbrace{L29}_{-COGS_0}$$

$$\underbrace{L34}_{-SGA_0} = SUM(\ \underbrace{L35:L36}_{-COP_0^{nm} - LC_0^{nm}}\ )$$

$$\underbrace{L37}_{EBITDA_0} = \underbrace{L33}_{GrossProfit_0} + \underbrace{L34}_{-SGA_0}$$

$$\underbrace{L39}_{EBIT_0} = SUM(\ \underbrace{L37:L38}_{+EBITDA_0 - Dep_0}\ )$$

$$\underbrace{L42}_{EBT_0} = SUM(\ \underbrace{L39:L41}_{+EBIT_0 + I_0^l - I_0^d}\ )$$

(see also Part I, Figure 5). The net income, I_t^e, is available in the split-screen strip as well. Of course, the analyst can pick it up and feed it into the conventional scheme (with the combined function INDEX-MATCH) or calculate it as

$$\underbrace{L44}_{I_0^e} = SUM(\underbrace{L42:L43}_{+EBT_0 - T_0}).$$

The analyst can now copy the range L28 : L44 and paste it in the cell range M28 : Q44 (or, more simply, use the fill handle).

CODE INSTRUCTIONS: FILLING THE CASH FLOW STATEMENT
The structure of the formula used for filling the BS and for the IS can be used for filling the Cash Flow Statement. An example of the formula is

$L48 = (-1) * INDEX($ SplitScreenStrip!$13 : $23,

$\underbrace{MATCH(\$F48, SplitScreenStrip!\$F\$13 : \$F\$23, 0)}$,

the result of this formula is the number of the row in the split-screen strip that has the same label as cell $F48 ("$-F^{ar}$")

$\underbrace{MATCH("-"\&L\$46, SplitScreenStrip!\$12 : \$12, 0)}$

the result of this formula is the number of the column in the split-screen strip that has the same label (preceded by$-$) as cell L$46 ("$-F_0$")
$)$

(see Figure 54).

Figure 54. Cell L48 contains the formula for picking up the cash receipts from customers, $+F^{ar}$, of period $t = 0$ ("ConventionalFinStat" sheet).

The statement of cash flows contains values that the analyst can find in the cash-flow column of the split-screen strip (e.g., F^{ar}, $F^{ap,m}$, $F^{ap,nm}$), but it also contains values available in the income columns (I^l, I^d). For these figures, the analyst can use the same formula employed for the IS. An example of the formula is

$$L49 = \text{INDEX}(\quad \text{SplitScreenStrip!}\$13:\$23,$$
$$\text{MATCH}(\$E49, \text{SplitScreenStrip!}\$F\$13:\$F\$23, 0),$$
$$\text{MATCH}("-"\&L\$26, \text{SplitScreenStrip!}\$12:\$12, 0)$$
$$)$$

ΔC^d is a special case because it is not available in the split-screen strip. However, the value C^d does appear in the strip, so the analyst can pick it up with the formula already used for the BS:

$$L61 = \text{INDEX}(\quad \text{SplitScreenStrip!}\$13:\$23,$$
$$\text{MATCH}(\$D61, \text{SplitScreenStrip!}\$F\$13:\$F\$23, 0),$$
$$\text{MATCH}(L\$7, \text{SplitScreenStrip!}\$12:\$12, 0)$$
$$)$$

The variation ΔC_t^d is $\Delta C_t^d = C_t^d - C_{t-1}^d$; in spreadsheet formula, this means, for period 0,

$$\underbrace{L62}_{\Delta C_0^d} = \underbrace{L61}_{C_0^d} - \underbrace{K61}_{C_{-1}^d}$$

(see Figure 55).

Figure 55. Cell L62 contains the formula for calculating the variation ΔC_0^d as the difference between values in row 61 ("ConventionalFinStat" sheet).

The three classes of cash flows of the standard CFS are obtained by summing the individual items:

$$\underbrace{\text{L56}}_{\text{Cash flow from operating activities}} = \text{SUM}(\underbrace{\text{L48 : L55}}_{\begin{subarray}{l}+F_0^{ar}+I_0^l - F_0^{ap,m} - F_0^{ap,nm} - F_0^{swp,m}\\ -F_0^{swp,nm} - I_0^d - F_0^{tp}\end{subarray}})$$

$$\underbrace{\text{L59}}_{\text{Cash flow from investing activities}} = \underbrace{\text{L58}}_{+F_0^{nfa}}$$

$$\underbrace{\text{L64}}_{\text{Cash flow from financing activities}} = \text{SUM}(\underbrace{\text{L62 : L63}}_{+\Delta C_t^d - F_t^e}).$$

The sum of the three components above is the change in cash and cash equivalents (ΔC^l):

$$\text{L66} = \text{L56} + \text{L59} + \text{L64}$$

The analyst can copy the range L48 : L66 and paste it in range M48 : Q66 (or, more simply, use the fill handle).

7. Module 7: Assessing Value Creation and Financial Efficiency

As we have seen, the NPVs can be found in the MVA matrix. This section is addressed to calculating some measures of economic profitability that provide different pieces of information from the NPV but are NPV-consistent and, therefore, reciprocally consistent. They offer an alternative, but logically equivalent, view on the project's value creation and financial efficiency (see Part I, Section 13). A new sheet for the presentation of the absolute and relative measures of worth must be created, called "ValueCreation". In it, we report the NPV and the economic residual income (ERI), which are absolute measures of worth, and, in addition, the rate of return (i) and the cash-flow return on capital (CFROC), along with the corresponding benchmark rates of return (respectively, ρ and CFROC^V), which are relative measures of worth.

7.1. Economic Residual Income (ERI)

The ERI informs about how value creation may be apportioned across the various periods, that is, how the project has contributed to increase shareholders' wealth in the

various periods. The total of such ERIs provide the overall value created (see Part I, Sections 12 and 13).

CODE INSTRUCTIONS: ERI TABLE

The analyst creates, in his workbook, a new sheet called "ValueCreation", where he prepares a range of cells that can contain the table of the ERIs (see Figure 56). Columns A and B contain the labels of the area (o, l, d, e, inv, and fin), and a header row (row 6) which contains the numbers of the periods. Each cell of this range contains the ERI of one area, $I_t^j - I_t^{Vj}$, $j = o, l, d, e, \text{inv, fin}$. These values are already available (changed in sign) in the MVA Matrix (SplitScreenStrip!98:101), so the analyst can pick them up with the following formulas:

$$C9 = (-1) * \text{INDEX}(\underbrace{\text{SplitScreenStrip!\$98:\$101}}_{\substack{\text{the MVA four-area Matrix} \\ \text{that contains the wanted values}}},$$

$$\underbrace{\text{MATCH}(\$B9, \text{SplitScreenStrip!\$B\$98:\$B\$101}, 0)}_{\substack{\text{the result of this formula is the number of the row in} \\ \text{MVA four-area Matrix that has the same label as cell \$B9 ("o")}},$$

$$\underbrace{\text{MATCH}(C\$6, \text{SplitScreenStrip!\$9:\$9}, 0)}_{\substack{\text{the result of this formula is the number of the first column in the} \\ \text{MVA four-area Matrix that has the same label as cell C\$6 ("0")}}$$
$$)$$

Then, the analyst copies and pastes the same formula for the whole strip C9:H12. The same table can also be framed in terms of investments vs. financings. For this purpose, it suffices to use the previous ERI strip. For example, for the ERI generated by the investments is calculated as

$$\underbrace{C14}_{\text{ERI}^{\text{inv}}} = \text{SUM}(\underbrace{C9 : C10}_{\text{ERI}^o + \text{ERI}^l})$$

The ERI informs that the project subtracts value for the firm's shareholders in the first two periods (-2367 and -367) but adds value in the remaining three periods (1185, 3074, and 5357). Overall, the Total ERI is positive and equal to 6882. It is calculated in column I as $\text{ERI} = \sum_{t=0}^{n} (I_t - I_t^V)$. In the spreadsheet,

$$I9 = \text{SUM}(C9:H9).$$

As shown in Part I, Equations (96) and (102), the Total ERI is equal to the NPV. Therefore, calculating the ERIs represent a way for decomposing the NPV by periods.

		0	1	2	3	4	5	
		$I_0-I^V_0$	$I_1-I^V_1$	$I_2-I^V_2$	$I_3-I^V_3$	$I_4-I^V_4$	$I_5-I^V_5$	Total ERI
9	o	0	-2,338	-535	932	2,709	4,853	5,622
10	l	0	-122	97	206	340	504	1,025
11	d	0	-93	-71	-48	-24	0	-236
12	e	0	-2,367	-367	1,185	3,074	5,357	6,882
14	inv	0	-2,460	-438	1,138	3,050	5,357	6,647
15	fin	0	-2,460	-438	1,138	3,050	5,357	6,647

Figure 56. Economic residual income ("ValueCreation" sheet).

7.2. Rate of Return, Average ERI, and Cash-Flow Return on Capital

Beside (the NPV and the) Total ERI, which are absolute measures of worth, some useful information is provided by the relative measures of worth, which can be extracted with simple formulas (see Part I, Section 13). The formulas of the measures employ either the sum of project book values or the sum of benchmark amounts. It is convenient to pick up such figures from the "TransMatrix" sheet, where they have already been calculated.

CODE INSTRUCTIONS: SUMS OF ROWS OF THE TRANSPOSED MATRICES
The analyst builds a table in the "ValueCreation" sheet and reports all the sums calculated in the "TransMatrix" sheet (see Figure 57). For example:

$$E20 = \text{TransMatrix!P6}$$
$$G20 = \text{TransMatrix!P16}$$
$$I20 = \text{TransMatrix!P26}$$
$$K20 = \text{TransMatrix!P57}$$
$$M20 = \text{TransMatrix!P67}$$

These values are used for assessing the project's economic profitability (see the code instructions below).

Figure 57. The table in the rows 18:26 contains the sums of the Transposed Matrices rows ("ValueCreation" sheet).

CODE INSTRUCTIONS: ABSOLUTE AND RELATIVE MEASURES OF ECONOMIC PROFITABILITY
The analyst sets up a range of cells that can host the values of the (absolute and relative) measures of worth, and the benchmark rate of return (see Figure 58).
NPV (COLUMN D). As noted in Section 7, the NPV is equal to the MVA at $t = 0$, which can be picked up from the MVA Matrix (rows 98:101 of the "SplitScreenStrip" sheet). For example, the NPV generated by the operations is obtained as

$$D31 = \text{SplitScreenStrip!J98}$$

(as we already know, this output is also equal to the operating Total ERI in cell I9). The analyst can then copy cell D31 and paste it in cells D32, D35, and D36. The NPV of the investment and financing areas are the sums of the previous rows. For example, the investment NPV is calculated as

$$\underbrace{D33}_{\text{NPV}^{\text{inv}}} = \text{SUM}(\underbrace{D31:D32}_{\text{NPV}^o + \text{NPV}^l})$$

AERI (COLUMN F). The Average Economic Residual Income (AERI) is the ratio of Total ERI and the project's lifespan:

$$\underbrace{F31}_{AERI^o} = \underbrace{I9}_{totalERI^o} / \underbrace{Assumptions!\$H\$5}_{n}$$

The analyst can copy cell F31 and paste it in cells F32, F35, and F36. The AERI of the investment and financing areas are the sums of the previous rows. For example, the investment AERI is:

$$\underbrace{F33}_{AERI^{inv}} = SUM(\ \underbrace{F31:F32}_{AERI^o + AERI^l}\ )$$

CFROC (COLUMN H). The Cash-flow return on capital (CFROC) is the ratio of the sum of cash-flows, $F\ (= \sum_{t=0}^{n} F_t)$, and the sum of book values, $C\ (= \sum_{t=0}^{n} C_t)$:

$$CFROC = \frac{\sum_{t=0}^{n} F_t}{\sum_{t=0}^{n} C_t}$$

The analyst can pick up the values of F and C from the table in rows 18:26:

$$\underbrace{H31}_{CFROC^o} = \underbrace{I20}_{\sum_{t=0}^{n} F_t^o} / \underbrace{E20}_{\sum_{t=0}^{n} C_t^o}$$

The analyst can then copy cell H31 and paste it in ranges H32:H33 and H35:H37.

RATE OF RETURN (COLUMN J). The rate of return of the project, i, is the ratio of the sum of project incomes, $I\ (= \sum_{t=0}^{n} I_t)$ and the sum of the project book values, C:

$$i = \frac{\sum_{t=0}^{n} I_t}{\sum_{t=0}^{n} C_t}.$$

The analyst can grab the values of I and C from the table in rows 18:26:

$$\underbrace{J31}_{i^o} = \underbrace{G20}_{\sum_{t=0}^{n} I_t^o} / \underbrace{E20}_{\sum_{t=0}^{n} C_t^o}.$$

As explained in Part I, Section 13, i and CFROC must coincide, so J31 = H31, as we expect. The analyst can then copy cell J31 and paste it in ranges J32:J33 and J35:J37. These rates of return refer to all the areas of the project. They are, respectively, the average ROI, average ROL, average ROA, average ROD, and average ROE, while cells J33 and J37 contain the average ROA (see Table 4 in Part I).

CFROC^V (COLUMN L). The cash-flow return on capital of the benchmark, CFROC^V, is the cutoff rate associated with CFROC which signal value creation (i.e., project acceptance) or value destruction (i.e., project rejection): it is the ratio of the sum of the cash flows generated by the benchmark $\left(\sum_{t=0}^{n} F_t^V\right)$ and the sum of the book values, C.

$$CFROC^V = \frac{\sum_{t=0}^{n} F_t^V}{\sum_{t=0}^{n} C_t}$$

The analyst can grab the values of F^V and C from the table in rows 18:26:

$$\underbrace{L31}_{CFROC^{Vo}} = \underbrace{M20}_{\sum_{t=0}^{n} F_t^{Vo}} / \underbrace{E20}_{\sum_{t=0}^{n} C_t^o}$$

The analyst can then copy the cell L31 and paste it in ranges L32:L33 and L35:L37.

BENCHMARK RATE OF RETURN (COLUMN N). The benchmark rate of return ρ, associated with i, is the ratio of the sum of benchmark profits $I^V\left(=\sum_{t=1}^{n} I_t^V\right)$, and the sum of book values, C :

$$\rho = \frac{\sum_{t=0}^{n} I_t^V}{\sum_{t=0}^{n} C_t}$$

The analyst can grab the values of I^V and C from the table in rows 18:26:

$$\underbrace{N31}_{\rho^o} = \underbrace{K20}_{\sum_{t=0}^{n} I_t^{Vo}} / \underbrace{E20}_{\sum_{t=0}^{n} C_t^o}$$

The analyst can then copy the cell N31 and paste it in ranges N32:N33 and N35:N37. As explained in Part I, Section 13, CFROC^V must coincide with ρ, so L31 = N31 (same for the other ones), as we expect.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1														
2			**Measuring value creation and financial efficiency**											
3														
28			NPV		AERI		CFROC		project rate of return		CFROC^V		MARR	
29			$V_0 - C_0$		$\dfrac{\text{Total ERI}}{n}$		$\dfrac{\sum_{t=0}^{n} F_t}{\sum_{t=0}^{n} C_t}$		$\dfrac{\sum_{t=0}^{n} I_t}{\sum_{t=0}^{n} C_t}$		$\dfrac{\sum_{t=0}^{n} F_t^V}{\sum_{t=0}^{n} C_t}$		$\dfrac{\sum_{t=0}^{n} I_t^V}{\sum_{t=0}^{n} C_t}$	
31			NPV^o	5,622	AERI^o	1,124	CFROC^o	46.1%	i^o average ROI	46.1%	CFROC^{Vo}	29.9%	ρ^o operating MARR	29.9%
32			NPV^l	1,025	AERI^l	205	CFROC^l	3.8%	i^l average ROL	3.8%	CFROC^{Vl}	1.1%	ρ^l non-operating MARR	1.1%
33			NPV^{inv}	6,647	AERI^{inv}	1,329	CFROC^{inv}	23.9%	i^{inv} average ROA	23.9%	CFROC^{Vinv}	14.8%	ρ^{inv} project MARR	14.8%
35			NPV^d	-236	AERI^d	-47	CFROC^d	2.0%	i^d average ROD	2.0%	CFROC^{Vd}	2.9%	ρ^d debt MARR	2.9%
36			NPV^e	6,882	AERI^e	1,376	CFROC^e	35.4%	i^e average ROE	35.4%	CFROC^{Ve}	21.0%	ρ^e equity MARR	21.0%
37			NPV^{fin}	6,647	AERI^{fin}	1,329	CFROC^{fin}	23.9%	i^{fin} average ROA	23.9%	CFROC^{Vfin}	14.8%	ρ^{fin} project MARR	14.8%
38														

Figure 58. Measures of economic profitability ("ValueCreation" sheet).

As the reader can see, areas D31:D32 and D35:D36 of the "ValueCreation" sheet show the NPV for the various areas: $\mathrm{NPV}^o = 5,622$ (value created by the project's operations), $\mathrm{NPV}^l = 1,025$ (value created by the reinvestment in liquid assets), $\mathrm{NPV}^d = -236$ (value lost by the debtholders at the expense of the firm's shareholders), and $\mathrm{NPV}^e = 6,882$ (value created for the firm's shareholders). Cells D33 and D37 report the project NPV: the value created by the project is $\mathrm{NPV} = 6,647$, part of which is generated by the liquid assets (because assumptions 21 and 24 imply that $i^l > r^l$, that is, the interest rate on liquid assets is greater than the required return on them). However, the equity NPV (USD 6,882) is greater than USD 6,647 because part of it (USD 236) is lost by the debtholders. This occurs because assumptions 19 and 25 imply $i^d < r^d$, that is, the interest rate on debt is smaller than the required return on debt (i.e., the maximum attractive financing rate for the firm).

7.3. The Product Structure

An alternative way of calculating the NPV consists in computing the product of the total invested capital (C) and the financial efficiency of the investment, which is equal to the difference between the rate of return and the benchmark rate of return ($i - \rho$). This

represents an explicit link between the capital, the rate of return and the MARR (see Part I, Equation (103), and the code instructions below).

CODE INSTRUCTIONS: ALTERNATIVE WAY OF CALCULATING THE NPV
The analyst sets up a range of cells that can host the alternative way of calculating the NPV.

TOTAL CAPITAL. Cells D42:D48 contain the total capital of the project ($\sum_{t=0}^{n} C_t$), grabbed from the Transposed Matrix. The analyst starts from

$$\underbrace{\text{D42}}_{\substack{\text{total investment} \\ \text{in operating assets}}} = \text{TransMatrix!P6}$$

and then copies cell D42 and pastes it in ranges D43:D44 and D46:D48.
  FINANCIAL EFFICIENCY. Cells F42:F48 contain the financial efficiency of the investment $(i - \rho)$, obtained from the values already calculated in the table above. The analyst starts from

$$\underbrace{\text{F42}}_{\substack{\text{financial efficiency} \\ \text{of the operating assets}}} = \underbrace{\text{J31}}_{i^o} - \underbrace{\text{N31}}_{\rho^o}$$

and then copies the cell F42 and pastes it in ranges F43:F44 and F46:F48.
  NPV. Cells H42:H48 contains the NPV as products of investment scale and financial efficiency. Starting from

$$\underbrace{\text{H42}}_{\text{NPV}^o} = \underbrace{\text{D42}}_{\substack{\text{total investment} \\ \text{in operating assets}}} * \underbrace{\text{F42}}_{\substack{\text{financial efficiency} \\ \text{of the operating assets}}}$$

the analyst can then copy the cell H42 and paste it in the ranges H43:H44 and H46:H48 (see Figure 59).
  In particular, the total capital invested in the project is $C =$ USD 72,923 at an above-normal rate of return of $i - \rho = 9.1\%$, which makes a USD 6,647 gain. The total capital borrowed is $C^d =$ USD 25,000 at a rate of return which is lower than the benchmark rate of return by $\left| i^d - \rho^d \right| = 0.9\%$, so the debt NPV is slightly negative and equal to NPV$^d = -$USD236. The total capital invested by shareholders is $C^e =$ USD 47,923, invested at an above-normal rate of return of $i^e - \rho^e = 14.4\%$, which makes a USD 6,882 increase in wealth (see also Part I, Equation (103)).

	total capital		financial efficiency		NPV	
Σc^o	34,681	$i^o - \rho^o$	16.2%	NPV^o	5,622
Σc^l	38,242	$i^l - \rho^l$	2.7%	NPV^l	1,025
Σc^{inv}	72,923	$i^{inv} - \rho^{inv}$	9.1%	NPV^{inv}	6,647
Σc^d	25,000	$i^d - \rho^d$	-0.9%	NPV^d	-236
Σc^e	47,923	$i^e - \rho^e$	14.4%	NPV^e	6,882
Σc^{fin}	72,923	$i^{fin} - \rho^{fin}$	9.1%	NPV^{fin}	6,647

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Figure 59. The product structure: an alternative way of calculating the NPV ("ValueCreation" sheet). (The red lines represent equality).

8. Conclusions

  This paper provides practitioners with a guide to innovative financial modeling. Specifically, it implements the accounting-and-finance engineering system (AFES) described in

Magni ([2020](#), [2023](#)) on spreadsheet software. The AFES is based on the split-screen approach, and we guide the modeler step by step, showing how to build a frugal, transparent, and easy-to-use model for performing a detailed financial analysis of a capital asset project. The AFES articulation is such that it acts as a diagnostic tool, spotting modeling errors and internal inconsistencies. In particular, if numbers in rows and columns do not match, there is some inconsistencies in the calculation. Furthermore, if the absolute measures of worth are not reciprocally consistent, then some problems arise in some parts of the model (either in the evaluation process or, earlier, in processing the accounting and financial magnitudes).

We start from the verbal description of the project, then carry out preliminary calculation and use them to obtain the split-screen strip, whereby the pro forma financial statements are chronologically chained. We divide the model into seven modules with seven associated worksheets and make the corresponding file available for downloading at the following address: https://morespace.economia.unimore.it/carloalbertomagni/spreadsheet-modeling/ (accessed 18 February 2023) (the file can also be requested at magni@unimo.it or d.baschieri@grafspa.it)

Author Contributions: Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing-original draft preparation, writing-review end editing, visualization, supervision, project administer, funding acquisition: D.B. and C.A.M. The authors contributed to all the various aspects of this research and paper production within their respective skill and expertise. The final form of this manuscript was read and approved for publication by the authors; the work described represents an original research that has not been published previously and is not under consideration for publication elsewhere, in whole or in part. All authors have read and agreed to the published version of the manuscript.

Symbols and Abbreviations

AERI	average economic residual income
AFES	Accounting and Finance Engineering System
AP_t	accounts payable
AP_t^m	accounts payable (manufacturing)
AP_t^{nm}	accounts payable (nonmanufacturing)
AR_t	accounts receivable
C_t^d	debt capital
C_t^e	equity capital
C_t^{fin}	capital raised from capital providers (claimholders)
C_t^{inv}	capital invested in the project
C_t^l	liquid assets
C_t^o	operating assets
CFD	cash flow to debt
CFE	cash flow to equity
CFL	cash flow from/to liquid assets
CFO	cash flow from operations
CFROC	project's cash-flow return on capital
$CFROC^V$	benchmark's cash-flow return on capital
$COGS_t$	cost of goods sold
COP_t	cost of purchases
COP_t^m	cost of purchases (manufacturing)
COP_t^{nm}	cost of purchases (nonmanufacturing)
Dep_t	depreciation

EBIT_t	earnings before interest and taxes
EBITDA_t	earnings before interest, taxes, depreciation, and amortization
EBT_t	earnings before taxes
F_t^{ap}	payments to suppliers
$F_t^{ap,m}$	payments to suppliers (manufacturing)
$F_t^{ap,nm}$	payments to suppliers (nonmanufacturing)
$F_t^{swp,m}$	payments to employees (manufacturing)
$F_t^{swp,nm}$	payments to employees (nonmanufacturing)
F_t^{ar}	cash receipts from customers
F_t^{cogs}	payments for COGS
F_t^{d}	cash flow to debt
F_t^{e}	cash flow to equity
F_t^{fin}	cash flow to capital providers (claimholders)
F_t^{inv}	cash flow from project's assets
F_t^{Inv}	cash flow from inventory $(= 0)$
F_t^{l}	cash flow from liquid assets (net of deposits)
F_t^{nfa}	asset disposal (net of capital expenditures)
F_t^{o}	cash flow from operations
F_t^{swp}	payments to employees
F_t^{tp}	payments for income taxes
F_t^{V}	benchmark's cash flow
F_t^{Vd}	cash flow of the benchmark portfolio replicating the project's CFD
F_t^{Ve}	cash flow of the benchmark portfolio replicating the project's CFE
F_t^{Vl}	cash flow of the benchmark portfolio replicating the project's CFL
F_t^{Vo}	cash flow of the benchmark portfolio replicating the project's CFD
FCFE	free cash flow to equity
I_t^{d}	interest expenses
I_t^{e}	net income
I_t^{fin}	income from the project's assets
I_t^{inv}	income to capital providers
I_t^{l}	interest income
I_t^{o}	operating income
I_t^{V}	benchmark profit
I_t^{Vd}	profit of the benchmark portfolio replicating the project's CFD
I_t^{Ve}	profit of the benchmark portfolio replicating the project's CFE
I_t^{Vl}	profit of the benchmark portfolio replicating the project's CFL
I_t^{Vo}	profit of the benchmark portfolio replicating the project's CFO
i^{d}	return on debt (loan interest rate)
i^{l}	return on non-operating assets (interest rate on liquid assets)
Inv_t	inventory
ΔInv_t	income from inventory (change in inventory)
LC_t	labor costs
LC_t^{m}	labor costs (manufacturing)
LC_t^{nm}	labor costs (nonmanufacturing)
MARR	minimum attractive rate of return
NFA_t	net fixed assets
NOL	net operating liabilities
NOL_t^{m}	net operating liabilities (manufacturing)
NOL_t^{nm}	net operating liabilities (nonmanufacturing)
NOWC_t	net operating working capital
NPV	net present value
r	project cost of capital (required return on assets)
r^{d}	cost of debt (required return on debt)
r^{l}	cost of non-operating assets (required return on non-operating assets)
r^{o}	cost of operating assets, pre-tax WACC (required return on operating assets)
ρ	MARR for the project

ρ^d	MARR for the debt
ρ^e	MARR for the equity
ρ^l	MARR for liquid assets
ρ^o	MARR for the operating assets
ROA	Return On Assets
ROD	Return On Debt
ROE	Return On Equity
ROL	Return On Liquid Assets
S_t	sales
SGA_t	selling, general, and administrative expenses
SSM	Split-Screen Matrix
SWP_t	salaries and wages payable
SWP_t^m	salaries and wages payable (manufacturing)
SWP_t^{nm}	salaries and wages payable (nonmanufacturing)
T_t	taxes
TP_t	taxes payable
T_t	income taxes
V_t	project's economic value
V_t^d	economic value of debt
V_t^e	economic value of equity
V_t^l	economic value of non-operating assets
V_t^o	economic value of operating assets
WACC	weighted average cost of capital

Appendix A. Alternative Schemes for CFE Calculation

In this paper, we have described the case where the firm applies a payout ratio to the net income for determining the CFE. In real-life applications, many different schemes may be employed. In this Appendix, we illustrate two alternative schemes, based on FCFE.

Let us assume that the firm determines the CFE by applying the payout ratio (20%) to the FCFE (instead of the net income). This implies that Table 7 turns to Table A1.

Table A1. Breakdown of CFE (payout ratio: 20% of FCFE).

	TIME	0	1	2	3	4	5
CASH FLOW TO EQUITY (F_t^e)	Shareholders' investment	$-6,000$	0	0	0	0	0
	Interim payout (20% of FCFE)	0	$0.2 \cdot FCFE_1$	$0.2 \cdot FCFE_2$	$0.2 \cdot FCFE_3$	$0.2 \cdot FCFE_4$	0
	Liquidation dividend	0	0	0	0	0	$C_4^e + I_5^e$

The difference between Tables 7 and A1 lies in the "Interim payout" row.

CODE INSTRUCTIONS: CASH FLOW TO EQUITY CALCULATED AS A FRACTION OF FCFE

Section 2.2.3 contains the formula used for filling the cells $-F_t^e$ of the full-scale matrix. The spreadsheet code for the cell I23 ($-F_0^e$) is:

$$\underbrace{I23}_{-F_0^e} = IF(\ \underbrace{I9}_{period} = 0, \underbrace{Assumptions!\ \$H\$21}_{case\ t=0}, \underbrace{IF(\ \underbrace{I9}_{period} < \$D\$2, \underbrace{-\underbrace{H23}_{I_0^e} * \underbrace{\$D\$6}_{20\%}}_{case\ 0<t<n}, \underbrace{-(G23 + H23)}_{case\ t=n}))}_{case\ t \neq 0}$$

interim payout (20% of net income) $\qquad$ liquidation dividend

Assuming FCFE is the calculation base for the CFE, one only needs change the part of the formula that calculates the interim payout ("$-H23 * \$D\$6$" in the example above).

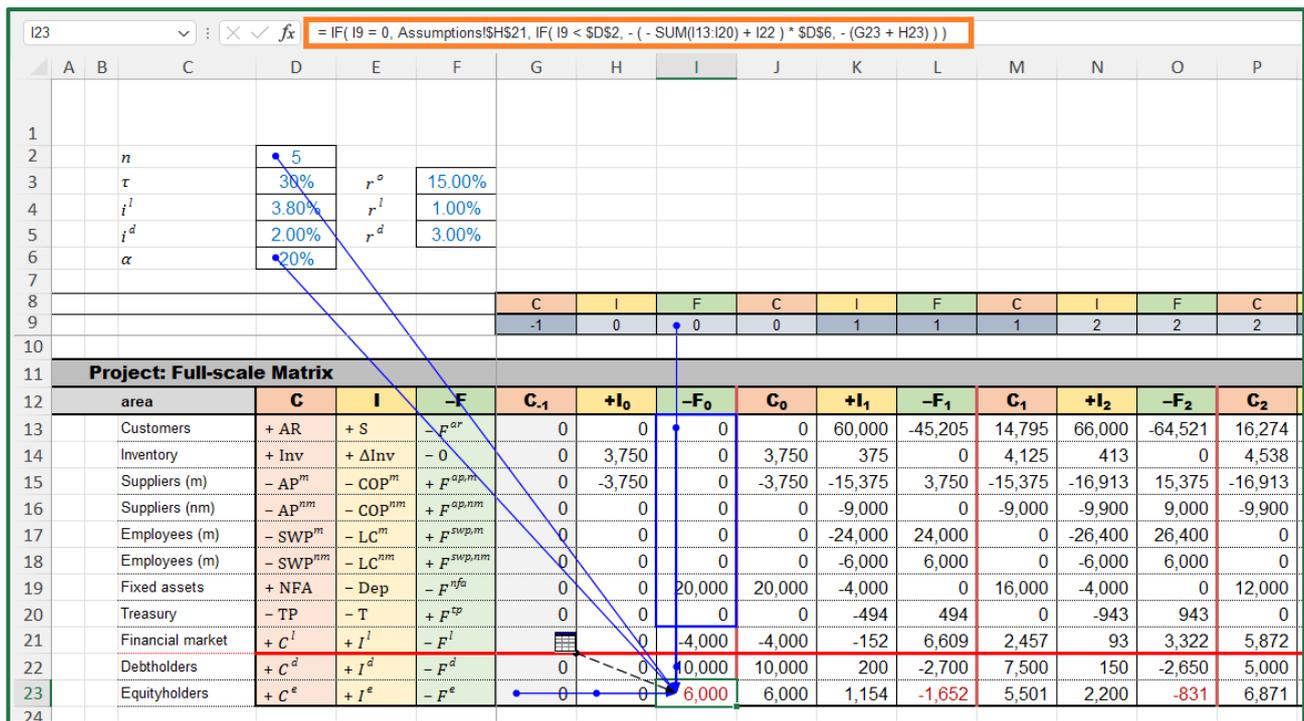Specifically, net income ($-$H23) must be replaced by FCFE. The latter is equal to the difference between CFO and CFD ($\text{FCFE}_t = F_t^o - F_t^d$) and the CFO is equal to

$$F_t^o = F_t^{ar} - F_t^{ap,m} - F_t^{ap,nm} - F_t^{swp,m} - F_t^{swp,nm} + F_t^{nfa} - F_t^{tp}.$$

The new spreadsheet code for I23 is then

$$\text{I23} = \text{IF}(\overbrace{\text{I9}}^{\text{period}} = 0, \underbrace{\overbrace{\text{Assumptions!}\,\$\text{H}\$21}^{\text{equity financing}}}_{\text{case }t=0},$$

$$\text{IF}(\overbrace{\text{I9}}^{\text{period}} < \$\text{D}\$2, \underbrace{\overbrace{-(-\overbrace{\text{SUM(I13:I20)}}^{n} + \overbrace{\text{I22}}^{=\text{CFO}_0}) * \$\text{D}\$6}^{\text{interim payout (20\% of FCFE)}}, \overbrace{-(\text{G23} + \text{H23})}^{\text{liquidation dividend}}))}_{\text{case }t\neq 0}$$

where the FCFE bracket is
$$\begin{aligned}&-F_0^{ar}-0\\&+F_0^{ap,m}+F_0^{ap,nm}\\&+F_0^{swp,m}+F_0^{swp,nm}\\&-F_0^{nfa}+F_0^{tp}\\&=\text{CFO}_0\end{aligned}$$
and $-F_0^d$ corresponds to I22, 20% to \$D\$6, case $0<t<n$.

At https://morespace.economia.unimore.it/carloalbertomagni/spreadsheet-modeling (accessed 18 February 2023), two Excel files are available, one where the payout ratio is applied to net income and another one where the payout ratio is applied to the FCFE.

Other ways to determine the distribution policy are possible and one just has to replace the nested formula that calculates the interim payout. For example, the payout to equity holders might be calculated as the minimum value between net income and FCFE:

$$\text{interim payout (period 0)} = -\underbrace{\text{MIN}(\overbrace{\text{H23}}^{I_0^e}, \underbrace{(-\overbrace{\text{SUM(I13:I20)}}^{\text{CFO}_0} + \overbrace{\text{I22}}^{-F_0^d})}_{\text{FCFE}_0})}_{\text{MIN}(I_0^e,\ \text{FCFE}_0)} * \overbrace{\$\text{D}\$6}^{20\%}$$

More generally, a firm may not be willing (or may not be allowed) to distribute cash to its shareholders if either the net income or the FCFE is negative. In this case, the previous formula changes to

$$\text{interim payout (period 0)} = -\text{MAX}(\underbrace{\text{MIN}(\overbrace{\text{H23}}^{I_0^e}, \underbrace{(-\text{SUM(I13:I20)} + \text{I22})}_{\text{FCFE}_0})}_{\text{MIN}(I_0^e,\ \text{FCFE}_0)}, 0) * \overbrace{\$\text{D}\$6}^{20\%}$$

which implies that the firm will pay the minimum between net income and FCFE only if both are positive (if one of them is zero or negative, then $\text{MIN}(\text{H23}, -\text{SUM}(\text{I13}:\text{I20}) + \text{I22}), 0) \leq 0$ and $\text{MAX}(\leq 0, 0) = 0$).

Figure A1. An alternative way to determine the Cash Flow to Equity in cell I23 ("SplitScreenStrip" sheet).

Notes

[1] We assume the reader is already familiar with Magni (2023). If not, we recommend reading it before tackling this applicative part.

[2] Some graphs are included in the spreadsheet file as well, conveying information in a visual form.

[3] In principle, the & operator is not even necessary if one uses homogeneous labels (see Section 4).

[4] For simplicity, we will refer to Magni (2023) as "Part I".

[5] The COGS are computed as $COGS_t = COP_t^m + LC_t^m - \Delta Inv_t$.. However, the relation between material used and manufacturing COP is as follows: material used in $t = COP_t^m - \Delta Inv_t$; material used in t is an estimated figure, based on the projection of units produced (equal to units sold by assumption). Material used in t = units sold in $t \cdot$ unit cost. Hence, COP_t^m = units sold in t · unit cost + ΔInv_t and we can also write

$$COGS_t = \text{unitssoldin t} \cdot \text{unitcost} + LC_t^m.$$

The latter equality may be used for checking consistency of COGS calculation in the model.

[6] The vertical bar in Figure 6 is now in Indian red. As explained in Part I, its meaning changes as follows: for each row, the sum of the three elements preceding the bar ($C_{t-1} + I_t - F_t$) is equal to the element following the bar (C_t).

[7] We note, again, that column D describes a statement of capital amounts (equality of investments and financings), column E describes a statement of incomes (equality of income from investments and income to capital providers), column F describes a statement of cash flows (equality of cash flow from investments and cash flow distributed to capital providers).

[8] Those unfamiliar with these functions may turn to Avon (2021, Ch. 11) or to any guide to spreadsheets.

[9] In principle, labels in the "TransMatrix" sheet may be adjusted with the addition of "+" so that the "&" operator is not necessary.

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