Certified International Investment Analyst

Formulae

Final Examination

Financial Accounting and Financial Statement Analysis

Equity Valuation and Analysis

Corporate Finance

Economics

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Straight Line Method

Depreciation per Year = (Original Cost – Salvage Value) / Useful Life

Accelerated Method
- Double-Declining-Balance-Depreciation

Depreciation = 2·Straight Line Rate · Book Value at the Beginning of the Year

where:

straight line rate = 1 / Estimated Useful Life

- Sum-of-the-Years Method (SYD)

Depreciation = (Original Cost – Salvage Value) · Applicable Fraction

where:

Applicable Fraction = number of years of estimated useful life remaining / *SYD*, where

$$SYD = \frac{n \cdot (n+1)}{2}$$

and *n* = estimated useful life

1.2 Financial Reporting and Financial Statement Analysis

1.2.1 Earning per Share

1.2.1.1 Calculation of EPS

$$EPS = \frac{Earnings\ available\ to\ the\ common\ stockholders}{Number\ of\ shares\ of\ common\ stock\ outstanding}$$

With a change in the number of shares outstanding during the year, the formula is modified as follows:

$$EPS = \frac{Earnings\ available\ to\ the\ common\ stockholders}{Weighted\ average\ number\ of\ common\ shares\ outstanding}$$

1.2.1.2 Using EPS to Value Firms

- Constant Dividend Growth Model (Gordon-Shapiro)

$$P_0 = \frac{\pi \cdot EPS_0 \cdot (1 + g)}{(k_e - g)}$$

where:

P_0	initial market price
g	growth rate
k_e	cost of equity
π	payout ratio
EPS_0	earning per share in t = 0

1.3 Analytical tools for Assessing Profitability and Risk

1.3.1 Profitability Analysis

1.3.1.1 Return on Assets

Annual Return

$$Annual\ Return = \frac{Annual\ profit}{Invested\ capital}$$

Return on Assets

$$ROA = \text{return on assets} = \frac{\text{Earnings before interests and tax (EBIT)}}{\text{Assets}}$$

$$ROA = \frac{EBIT}{Sales} \cdot \frac{Sales}{Assets} = EMR \cdot ATR$$

where:

EMR = economic margin ratio = $\frac{EBIT}{Sales}$

ATR = asset turnover ratio = $\frac{Sales}{Assets}$

Return on Total Assets

$$ROTA = \frac{EBIT}{\text{Total assets}}$$

Return on Operating Assets

$$ROOA = \frac{OEBIT}{\text{Operating assets}}$$

Return on Non-Operating Assets

$$RONOA = \frac{EBIT - OEBIT}{\text{Assets} - \text{Operating assets}}$$

where:

OEBIT	operating earnings before interests and tax
ROOA	return on operating assets
RONOA	return on non-operating assets

Let **ROTA** be an average return of the two parts:

$$ROTA = ROOA \cdot x_1 + RONOA \cdot x_2$$

where:

x_1	weight of the operating assets (Operating assets/Total assets)
x_2	weight of the non-operating assets ($x_2 = 1 - x_1$)

1.3.1.2 ROCE

Return on Equity (*ROE*) or **Return on Common Equity (*ROCE*)**

$$ROE = \frac{Net\ Profit}{Equity} = \frac{(1 - t)(EBIT - Interest)}{Equity}$$

which can be written:

$$\begin{aligned} ROE &= (1-t) \cdot \left[\frac{EBIT - Interest}{Equity} \right] \\ &= (1-t) \cdot \left[\frac{ROA \cdot Assets - i \cdot Debt}{Equity} \right] \\ &= (1-t) \cdot \left[ROA \cdot \frac{Equity + Debt}{Equity} - i \cdot \frac{Debt}{Equity} \right] \\ &= (1-t) \cdot \left[ROA + (ROA - i) \cdot \frac{Debt}{Equtiy} \right] \\ &= (1-t) \cdot ROEbT \end{aligned}$$

ROE can be decomposed as follows:

$$ROE = \frac{Net\ profit}{Earning\ before\ tax} \cdot \frac{Earning\ before\ tax}{EBIT} \cdot \frac{EBIT}{Sales} \cdot \frac{Sales}{Assets} \cdot \frac{Assets}{Equity}$$

where:

i	average interest rate on total debts = $\frac{\text{Interest expenses}}{\text{Total debts}}$
EBIT	earnings before interests and tax
t	corporate tax rate

Return on Equity before Tax

$$ROEbT = \frac{EBT}{Equity} = ROA + (ROA - i) \cdot \frac{Debt}{Equity}$$

where:

i average interest rate on total debts = $\frac{\text{Interest expenses}}{\text{Total debts}}$

EBT earnings before income tax

1.3.2 Risk Analysis

1.3.2.1 Short-Term Liquidity Risk

Current Ratio

$$\frac{Current\ assets}{Current\ liabilities}$$

Quick Ratio

$$\frac{Current\ assets - Inventory}{Current\ liabilities}$$ or

$$\frac{Cash + Marketable\ securities + Receivables}{Current\ liabilities}$$

Working Capital Activity Ratio

$$\frac{Sales\ revenue}{Average\ Working\ Capital}$$

1.3.2.2 Long-Term Solvency Risk

Debt Ratio

$$\frac{Debt}{Equity}$$

Interest Coverage Ratio

$$\frac{EBIT}{Interest\ Expenses}$$

1.3.3 Break-Even Analysis

$$\text{Break-even volume} = \frac{F}{m}$$

where:

s	unit sales price
v	unit variable costs
F	fixed cost during a period
s - v = m	unit contribution margin

2. Equity Valuation and Analysis

2.1 Valuation Model of Common Stock

2.1.1 Dividend Discount Model

2.1.1.1 Zero Growth Model

$$P_0 = \frac{Div}{k_E}$$

where

P_0	price of share
Div	dividend (assumed constant)
k_E	cost of equity capital

2.1.1.2 Constant Growth Model

Constant Dividend Growth Model

$$P_0 = \frac{Div_1}{k_E - g}$$

where

P_0	price of share
Div_1	$Div_0 \cdot (1+g)$ = expected dividend in period 1
k_E	cost of equity capital
g	growth rate of dividend (assumed constant)

Gordon Shapiro Model

$$P_0 = \frac{EPS_1 \cdot \pi}{k_E - (1-\pi) \cdot r}$$

where

P_0	price of share
EPS_1	earnings per share in $t = 1$
π	payout ratio
k_E	cost of equity capital
$1 - \pi$	earnings retention rate
r	return on equity (*ROE*)

2.1.2 Free Cash Flow Model

Net Income (Net Profit)

	Net Sales
–	Cost of goods sold
–	Selling, general + administrative expenses
–	Depreciation
=	EBIT = Earnings before interest and taxes
–	Interest
=	EBT = Earnings before taxes
–	Taxes
=	Net Income

Free Cash Flows (FCF)

	Earnings from operations before interest and taxes (EBIT)
–	Taxes (calculated as EBIT · tax rate)
+	non cash relevant expenses (depreciation, provisions for doubtful debt, etc.)
–	non cash relevant revenues (adjustments for currency changes, etc.)
=	Gross cash flow
–	Increase in net working capital
+	Reduction in net working capital
–	Capital expenditure (buildings, equipment, …)
+	Liquidation of fixed assets
=	Free cash flow from operations

2.1.3 Measures of Relative Value

2.1.3.1 Price Earnings Ratio

$$P_0 = EPS \cdot \frac{P}{E}$$

where

P_0	price of the share
EPS	earnings per share
P/E	price-earnings ratio

3. Corporate Finance

3.1 Fundamentals of Corporate Finance

3.1.1 Discounted Cash Flow

The present value of an annuity is given by

$$\text{Present value} = \sum_{t=1}^{n} \frac{CF}{(1+k)^t} = \frac{CF}{k} \cdot \left(1 - \frac{1}{(1+k)^n}\right)$$

where

CF	constant cash flow
k	discount rate, assumed to be constant over time
n	number of cash flows

The future value of an annuity is given by

$$\text{Future value} = CF \cdot \left(\frac{(1+k)^n - 1}{k}\right)$$

where

CF	constant cash flow
k	discount rate, assumed to be constant over time
n	number of cash flows

3.1.2 Capital Budgeting

3.1.2.1 Investment Decision Criteria

Net Present Value

$$\text{NPV} = -I_0 + \sum_{t=1}^{N} \frac{E(FCF_t)}{(1+WACC_t)^t}$$

where

I_0	initial investment
$E(FCF_t)$	expected free cash flows in period *t*
$WACC_t$	weighted average cost of capital in period *t*
N	number of cash flows
NPV	Net Present Value

3.1.2.2 Cost of Capital

Cost of Equity Capital

<u>CAPM</u>

$$k_E = R_f + \left(R_M - R_f\right) \cdot \beta_E$$

where

k_E	cost of equity capital
R_f	risk-free return
$R_M – R_F$	expected return on the market portfolio – risk-free return, expected Risk premium
β_E	beta equity = systematic or market risk of equity

The beta equity (β_E) can be calculated using the following formula:

$$\beta_A = \beta_D \frac{D(1-t_c)}{D(1-t_c)+E} + \beta_E \frac{E}{D(1-t_c)+E}$$

where

β_A	beta asset
β_D	beta debt
β_E	beta equity
t_c	marginal corporate tax rate for the firm being valued
D	market value of interest-bearing debt
E	market value of equity

If we assume that the debt is riskless ($\beta_D = 0$) the beta of the firm's asset can be written as:

$$\beta_A = \beta_E \frac{E}{D(1-t_c)+E}$$

In this case, the beta equity (β_E) can be written as:

$$\beta_E = \beta_A\left(1 + \left(1-t_c\right) \cdot \frac{D}{E}\right)$$

with

beta asset = $\beta_A = \beta_{Unlevered}$
beta equity = $\beta_E = \beta_{Levered}$

Modigliani-Miller

$$k_E = \quad k_u + (k_u - k_d)(1-T) \cdot \frac{D}{E}$$

where

k_E	cost of equity (required return on equity)
k_u	equity rate of return were the company 100% equity
k_d	cost of debt (required return on debt)
T	statutory marginal tax rate
D	debt (market value)
E	equity (market value)

Zero Growth Model

$$k_E = \frac{Div}{P_0}$$

where

k_E	cost of equity capital
Div	dividend (assumed constant)
P_0	price of share

Constant Growth Model

$$k_E = \frac{Div_1}{P_0} + g$$

where

k_E	cost of equity capital
g	growth rate of dividend
Div_1	$Div_0 \cdot (1+g)$ = expected dividend in period 1
P_0	market price of share

Earnings-Price Ratio Approach

$$k_E = \frac{EPS_1}{P}$$

where

k_E	cost of equity capital
EPS_1	expected earnings per share in t=1
P	current market price of share

Gordon Shapiro Model

$$k_E = \frac{EPS_1 \cdot \pi}{P_0} + (1-\pi) \cdot ROE$$

where

k_E	cost of equity capital
EPS_1	earnings per share in t=1
π	payout ratio
P_0	price of share
ROE	return on equity

Cost of Debt Capital

Cost of Debt Capital before Taxes

- CAPM

$$k_D = R_f + \left(R_M - R_f\right) \cdot \beta_D$$

where

k_D	cost of debt capital (expected return on debt)
R_f	risk-free return
$R_M - R_f$	expected excess return on the market portfolio
β_D	beta debt = systematic or market risk of debt

- Yield to Maturity

$$k_D = \sum_{i=1}^{N} w_i \cdot YTM_i$$

where

k_D	cost of debt capital
w_i	weight of debt i
YTM_i	yield to maturity of debt i

Cost of Debt Capital after Taxes

$$k_{DA} = k_D \cdot (1 - t_c)$$

where

k_{DA}	cost of debt capital after taxes
k_D	cost of debt capital before taxes
t_c	marginal corporate tax rate

Weighted Average Cost of Capital (WACC)

$$WACC = k_D(1-t_c)\frac{D}{V} + k_E\frac{E}{V}$$

where

k_D	pre (corporate) tax cost of debt
k_E	cost of equity
t_c	marginal corporate tax rate for the entity being valued
D	market value of interest-bearing debt
E	market value of equity
V	$=E + D$

If the firm has preferred stock, *WACC* becomes:

$$WACC = k_D(1-t_c)\frac{D}{V} + k_E\frac{E}{V} + k_P\frac{P}{V}$$

where

k_P	after tax cost of preferred stock
P	market value of preferred stock
V	$= E + D + P$ (here)

Corporate Taxes, Interest Subsidy and Cost of Capital

Average Tax Rate

$$t = \textit{average tax rate} = \frac{\textit{Taxes}}{\textit{Earnings before taxes}}$$

Average Interest Rate

$$\underline{i} = \text{average interest rate} = \frac{\text{Interest payments}}{\text{Debt}}$$

Value of Tax Shield

$$\textit{Value of tax shield} = \frac{k_D \cdot D \cdot t_c}{k_D} = D \cdot t_c$$

where

D	market value of debt
k_D	cost of debt
t_C	marginal average corporate tax rate

3.2 Short-Term Finance Decisions

3.2.1 Short-Term Financing

3.2.1.1 Current Asset Financing

Net Working Capital

Net Working Capital = Current assets – Current liabilities

where

Current assets = cash + receivable + inventories

3.2.2 Cash Management

Inventory Turnover

$$\frac{\text{Cost of goods sold}}{\text{Inventory}}$$

Accounts Receivable Turnover

$$\frac{\text{Sales}}{\text{Accounts receivable}}$$

Accounts Payable Turnover

$$\frac{\text{Material purchases}}{\text{Accounts payable}}$$

Inventory Period

$$\frac{\text{365 (or 360) days}}{\text{Inventory turnover}}$$

Accounts Receivable Period

$$\frac{\text{365 (or 360) days}}{\text{Accounts receivable turnover}}$$

Accounts Payable Period

$$\frac{\text{365 (or 360) days}}{\text{Accounts payable turnover}}$$

Operating Cycle

Inventory period + Accounts receivable period

Cash Conversion Cycle

Operating Cycle - Accounts payable period

Average Collection Period

$$\frac{Accounts\ Receivable \cdot 365}{Sales}$$

Optimal Cash Balance (Baumol Model)

$$\sqrt{\frac{2FC}{I}}$$

where

F	fixed cost incurred when selling securities to raise cash
C	annual cash disbursement
I	annual interest earned on the marketable securities portfolio

Target Cash Balance (Miller-Orr model)

$$Target\ Cash\ Balance = Z = \left[\frac{3F\ \sigma^2}{4\ I_{daily}}\right]^{\frac{1}{3}} + L$$

where

F	fixed cost of buying and selling securities
σ^2	variance of the net daily cash flows
L	lower control limit, determined by the firm
I_{daily}	opportunity cost of holding cash

3.3 Capital Structure and Dividend Policy

3.3.1 Leverage and the Value of the Firm

Free Cash Flow Approach

$$V = -I_0 + \sum_{t=1}^{N} \frac{\mathbf{E}(FCF_t)}{(1+WACC_t)^t}$$

where

V	value of the firm
$\mathbf{E}(FCF_t)$	expected free cash flows in period *t*
$WACC_t$	weighted average cost of capital in period *t*

With **the continuing value (terminal value) of the firm at time *T*** equal to:

$$\text{Continuing value at time } T = \frac{FCF_{T+1}}{WACC - g}$$

where

T	point in time where the explicit free cash flow forecasting horizon ends
FCF_{T+1}	level of expected free cash flow in the first year after the explicit forecast period; then assumed to grow at rate g
$WACC$	weighted average cost of capital (assumed constant)
g	expected growth rate of free cash flows after T (assumed constant)

Firm Value

$$V = D + E$$

where

V	value of the firm
D	debt (market values)
E	equity (market values)

MM Proposition I (assuming no taxes)

$$V = V_L = V_U = D + E = \frac{EBIT}{k_A}$$

where

V_L	value of levered firm
V_U	value of unlevered firm
D	debt (market values)
E	equity (market values)
$EBIT$	earning before interest and taxes (assumed permanent)
k_A	constant overall cost of capital (return on assets)

4. Economics

4.1 Macroeconomics

4.1.1 Measuring National Income and Prices

GNP

$$Y = C + I + G + \left(X - M\right) + NIRA$$

where:

Y	GNP
C	private consumption
I	investment
G	government expenditure
X	exports
M	imports
$NIRA$	net income received from abroad
$X - M + NIRA$	current account balance

National Saving and Current Account Balance

$$\begin{aligned} CA &= S^P + S^G - I \\ &= S^P - BD - I \end{aligned}$$

where

CA	current account balance
S^P	private saving
S^G	government saving
$S^P + S^G$	national saving (*S*)
BD	budget deficit
I	investment

Price Index: GDP (implicit price) Deflator and Consumer Price Index (CPI)

$$GDP\ deflator_t = \frac{Nominal\ GDP_t}{Real\ GDP_t} \cdot 100 = \frac{\sum_{it} p_{it} \cdot q_{it}}{\sum_i p_i^* \cdot q_{it}} \cdot 100$$

$$CPI_t = \frac{\sum_i p_{it} \cdot q_i^*}{\sum_i p_i^* \cdot q_i^*} \cdot 100$$

where

p_{it}	price of final good or service *i* in year *t*
q_{it}	quantity of final good or service *i* in year *t*
p_i^*	price of final good or service *i* in the base year
q_i^*	quantity of final good or service *i* in the representative basket

Inflation Rate

$$\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

where

P_t	(index) price level at time *t*
P_{t-1}	(index) price level at time *t*-1
π_t	inflation rate over period *t*-1 to *t*

Ex-post Fisher Parity

$$r_t \approx i_t - \pi_t$$

where

r_t	real interest rate for the period (*t*-1, *t*)
i_t	nominal interest rate for the period (*t*-1, *t*)
π_t	inflation rate for the period (*t*-1, *t*)

4.1.2 Equilibrium in the Real Market

Consumption Function

$$C^D = c_0 + MPC(Y - T)$$

where:

C^D	desired consumption
c_0	constant intercept term
MPC	marginal propensity to consume
$Y - T$	disposable income with $T = T(Y)$

Desired Investment

$$I^D = Y - C^D - G$$

where:

I^D	desired investment
C^D	desired consumption
G	government expenditure
Y	output

Budget Surplus

$$BS = T - (G + TR + NINT)$$

where:

BS	budget surplus
T	taxation
TR	transfer payments
$NINT$	net interest payments on public debt
G	government expenditure

Government-Purchases Multiplier

$$Y = \frac{c_o}{1-MPC} - \frac{MPC}{1-MPC} \cdot T + \frac{1}{1-MPC} \cdot I + \frac{1}{1-MPC} \cdot G$$

where:

c_0	constant intercept term of the consumption function
MPC	marginal propensity to consume
T	taxation
I	investment
$\frac{1}{1-MPC}$	government-purchases multiplier
G	government expenditure
Y	output

IS Relation

$$Y = C(Y-T) + I(i) + G,$$

where:

Y	output
$C(.)$	private consumption function
$Y-T$	disposable income
$I(.)$	investment function
i	interest rate
G	government expenditure

Equilibrium Condition for the Market for Goods and Services

$$I + G = S + T,$$

where:

I	investment
G	government expenditure
S	saving
T	taxation

4.1.3 Equilibrium in the Money Market

4.1.3.1 Demand for Money

$$\frac{MD}{P} = L(Y,i) = b_0 + b_1 \cdot Y - b_2 \cdot i,$$

where:

MD	nominal money demand
P	general price level
$L(.)$	demand function
Y	real income (output)
i	nominal interest rate
b_0	constant parameter
b_1, b_2	positive parameters

4.1.3.2 Equilibrium Relationship in the Monetary Market: LM Curve

$$\frac{MS}{P} = \frac{MD}{P} \equiv L(Y,i),$$

where:

MS	nominal money supply (exogenous)
MD	nominal money demand
P	general price level
$L(.)$	demand function
Y	real income (output)
i	nominal interest rate

4.1.4 Equilibrium in Economy and Aggregate Demand

4.1.4.1 Aggregate Demand

$$AD = Y = C^D + I^D + G,$$

where:

AD	aggregate demand
Y	real income (output)
C^D	desired consumption
I^D	desired investment
G	government expenditure

Quantity Theory of Money (Absolute Form)

$$M \cdot V = P \cdot Y,$$

$$\Rightarrow P = \frac{M \cdot V}{Y},$$

where:

M	quantity of money
V	velocity, a measure of turnover of money stock in a year
P	general price level
Y	real income (output)

4.1.5 Aggregate Supply and Determination of Price of Goods/Services

4.1.5.1 Aggregate Supply Relation (short-run)

$$P = E(P) \cdot (1+\mu) \cdot F(1 - \frac{Y}{L}, z),$$

where:

P	price level
$E(P)$	expected price level
□	markup variable
$F(.)$	function
Y	output
L	labor force
z	catchall variable

4.2 Macro Dynamics

4.2.1 Inflation

Expectations-Augmented Phillips Curve

$$\pi_t = \pi_t^e + \alpha - \beta(u_t - u_t^*),$$

where:

π_t	inflation rate
π_t^e	expected inflation rate for time *t*
α	constant parameter
β	constant positive parameter
$u_t - u_t^*$	cyclical unemployment (or "Keynesian" unemployment) at time *t*

4.2.2 Economic Growth

Aggregate Production Function

$$Y = A \cdot F(K, L),$$

where:

Y	aggregate output
A	total factor productivity
$F(.)$	aggregate production function
L	aggregate labour supply
K	aggregate capital stock

Growth Accounting Equation

$$\frac{\Delta Y}{Y} = \frac{\Delta A}{A} + \xi_K \cdot \frac{\Delta K}{K} + \xi_L \cdot \frac{\Delta L}{L},$$

where:

$\frac{\Delta Y}{Y}$	growth of the output
$\frac{\Delta A}{A}$	growth in productivity
$\frac{\Delta K}{K}$	growth of the capital stock
$\frac{\Delta L}{L}$	growth of the labour supply
$\xi_K = \frac{K}{F(K,L)} \cdot \frac{\partial F(K,L)}{\partial K}$	elasticity of output with respect to capital

$$\xi_L = \frac{L}{F(K,L)} \cdot \frac{\partial F(K,L)}{\partial L}$$ elasticity of output with respect to labour

4.2.3 Business Cycles

Random Productivity Shocks

$$Y_t = F(K_t, L_t) \cdot A_t \varepsilon_t,$$

where:

Y_t	aggregate output at time t
$F(.)$	aggregate function production
K_t , L_t	aggregate capital and labour supply at time t
ε_t	random productivity shock at time t
$A_t \varepsilon_t$	total factor productivity at time t

4.3 International Economy and Foreign Exchange Market

4.3.1 Open Macro Economics

4.3.1.1 International Balance of Payment and Capital Flows

Balance of Payments Accounting

$$BP = CA + KA - \Delta RA,$$

where:

BP	balance of payments
CA	current account
KA	capital account
ΔRA	official reserve account

Government-Purchases Multiplier in an Open Economy

$$\Delta Y = \frac{1}{1 - MPC + m_1} \cdot \Delta G,$$

where:

ΔY	variation of the output
m_1	positive constant parameter (marginal propensity to import)
MPC	marginal propensity to consume
ΔG	variation of the government expenditure

IS Relation in an Open Economy

$$Y = C + I + G - S_{real} \cdot M + X \ ,$$

where:

Y	output
C	private consumption
I	investment
G	government expenditure
S_{real}	real exchange rate
X	exports
M	imports in foreign currency

Equilibrium Condition for the Goods and Services Market in an Open Economy

in terms of GDP:

$$NX = S + (T - G) - I,$$

in terms of GNP:

$$CA = S + (T - G) - I,$$

where:

NX	net exports
CA	current account balance
S	private saving
T–G	public saving
I	investment

Real Exchange Rate

$$S_{real} = \frac{S_n \cdot P^F}{P},$$

where:

S_n	nominal spot exchange rate (in American terms)
P^F	foreign general price level in foreign currency
P	domestic general price level in domestic currency

Trade Balance and Depreciation: the Marshall-Lerner Condition

$$\frac{\Delta X}{X} - \frac{\Delta M}{M} - \frac{\Delta S_{real}}{S_{real}} > 0.$$

where:

$\frac{\Delta X}{X}$	proportional change in exports
$\frac{\Delta M}{M}$	proportional change in imports
$\frac{\Delta S_{real}}{S_{real}}$	proportional change in the real exchange rate

Equilibrium Model of an Open Economy, the Mundell-Fleming Model

$$\mathrm{Y} = \mathrm{C}(\mathrm{Y} - \mathrm{T}) + \mathrm{I}(\mathrm{i}) + \mathrm{G} + \mathrm{NX}(\mathrm{Y}, \mathrm{Y_F}, \frac{\mathrm{E}(\mathrm{S_n})}{1 + \mathrm{i} - i_F}) \text{ ,}$$

$$\frac{MS}{P} = \frac{MD}{P} = L(Y, i).$$

where:

Y	output
C(.)	consumption
T	taxation
I(.)	investment function
i	interest rate
G	government expenditure
NX(.)	net exports function
Y_F	output in the rest of the world
i_F	foreign nominal interest rate
$E(S_n)$	expected nominal spot exchange rate (in American terms)
MS	nominal money supply
MD	nominal money demand
P	general price level
L(.)	demand function

Aggregate Demand in an Open Economy (for the Mundell-Fleming Model with Fixed Exchange Rate)

$$AD = C(Y - T) + I(i - E(\pi)) + G + NX(Y, Y_F, \frac{S_n \cdot P^F}{P})$$

where:

$C(.)$	consumption function
Y	domestic output (income)
T	taxation
$I(.)$	investment function
i	domestic nominal interest rate
$E(\pi)$	expected inflation
G	government expenditure
$NX(.)$	net exports function
Y_F	foreign output (income)
$\bar{S}_n$	nominal fixed exchange rate
P, P^F	domestic and foreign prices level

4.3.2 Foreign Exchange Rate

Absolute Purchasing Power Parity

$$S_t = \frac{P_t}{P_t^F},$$

where:

S_t	nominal spot exchange rate at t
P_t^F	foreign general price level in foreign currency at t
P_t	domestic general price level in domestic currency at t

Relative Purchasing Power Parity

$$s_t = \frac{S_t - S_{t-1}}{S_{t-1}} = \frac{(1+\pi_t)}{(1+\pi_t^F)} - 1 \approx \pi_t - \pi_t^F,$$

where:

s_t	relative spot exchange rate over period t-1 to t
S_t	nominal spot exchange rate at t
π_t^F	foreign inflation rate over period t-1 to t
π_t	domestic inflation rate over period t-1 to t

Covered Interest Rate Parity (CIP)

$$\frac{F_{t-1,t}}{S_{t-1}} - 1 = \frac{1+i_t}{1+i_t^F} - 1 \approx i_t - i_t^F \ ,$$

where:

$\frac{F_{t-1,t}}{S_{t-1}} - 1$	relative forward foreign exchange rate premium
$F_{t-1,t}$	forward foreign exchange rate over period *t*-1 to *t*
S_{t-1}	nominal spot exchange rate at *t*-1
i_t^F	foreign nominal interest rate over period *t*-1 to *t*
i_t	domestic nominal interest rate over period *t*-1 to *t*

Uncovered Interest Rate Parity (UIP)

$$\frac{E(S_t)}{S_{t-1}} - 1 = \frac{1+i_t}{1+i_t^F} - 1 \approx i_t - i_t^F \ ,$$

where:

$\frac{E(S_t)}{S_{t-1}} - 1$	expected relative depreciation of the domestic currency
i_t^F	foreign nominal interest rate over period *t*-1 to *t*
i_t	domestic nominal interest rate over period *t*-1 to *t*

Monetary Approach

- The central bank's balance sheet identity

$$MS = B^C + S_n \cdot R^F + N,$$

where:

MS	home money supply, which is assumed to consist only of monetary base
B^C	central bank's holdings of home securities (constant term)
S_n	exchange rate
R^F	central bank's international reserve holdings in units of foreign currency
N	net worth (the residual), constant term

Balance of payments identity in terms of official reserve and value of the trade balance:

$$\Delta R^F = P^F \cdot T,$$

where T is the trade balance (i.e. $T = Y - E$, where E is the home expenditure), and P^F is the foreign price level.

- Link between the trade balance and the flows of money (BC and N are held constant, S_n is fixed):

$$\Delta MS = P \cdot T,$$

where P is the home currency price.

- The condition for money market equilibrium

$$\frac{MS}{P} = L\left(i, Y, \frac{w}{P}\right),$$

where w is the nominal value of privately held assets, $w = MS + B$, where B is the home interest bearing securities or bonds.

Overshooting Model: the Basic Equations

- $i = i^* + \dfrac{E(s_t - s_{t-1})}{s_{t-1}},$
- $\dfrac{E(s_t - s_{t-1})}{s_{t-1}} = -\theta \cdot (s - \bar{s}),$
- $m - p = \phi \cdot y - \lambda \cdot i$,
- $y = u + \delta \cdot (p^* + s - p) + \gamma \cdot y - \sigma \cdot i$,
- $\dfrac{p_t - p_{t-1}}{p_{t-1}} = \pi \cdot (y - \bar{y})$,

where:

i, i^*	the domestic and foreign interest rates
$E(.)$	expectation
s	the logarithm of the spot exchange rate measured in domestic currency per unit of foreign currency
$\bar{s}$	the long-run equilibrium level of s
m	the logarithm of the domestic money supply
p, p^*	are the logarithms of the domestic and foreign price levels
$y, \bar{y}$	the level of domestic real income (output) and the steady state level of y
$\phi, \lambda, u, \delta, \gamma, \sigma$	and π are constant parameters
θ	a model-consistent function of the other parameters

Portfolio Balance Approach

The nominal portfolio wealths of the home and foreign private sectors:

$$w = MS + B + S_n \cdot F,$$

$$w^* = MS^* + B^* \cdot \frac{1}{S_n} + F^*,$$

where $B + B^* = \overline{B}$, $F + F^* = \overline{F}$, and where:

w, w^*	the nominal portfolio wealths of the home and foreign private sectors
MS, MS^*	home and foreign money supply, which is assumed to consist only of monetary base
$\overline{B}$, $\overline{F}$	respectively denote the privately-held stocks of interest bearing claims on the home and foreign governments, referred to as bonds or securities
B^*, F^*	foreign residents privately-held stocks of interest bearing claims on the home and foreign governments
B, F	home residents privately-held stocks of interest bearing claims on the home and foreign governments
S_n	nominal exchange rate

The Risk Premium

$$\phi_t = i_t - i_t^* - \frac{E_{t-1}(S_t) - S_{t-1}}{S_{t-1}},$$

where:

i, i^*	the domestic and foreign interest rates
$E_{t-1}(.)$	expectation at time t-1
ϕ	represents a premium for bearing a composite of exchange rate risk and the difference in credit risks
S_t	nominal exchange rate at time t

4.3.3 Central Bank and Monetary Policy

Money Multiplier

$$M_1 = m \cdot M_0, \quad \text{with} \quad m = \frac{1+c}{c+\theta},$$

where:

M_1	money stock M_1
m	money multiplier
M_0	monetary base
c	the ratio of the demand for currency to the demand for sight deposit
θ	the ratio of reserves to sight deposits