The UK arm of Handelsbanken is another such organisation: it devolves the asset origination authority to the local branch manager, and the success of this firm shows that branch-based banking still has a future.

Irrespective of their intended strategy, operating model and customer franchise, for all ‘challenger’ banks there is one simple message: if you expect to survive and thrive, you will need to adopt this approach. Genuinely good customer service, and decision-making that is adaptable to local needs, are an imperative.

Of course while such a strategy is necessary, it is by no means sufficient. For the customer to be treated with respect as an individual and not a number, the bank also has to operate internally as an effective team. That means a high quality of management that is expert in the ‘soft’ skills of leadership and team-building. Too many of the senior executives one meets in this industry are excellent at bureaucracy and process, and implementing the latest consultant-developed HR fad, but lack even the slightest ability to inspire their people. This makes for a turgid atmosphere within the firm, which does nothing for customer service. Challenger banks take note.

In this issue we’re pleased to bring you yet again three diverse but very topical articles on different aspects of the markets. Don’t let the maths in Mr Lizzio’s paper put you off, he makes a very valid and practically worthwhile observation about the non-applicability of the tax benefit of orthodox corporate finance theory, as originally put forward by Modigliani and Miller. Firms looking to optimise their capital structure need to look less at tax benefits and more at what makes sense from a conservative balance sheet management perspective. Depending on one’s jurisdiction, there is something of genuine insight here.

One would not be surprised to learn that in the post-2008 economic environment the level of non-performing loans (NPLs) in the asset portfolios of European banks has been increasing. Michael Widowitz writes about the need to deploy more effective data analytics capability if one is to manage NPL portfolios more effectively, and this paper is required reading for any corporate banker.

Our final paper is something of a ‘learning curve’ piece for all firms that use derivatives, be they banks or institutional investors. Too often those turning to derivatives to hedge structural balance sheet risk are not aware of the correlation effects on derivative valuation, and this piece is an accessibly written attempt to plug this gap.

Enjoy the issue.

Professor Moorad Choudhry FCSI, Editor

ABOUT THE EDITOR

Moorad Choudhry FCSI FIFS is Professor at the Department of Mathematical Sciences, Brunel University and was latterly Treasurer, Williams & Glynn plc at the Royal Bank of Scotland. He is also Honorary Professor, Kent University Business School and Visiting Teaching Fellow, Department of Management, Birkbeck, University of London.

Professor Choudhry is Managing Editor of the International Journal of Monetary Economics and Finance and on the Editorial Boards of Qualitative Research in Financial Markets and American Securitization.

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REVIEW OF FINANCIAL MARKETS

A REVISITED VERSION OF THE COST OF CAPITAL: THE IRRELEVANCE OF THE PARTIAL INTEREST TAX DEDUCTIBILITY ON INVESTMENT AND FINANCING DECISIONS

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ABSTRACT

The purpose of this paper is to investigate the interest tax deductibility effect on cost of capital under earning stripping rules recalling Modigliani-Miller’s theorem (1958, 1963). In fact, Italy’s corporate taxation, as other countries, does not allow to fully deduct interest expenses of debt but it imposes a threshold by linking the interest tax deductibility to the ebitda driver. This limit could reduce the tax shield benefit for firms with higher financial leverage, creating a misconception about optimal capital structure and firm value.

The findings have led to an adjustment of the weighted average cost of capital (WACC) formula analysing the single and multi-period analysis by which in both cases the limitation is irrelevant in terms of optimal capital structure decision and firm value.

SECTION I: INTRODUCTION

In 1958, Modigliani and Miller made an important contribution to the financial community, developing assumptions about financing behaviour. In their classic article they showed the first proposition, known as ‘Irrelevance Proposition’, in which, in perfect capital markets without taxes and transaction costs, the capital structure choice does not affect firm value. In the second proposition, reinforced in the ‘Tax Correction article’ (1963), they argued that the firm value is not independent from the capital structure, which any tax-paying corporation gains by borrowing, that is, the greater the marginal tax rate, the greater the gain (Myers 1984).

Other authors interpreted the capital structure; for instance, Miller (1977) asserted that tax benefit is overstated if we do not consider the personal income taxation. Another important contribution comes from Kraus and Litzenberger (1973), concluding that in a firm with increasing leverage the tax shield advantage is compensated by increased probability of default, or by enhancing bankruptcy costs. Thus, additional leverage adds value until the value of tax shields matches bankruptcy costs.

However, the borrowing does not depend only on the tax benefit but also on the ability to cater for the different interests between management and shareholders. In this sense, Jensen (1986) called it ‘control hypothesis’ which represents the threat that not being able to repay debt makes the management more disciplined and more credible than if they promise future cash return to shareholders (dividends or stock buy-backs).

SECTION II: THE EFFECT OF CAPITAL STRUCTURE ON FIRM VALUE UNDER FULL-DEDUCTIBILITY (FD) HYPOTHESIS

Back to Modigliani and Miller’s theory, in a valuation with taxes the cost of capital seems unaffected by the change of debt, therefore any benefits substituting cheaper debt for more expensive equity are offset by increases in both their costs (Damodaran 2010). However, empirical evidence shows the existence of the optimal capital structure for which the benefit of debt may be greater than cost of debt.

Moreover, the optimal capital structure is not equal for any firm, but it is influenced in several aspects as:

- marginal tax rate: the level of tax rate determines the level of tax advantage;
- deductibility: the level of tax benefit depends on the degree of interest tax deduction;
- type of firm: the type of firm is a crucial element which determines the capability to raise debt and repay it according to the variability of cash flows;
- flexibility: the excess of debt reduces the financial flexibility;
- cost of debt and credit crunch: the cost of debt and availability of resources depend also on macro-economic factors, that can make it more difficult to reach the target capital structure;
- agency costs: the greater the separation between management and shareholders, the greater the need for debt discipline.

At the basis of Modigliani and Miller’s propositions, the central role is given to the after taxes operating profit, which represents an uncertain stream. In fact, the volatility in operating earning is related to both, the capability to cover interest payments and tax advantage. Differently, according to Modigliani and Miller (1963), the tax shield is a certain flow. However, this is not always true because the tax shield benefit is tightly linked to the level of ebit. For instance, negative ebit could reduce, possibly substantially, any benefits from interest tax shield (Miller 1988). Consequently, according to Modigliani and Miller’s theorem, the value of a firm in a world with taxes is equal to the following formula:

\[ V_d = \frac{\text{NOPAT}}{\text{WACC}} = \frac{\text{EBIT}(1 - t_c)}{K_E} + \frac{\text{I}_t}{K_D} \]

(1)

where \( V_d \) is the value for a levered firm, NOPAT is the net operating profit after taxes, WACC is the cost of capital, EBIT is the earning before interest and taxes, \( t_c \) is the corporate tax rate, \( K_E \) is the unlevered cost of equity, \( I_t \) are interest expenses on debt and \( K_D \) is the cost of debt.

Thus, after these academic underpinnings, the example about the optimal capital structure under full-deductibility hypothesis is based on the following assumptions²:

- we reject the hypothesis of perfect capital markets where financing decisions affect firm value;
- we suppose ten scenarios with a different debt ratio. We also suppose the ability of the company to borrow and raise debt until the last scenario with a maximum weight of debt of 90%;
- we suppose that in each scenario the cost of debt is refinanced at the new cost of debt rate;
- we refuse that the tax shield acts as a cash flow before taxes.
- We also believe in my career.

1 The author acknowledges the helpful contribution of Giorgio Luraschi (Senior Analyst at Deloitte Financial Advisory – Valuation Services – Milan Office) and Andrea Gallucci (Bocconi University). This paper is dedicated to Professor Alberto Falini and another Professor of Finance who believed in my career.

2 As introduced, the assumptions are valid in perfect capital markets where a firm’s financing decisions have no effect on its market value and its financing decisions have no consequence to its security holders (Fama 1978).

3 The condition is satisfied with two requirements: first, the tax shield is always obtained through taxable income and when the latter is negative it should be carried backward or forward; second, the tax rate must remain the same. Differently, according to Miles and Ezzell (1980, 1985), since the future asset value is uncertain, then the value of tax shields is also uncertain.

4 In this case the ebit is assimilated as a cash flow before taxes.

5 All values are assumed in euro currency.
the cost of debt increases as the leverage enhances; 
the ebitda and ebit are equal for each scenario; 
the marginal tax rate is the same for each scenario; 
the interest expenses on debt are fully tax deductible; 
we do not consider interest income on cash.

Therefore, starting with the single-period analysis, the example assumes for each scenario an ebitda equal to 140, an ebit equal to 110 and a NOPAT equal to 80. The balance sheet considers an enterprise value equal to 1000. Table 1 shows the results from the analysis. The $K_{EU}$ (unlevered cost of equity) is obviously the same in every scenario. Conversely, a greater leverage causes an increased $K_{EL}$ (levered cost of equity). With these assumptions WACC and firm value are respectively minimised and maximised in the fifth scenario (debt ratio of 40%) with a value of 2,195. The multi-period analysis is related to the Myers' assertion (1984), defined static trade-off framework, that is, supposing to substitute debt for equity until the firm value is maximised and maintain the leverage on hedge of the asset life. Thus, the firm value is determined considering every scenario as a future year of the overall time horizon. Discounting the cash flows at the same WACC used in the single-period analysis, the present value is equal to 517. See Table 1 below.

Table 1 Cost of capital and firm value under full-deductibility hypothesis.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>D/D+E</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
<td>70%</td>
<td>80%</td>
<td>90%</td>
</tr>
<tr>
<td>$K_{EU}$</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
</tr>
<tr>
<td>$K_{EL}$</td>
<td>8.0%</td>
<td>8.3%</td>
<td>8.7%</td>
<td>9.2%</td>
<td>9.9%</td>
<td>10.9%</td>
<td>12.4%</td>
<td>14.6%</td>
<td>16.9%</td>
<td>19.6%</td>
</tr>
<tr>
<td>After-tax $K_0$ (FD)</td>
<td>1.7%</td>
<td>1.7%</td>
<td>1.7%</td>
<td>2.0%</td>
<td>2.5%</td>
<td>4.0%</td>
<td>6.7%</td>
<td>8.3%</td>
<td>8.3%</td>
<td>8.3%</td>
</tr>
<tr>
<td>WACC (FD)</td>
<td>8.0%</td>
<td>7.7%</td>
<td>7.3%</td>
<td>7.0%</td>
<td>6.7%</td>
<td>8.2%</td>
<td>9.9%</td>
<td>9.9%</td>
<td>10.6%</td>
<td>10.9%</td>
</tr>
<tr>
<td>Interest Tax Deductible</td>
<td>0</td>
<td>2.4</td>
<td>4.8</td>
<td>7.2</td>
<td>10.8</td>
<td>13.7</td>
<td>17.6</td>
<td>22.7</td>
<td>28.8</td>
<td>32.5</td>
</tr>
<tr>
<td>Marginal Tax Rate</td>
<td>27.5%</td>
<td>27.5%</td>
<td>27.5%</td>
<td>27.5%</td>
<td>27.5%</td>
<td>27.5%</td>
<td>27.5%</td>
<td>27.5%</td>
<td>27.5%</td>
<td>27.5%</td>
</tr>
<tr>
<td>Value of Tax Shields</td>
<td>0</td>
<td>0.7</td>
<td>1.3</td>
<td>2.0</td>
<td>3.0</td>
<td>10.3</td>
<td>15.3</td>
<td>20.7</td>
<td>25.3</td>
<td>28.5</td>
</tr>
<tr>
<td>Firm Value (FD)</td>
<td>1,643</td>
<td>1,761</td>
<td>1,898</td>
<td>2,058</td>
<td>2,195</td>
<td>1,589</td>
<td>1,377</td>
<td>1,193</td>
<td>1,082</td>
<td>1,038</td>
</tr>
<tr>
<td>Firm Value as PV of Cash Flows (FD)</td>
<td>517</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Personal elaboration.

Figure 1 WACC, debt ratio and firm value.

As we know, the rating is attributed by considering quantitative and qualitative elements. In this case, we simply determine the rating and spread on debt by adopting the interest coverage ratio which is strictly linked to the level of ebit. However, it creates a circular reasoning in calculating the cost of debt because it needs the spread on debt, and consequently, the spread on debt needs the rating, determined from the level of interest expenses to ebit.

We refer to the corporate income tax for Italy equal to 27.5%.

The firm value is calculated through the DCF model in hypothesis of stable growth firm as follows: $\text{Firm value} = \frac{\text{NOPAT} \times (1 + g)}{WACC - g}$, where $g$ is assumed 3%.

In this analysis, the firm value is the present value of expected cash flows (ten periods) calculated as follows: $\sum_{t=1}^{10} \frac{\text{NOPAT}_t}{(1 + \text{WACC})^t}$.
I PD partial and full-deductibility hypothesis, match this disadvantage; for instance, the excess of ebitda capacity on with the excess not deductible. However, there are several issues that characterize doubts and misconceptions about what the effect is in terms of value added. In a better way, the unlevered DCF model, as used in the prior example, highlights the advantage to borrow from the minimisation of WACC. Thus, usually the WACC is applied adopting the marginal tax rate without considering the partial interest tax deductibility. This carelessness does not create any difference below the threshold; after that, the tax shield into WACC formula does not reflect the required return, overestimating the firm value.

A. Single-period analysis

In the single-period analysis, we consider the same assumptions adopted in Section II. Conversely, we edit the WACC by taking into account the lower tax benefit on cost of debt. In fact, the tax shield on debt is steady while the corporate income tax decreases as the leverage increases. Thus, since the deductibility is not a simple percentage on cost of debt but it is linked to the size of ebitda and interest expenses, this means that there is not a static way to correct the WACC and in numerical terms it changes firm by firm. In other words, the WACC formula should be modified for a lower tax advantage through the following tax rate formulas:

First formula

The first formula suggests the adjusted tax rate for $K_e$ as the ratio between $T_o$ and $\pi_{PD}$, where $t_o$ is the adjusted tax rate for $K_e$, $T_o$ is the corporate tax rate, $\pi_{PD}$ and $\pi_{FD}$ are respectively the taxable income under partial and full-deductibility hypothesis, $T_o$ and $T_F$ are respectively the taxes paid under partial and full-deductibility hypothesis, $t_o$ and $t_F$ are respectively the interest tax deductible under partial and full-deductibility hypothesis, $TSL$ is the tax shield lost and $I_o$ or $I_D$ are the interest expenses.

While for the numerator the marginal tax rate is multiplied by the taxable income, under the full-deductibility hypothesis, where it is the difference between debt and interest expenses, the denominator (which is the taxable income under partial-deductibility hypothesis) is the result between ebit and the minimum of the limit of 30% on ebitda and interest expenses on debt. In other words, before the limit the function considers all interest expenses; when the limit is overcome the interest tax deductible is limited to 30% of ebitda:

$$t_c(\text{adj}) = \frac{t_c \cdot \text{ebit} - rD}{\text{ebit} - \min(0.3 \cdot \text{ebitda}; rD)} = \frac{t_c \cdot \pi_{FD}}{t_c \cdot \pi_{PD}} = \frac{T_P}{\pi_{PD}}$$

Or equivalently, at numerator the taxes paid under full-deductibility hypothesis are equal to the taxes paid under partial-deductibility hypothesis less the difference between the value of tax shields in both hypotheses:

$$= \frac{T_P - t_c (I_D - \pi_{PD})}{\pi_{PD}} = \frac{T_P - (t_c I_D - (t_c I_F))}{\pi_{PD}}$$

that is, for a given level of debt, the adjusted tax rate for $K_e$ is the ratio between the taxes paid under partial-deductibility hypothesis less the tax shield lost and taxable income under partial-deductibility hypothesis. Consequently, the marginal tax rate is adjusted by the ratio between tax shield lost and taxable income under partial-deductibility hypothesis:

$$\frac{T_P - TSL}{\pi_{PD}} = \frac{T_P - TSL}{\pi_{PD}} = t_c - \frac{TSL}{\pi_{PD}}$$

(2)

Second formula

The second formula is obtained through the one proposed by Damodaran (2010) when interest expenses are greater than operating income. In fact, the formula is defined as the ratio between $MTS$ (maximum tax shield) and $I$ (interest expenses):

$$t_c(\text{adj}) = \frac{MTS}{I}$$

(3)

where the $MTS$ is the tax benefit from the interest tax deduction obtained under partial-deductibility hypothesis as follows:

$$MTS = \min(0.3 \cdot \text{ebitda}; rD) t_e$$

(4)

In this formula, the marginal tax rate is proportionally adjusted by the ratio of maximum interest tax deductible to interest expenses, defined as $\pi$ (Deductibility Interest Factor):

$$t_c(\text{adj}) = \frac{\min(0.3 \cdot \text{ebitda}; rD)}{rD} t_e = \frac{l_{PD}}{I} t_e = \pi t_e$$

(5)

Empirically, both formulations give the same effect, decreasing the marginal tax rate as interest expenses become not fully deductible. Thus, a reduction of tax rate, and hence, a loss of tax shields, implies a greater cost of capital than the one exposed in Section II, making inevitable the adjustments.

First of all, if the comparable method\textsuperscript{12} for beta calculation has been used, the adjustment should be made on cost of equity through the Hamada’s formula (1969):

$$K_{EL} = R_F + (R_M - R_F) \beta_L$$

(6)

where the levered beta is equal to:

$$\beta_L = \beta_U \left[ 1 + (1 - t_c(\text{adj})) \frac{D_t}{E_t} \right]$$

(7)

Secondly, the tax rate adjustment is implemented into WACC\textsuperscript{13} formula:

$$WACC = K_{EL} \frac{E_t}{D_t + E_t} + K_{D(\text{adj})} \frac{D_t}{D_t + E_t}$$

(8)

where the after-tax cost of debt is calculated as follows:

$$K_{D(\text{adj})} = \text{pre-tax} K_D (1 - \alpha t_e) = \text{pre-tax} K_D (1 - t_c(\text{adj}))$$

(9)

Back to the example, the central point is the loss of tax shields after the

\textsuperscript{10} Net of interest income on cash.
\textsuperscript{11} When net interest expenses are lower than limit (0.3ebitda).
\textsuperscript{12} The comparable method extracts the unlevered or asset beta from comparable firms or industry average and it is adjusted for the different degree of financial leverage and marginal tax rate. The adjustment on beta is not useful if other methods have been used, such as regression method, unless the degree of financial leverage of the company is changed.
\textsuperscript{13} $D =$ Debt, $E =$ Equity, $\beta_L =$ Levered Beta, $\beta_U =$ Unlevered Beta, $R_s =$ Risk Free Rate, $R_M =$ Market Return.
threshold in which, as Table 2, after the sixth scenario there is a difference between partial and full deductibility. This difference is due to lower interest tax deductible under partial-deductibility hypothesis.

In fact, while in the case of full deductibility the tax shield increases until the tenth scenario with a value of 28.5, in the partial deductibility, the tax shield becomes flat once it exceeds the limit, maintaining a steady value of 11.6. Therefore, because the tax shield does not follow the growth of debt, this confirms the inclusion of the tax-rate adjustment into WACC formula. See Table 2 below.

Observing Table 2, the tax-rate adjustment creates differences after the sixth scenario for the following key-drivers: the \( K_{ue} \) (unlevered cost of equity) is the same because it is not influenced from the capital structure; differently, the higher cost of debt due to lower marginal tax rate makes the \( K_{el} \) (levered cost of equity) and WACC more expensive. For instance, in the seventh scenario the WACC under full deductibility is equal to 8.96% while in this case it is equal to 9.50%.

What is the effect of the partial-interest deductibility on firm value? Comparing the two hypotheses, that is, full and partial deductibility, the evidence is that after the limit there is a loss of tax shields, and hence, of firm value. This means that a firm with a higher degree of financial leverage will have a lower value. In fact, after the sixth scenario we find a different firm value, with the largest gap in the tenth scenario (806 for the partial deductibility, 1,038 for the full deductibility). However, as Figure 2 shows, because the capital structure is maximised at the same point in both hypotheses (debt ratio of 30% and 40%), and since until the sixth scenario there is no difference between partial and full deductibility in terms of tax shield and firm value, this proves that the partial deductibility does not influence the optimal capital structure choice, that is, it is irrelevant.

Figure 2. Firm value under partial and full-deductibility hypothesis.

Source: Personal elaboration.

Numerically, the best capital structure choice is in the fifth scenario with a value of 2,195.

**Lemma 1:** In the single-period analysis the optimal capital structure is at the same point for both hypotheses which is always before the loss of tax shields. After the limit, higher financial leverage determines a loss of value.

**Proof:** If interest expenses under partial deductibility hypothesis are less or equal than maximum interest tax deductible, that is:

\[ rD \leq 0.3 \text{ebitda} \]  

(10)

Table 2 Cost of capital and firm value under partial-deductibility hypothesis (single-period analysis).

<table>
<thead>
<tr>
<th>Scenario</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>6</th>
<th>7</th>
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<tr>
<td>DD+E</td>
<td>9%</td>
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<td>30%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
<td>70%</td>
<td>80%</td>
<td>90%</td>
</tr>
<tr>
<td>( K_{ue} )</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
<td>8.0%</td>
</tr>
<tr>
<td>( K_{el} )</td>
<td>8.0%</td>
<td>8.3%</td>
<td>8.7%</td>
<td>9.2%</td>
<td>9.6%</td>
<td>9.9%</td>
<td>9.9%</td>
<td>10.4%</td>
<td>10.9%</td>
<td>12.4%</td>
</tr>
<tr>
<td>After-tax ( K_{el} ) (PD)</td>
<td>1.7%</td>
<td>1.7%</td>
<td>1.7%</td>
<td>1.7%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
</tr>
<tr>
<td>WACC (PD)</td>
<td>8.6%</td>
<td>7.7%</td>
<td>7.3%</td>
<td>7.0%</td>
<td>6.7%</td>
<td>6.4%</td>
<td>6.1%</td>
<td>5.8%</td>
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<td>5.2%</td>
</tr>
<tr>
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<td>16.8</td>
<td>19.2</td>
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</tr>
<tr>
<td>Maximum Interest Tax Deductible [30%EBITDA]</td>
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<td>42.0</td>
<td>42.0</td>
<td>42.0</td>
<td>42.0</td>
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<td>42.0</td>
<td>42.0</td>
<td>42.0</td>
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<tr>
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<td>12.0</td>
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<tr>
<td>Value of Tax Shields (PD)</td>
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<tr>
<td>Tax Shield Lost</td>
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<td>0</td>
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<td>-9.1</td>
<td>-14.5</td>
<td>-20.0</td>
<td>-25.4</td>
</tr>
<tr>
<td>Firm Value (FD)</td>
<td>1,643</td>
<td>1,761</td>
<td>1,898</td>
<td>2,058</td>
<td>2,219</td>
<td>1,589</td>
<td>1,377</td>
<td>1,193</td>
<td>1,038</td>
<td>870</td>
</tr>
<tr>
<td>Firm Value (PD)</td>
<td>1,643</td>
<td>1,761</td>
<td>1,898</td>
<td>2,058</td>
<td>2,219</td>
<td>1,589</td>
<td>1,377</td>
<td>1,193</td>
<td>1,038</td>
<td>870</td>
</tr>
</tbody>
</table>

Source: Personal elaboration.

---

14 The tax rate adjustment is fundamental in order to underline the loss of value. In this sense, Fernández and Bilan (2007) advise not to use the statutory tax rate (marginal tax rate) in a levered company but the effective tax rate which is related to the cash flows.

15 In Appendix 2, Figure 3 shows the loss of tax shields.

16 See Table 4, Appendix 2.
there is not a loss of tax shields because the value of interest expenses under partial deductibility hypothesis is the same as the one under full deductibility hypothesis:

\[ TSL = 0, \text{ when } \alpha = \frac{\tau_{PD}}{\tau_{FD}} = 100\% \]  

(11)

that is, the taxes paid and taxable income are the same in both hypotheses as the first formula (2):

\[ t_{c(adj)} = \frac{\tau_{PD} - TSL}{\pi_{PD}} = \frac{\tau_{PD} - \tau_{FD}}{\pi_{FD}} = t_c \]  

(12)

and second formula (5), with \( \alpha \) of 100%:

\[ t_{c(adj)} = \alpha t_c = t_c \]  

(13)

therefore, because the optimal capital structure is always maximised before the limit, the two hypotheses have the same corporate tax rate and WACC:

\[ WACC_{PD} = WACC_{FD} \]  

(14)

or, the firm value under partial deductibility hypothesis is maximised at the same point of the firm value under full deductibility hypothesis.

\[ \max V_{PD} = \max V_{FD} \]  

(15)

Moreover, as Figure 2 shows, in this case the loss of tax shields is at the point at which the firm value in both hypotheses, partial and full deductibility, is lower than the one under all equity financing. This means that in both cases it should be favourable for an investor to shift wealth from debt to equity, making the partial interest deductibility irrelevant in terms of financing decisions.

B. Multi-period analysis

As shown in Section II, we determine the firm value in the multi-period analysis supposing every scenario \( t \) as a future year. Therefore, the purpose of this section is to investigate the impact of the partial-interest deductibility for which the firm value is defined as the present value of expected cash flows.

As exposed in the introduction of Section III, the art. 96 allows to carry forward the excess of ebita and hence to recover the loss of tax shields for years when the interest expenses will overcome the limit (30% ebita).

The excess of ebita is defined as the difference between maximum interest tax deductible (30% ebita) and interest expenses. If interest expenses are less than limit (30% ebita), the excess of ebita is positive and its accumulation allows to create the Deductibility Interest Reserve (DIR). For instance, looking at Table 3, in the sixth scenario (year) the excess of ebita is 4.5, as the difference between 42 and 37.5.

Therefore, between the first and sixth year, the excess of ebita allows an increase in the DIR when, after the sixth scenario, the interest expenses will be greater than maximum interest tax deductible\(^17\). In fact, after the sixth year the DIR is equal to 189\(^18\) and allows to recover \( \gamma \) (cumulated interest amount for full deductibility) equal to 158\(^19\), giving the same result of the full deductibility hypothesis. In fact, the present value is the same as the one obtained under full deductibility hypothesis (see Table 1) equal to 517.

Table 3  Cost of capital and firm value under partial-deductibility hypothesis (multi-period analysis)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Cost of Capital</th>
<th>Firm Value as PV of Cash Flows (PD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>3</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>4</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>5</td>
<td>40%</td>
<td>40%</td>
</tr>
<tr>
<td>6</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>7</td>
<td>60%</td>
<td>60%</td>
</tr>
<tr>
<td>8</td>
<td>70%</td>
<td>70%</td>
</tr>
<tr>
<td>9</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>10</td>
<td>90%</td>
<td>90%</td>
</tr>
</tbody>
</table>

\[ \gamma = \text{the difference between interest expenses and maximum interest tax deductible. For instance, at year seventh } \gamma \text{ is 13.5 and represents the amount required in order to obtain the full deductibility at that year. } 158 \gamma \text{ is the result of } 13.5 + 33.3 + 50 + 61.5 \text{ rounded.} \]

\[ 17 \text{ In that case the excess of ebitda is negative and assumed equal to zero.} \]

\[ 18 \text{ 189 (DIR) is the result of } 42 + 39.6 + 37.2 + 34.8 + 31.2 + 4.5 \text{ rounded.} \]

\[ 19 \gamma \text{ is the difference between interest expenses and maximum interest tax deductible. For instance, at year seventh } \gamma \text{ is 13.5 and represents the amount required in order to obtain the full deductibility at that year. } 158 \gamma \text{ is the result of } 13.5 + 33.3 + 50 + 61.5 \text{ rounded.} \]
LEMMA 2: In the multi-period analysis the full interest deductibility is obtained if the DIR is greater or equal to cum-γ.

Proof. If interest expenses at period t are greater than maximum interest tax deductible:

\[ I_t > 0.3 \times \text{ebitda}_t \]

t=1…10

and if the DIR is enough to save the full interest deductibility:

\[ \text{DIR} \geq \text{cum-γ} \]

where \( \text{cum-γ} \) is the cumulated value of:

\[ γ_t = l_t - 0.3 \times \text{ebitda}_t \]

t=1…10

then, the loss of tax shields is nil because in both hypotheses we have the same amount of interest tax deductible:

\[ \text{TSL}_t = 0, \text{ when } l_{FD} = l_{PD}(\text{without DIR}) + γ = l_{FD}(\text{with DIR}) \]

t=1…10

Therefore, as in Table 3, the marginal tax rate does not change (27.5%) and the cost of capital is the same than the one used under full deductibility hypothesis:

\[ \text{WACC}_{PD} = \text{WACC}_{FD} \]

(20)

Consequently, we obtain the same present value of cash flows in which the partial deductibility does not affect financing and investment decisions, or else, it is irrelevant.

\[ \text{PV of cash flows}_{PD} = \text{PV of cash flows}_{FD} \]

(21)

CONCLUSION

Concluding, in corporate investment and financing decisions it is necessary to know the financial leverage effect on value. The art. 96 may give a disadvantage making it helpful to adjust the WACC with a lower marginal tax rate. However, the effect may be different between single period and multi-period analysis in terms of optimal capital structure decision and firm value.

In the single-period analysis, the proof shows that optimal capital structure choice is not influenced from the application of the rule, but it affects the value when the interest threshold is overcome, making fundamental adjustments on tax rate and WACC; otherwise, the firm is overvalued.

In the multi-period analysis, the firm value is the same in both hypotheses only when the DIR is equal or greater than cum-γ. Conversely, if the DIR is not capacious and the WACC is not adjusted, the firm is still overvalued.

Therefore, since each firm has different characteristics in terms of cash flows, risk and growth, it is advisable to implement the formulation in order not to overstate the firm.

REFERENCES


The Appendix cited in this paper can be found at: cisi.org/rofmdec2014
**REVIEW OF FINANCIAL MARKETS**

A QUANTITATIVE ANALYSIS APPROACH TO NON-PERFORMING LOAN PORTFOLIO MANAGEMENT: OBSERVATIONS FROM EUROPEAN BANKS

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Widowitz.Michael@bcg.com

**ABSTRACT**

In order to improve their credit risk management practices, European banks are moving towards an optimised approach towards their non-performing loan (NPL) books. Quantitative analysis can help significantly in this process, supporting the NPL management in various dimensions. Early-warning patterns enable bank risk managers to take mitigating actions before risks materialise, an increased automation of processes reduces administrative cost, and portfolio management tools help to select client clusters that are in line with the bank’s overall risk strategy. Introducing quantitative analytics instruments into the day-to-day business has shown in several case examples to significantly increase the value derived from problematic portfolios and thus plays an important role in post-crisis management of banks’ credit portfolios.

NPL management has become a significant balance sheet management factor for European banks, since their incidence has risen inexorably above pre-crisis levels. In the eurozone alone, the share of NPLs in total loans in 2013 has risen to 6.9%, up from 4.6% back in 2009. These numbers are partly driven by the more distressed countries within the eurozone (Cyprus, Greece, Spain, Portugal), but also by Central and Eastern Europe countries such as Hungary (17% NPL), Lithuania (12% NPL), Romania (22% NPL), or Slovenia (13% NPL). In total, currently banks in the eurozone have over one €1 trillion (€million million) in NPL assets on their balance sheets, including €290 billion in Italy, €210 billion in Spain, and €170 billion in France.

**PROTECTION AGAINST CRISES REQUIRES STRINGENT NPL MANAGEMENT**

As the current economic outlook is still dominated by insecurity and fear of a rebound of the crisis, it is worthwhile to observe the link between macroeconomic vulnerabilities and the development of banks’ NPL portfolios. As pointed out in Mwanza Nkusu’s IMF Working Paper on the subject, the NPL ratio is as a general trend – positively affected by real GDP growth, growth in equity prices or increase in house prices, while on the other hand it is negatively impacted by a rising unemployment rate. These observations are in line with the 2013 ECB working paper on NPL and the economic cycle, which also highlights the effect of foreign exchange rate fluctuations (depreciations) as a factor increasing NPL ratios.

Based on these observations, we conclude that economic crises are expected to drive the NPL ratio in banks’ loan books. On the other hand, we observe increasing pressure on banks to become more stress-resilient, as evidenced by the ECB’s comprehensive assessment exercise and regularly recurring stress tests. We believe that banks seeking to prepare for future crises and stress tests will need to improve their NPL management practices accordingly, as “sitting on NPLs makes a bank far more vulnerable”.

In this paper, we present a quantitative decision-making process with which banks can actively manage their NPL performance. We have seen these elements applied by a number of banks in practice, and believe that the improvement in banks’ NPL management processes that results will be a key competitive advantage going forward.

**ELEMENTS OF A BEST PRACTICE APPROACH FOR NPL MANAGEMENT**

In building a best practice collection and NPL management function, we believe in three success principles: Standardised and automated processes, a data-driven decision support with a high degree of underlying quantitative analysis, and specific tailoring to the bank’s overall risk strategy. These principles should be applied across the entire value chain, starting already at the level of the performing loan portfolio.

Introducing **standardised and automated processes** primarily aims at avoiding case-specific loops and potentially inconsistent individual decision making. It involves:

- defining clear handover and escalation criteria to collection/workout/intensive care units (and potentially back to the performing loan book, once the position has recovered)
- stringent process definitions and centralised process control with a short time to market of steering impulses, and
- a client-oriented collection process with incentives for (client) cooperation.

**Quantitative analysis** helps make the decision processes faster and more objective. Specifically, banks should:

- establish early-warning-systems and risk heatmaps already at the level of the performing portfolio, so that they can anticipate potential difficulties
- establish portfolio monitoring systems including regular analysis of collection buckets (performing vs. watch vs. past due etc.) as well as roll rates (time-over-time migrations between buckets)
- define and implement quantitative decision support tools including cash flow projections and NPV calculations simulating different possible actions, and
- systematically record data on success/failure after taken actions to serve as input data for future fine-tuning of the algorithms.

Banks will need to tailor systems to their needs, especially to their risk strategy. For example, they need to consciously decide the trade-off between NPL book size vs. P&L burden of loan loss provisions. Furthermore, banks benefit when they manage to set up flexible systems – being able to adapt quickly to a new strategy and making sure that new directions get implemented rapidly and change the behaviour of workout employees.

As another example, reputational risks are difficult to quantify but need to be factored in as well. The more specific the bank’s risk strategy is defined, the easier it is to establish a collection logic which goes beyond simple recovery maximisation.

Two recent case studies of our project work illustrate how quantitative decision-making support together with the right systems and processes can tangibly alter the performance of NPL portfolios:

3. **Risk magazine ‘Stress tests prompt NPL rethink’, Joe Rennison, May 2014**
Case study 1: High importance of early warning systems

Similar to successful soccer teams, where successful defence starts already at the level of the attackers, successful NPL management has to start already with the management of the performing parts of the portfolio. Essentially, being the first to know increases the probability of successful recovery in comparison to other creditors. Quantitative analysis of past NPL migrations can uncover patterns which help detect similar migrations. In a typical scoring model, financial and non-financial information on the client (which needs to be actively collected leveraging the client relationship) get connected, which generates new insight on the specific client situation and can help to identify potential defaults well in advance (see Figure 1). As an example, variances in the booking date of periodic inflows or a switch of automatic direct debits to manual cash transfers can indicate a worsening of the client’s financial condition.

Building such a scoring model depends heavily on supply of behavioural information (current account, external payment experience), which implies accordingly that processes for the collection and systematisation of such information need to be established.

Case study 2: Non-performing loan strategy

If the organisation was not able to prevent a loan from migrating into the NPL portfolio, the return can be maximised by following efficient processes with clear guidelines and a well-defined NPL strategy. As a first step, there should be objective criteria established to determine whether a loan will be moved into intensive care, restructuring, workout, or liquidation. An analytical scoring function can help to arrive at such a classification (see Figure 2). Within restructuring and workout, conflicting interests need to be accounted for, for example between maximising NPV for the bank, unattractive NPL bulks in the balance sheet, and risking reputational damage. To make sure that the actions the bank takes are consistent, clear guidelines need to be put in place to keep control and to enable timely adjustments to the steering impulses. For example:

- **Goal:** avoiding systematic delays → Lever: systematically contact clients immediately (ie, within the first two days) of payment delays
- **Goal:** optimising liquidation return → Lever: consider timing effects in liquidation of collateral
- **Goal:** satisfying external investors → Lever: run down NPL portfolio to improve overall quality of bank portfolio
- **Goal:** keep long-term reputation in marketplace high → Lever: avoid harsh treatment of debtors late in the collection phase.

![Early-warning scoring system could have identified 74%/90% of today’s default 18 months in advance](image1)

![Collection strategy based on analytical scoring function](image2)

**Figure 1:** Early identification of potential defaults with early-warning scoring system

**Figure 2:** Elements of an analytical scoring function
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CONCLUSION
Quantitative decision-making support can improve the value derived from NPL portfolios. In essence, starting with highly sensitive early-warning systems, continuing to selection criteria deciding on the most promising treatment of the debtor, then on to differentiated collection strategies and modelling of past experiences can provide valuable insights into how one can optimise non-performing portfolio management. However, such systems rely on collection of the right data – including behavioural data – and embedded processes which make sure the quantitatively derived conclusions get properly executed. The result of all these measures has been observed to increase the value derived from NPL portfolios by up to 20% and on occasion even manage a turnaround in the client’s performance. This suggests that banks would benefit from investing further in their data modelling capabilities as part of their risk infrastructure maintenance.

DERIVATIVES RISK MANAGEMENT: THE IMPORTANCE OF UNDERSTANDING CORRELATION
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ABSTRACT
In this article we discuss the concept of correlation, and explain its relevance to finance. We start with a discussion of how it can be measured. We then move on to some simple products that allow us to trade the correlation and covariance. We explain the importance of understanding correlation impact on investment performance. Assets and other observable market instruments can be correlated for various reasons. We discuss some major causes of correlations below.

MACRO-ECONOMIC REASONS
If economic conditions change, this is likely to impact many assets in the same way, due to their exposure to systematic risk (referred to as Beta in the Capital Asset Pricing Model). The closer related that two assets are, the higher their correlation is likely to be. For example, almost all stock prices will have some kind of positive correlation. Changes in the values of shares of companies that are in the same country or business area will be particularly highly correlated. This is because there will exist specific risks that affect these closely related companies all to a large extent, while having less or no effect on the rest of the economy. For example, price moves of the shares of Mitsubishi and Nissan, both Japanese auto manufacturers, will be higher correlated than price moves of the shares of Nissan and Tesco.

CORRELATIONS AND VOLATILITIES IN A CRISIS
It is a well-known fact that both volatilities and correlations increase in times of financial stress. In normal market conditions, the value of an asset is determined by a combination of systematic (macro) factors that affect the market as a whole, and idiosyncratic factors that affect that asset in particular. Investors and other market participants seek to diversify their risk by taking out a wide range of investments. In a crisis, the systemic factors start to dominate, compared to the idiosyncratic ones. For example, a default by a central bank will lead to correlated defaults by commercial banks in that country which hold a large proportion of their assets in the central bank’s bonds. This, in turn, will lead to the default of domestic companies which have deposited their assets in the commercial banks. Policy-makers (eg. governments, central banks) intervene to a greater extent in the markets during a crisis. Under normal market conditions, there is a general desire to allow the economy to grow under its own steam, without taking any interventionist action. In a crisis, governments will intervene to try to avert the problems. These interventions can take many forms, including the printing of money, support for failing companies and banks, and changes in monetary and fiscal policy. These actions are more likely to have a systemic than an idiosyncratic effect.

It is also true that free market participants (eg. investors) behave in a more correlated fashion during a crisis. People become naturally more risk adverse, and will move their assets to perceived safe havens. They will prefer holding bonds to equities, government bonds to commercial bonds, and bonds of large robust economies rather than small volatile ones. As the crisis worsens, low-risk assets will appreciate compared to high-risk assets. As it alleviates, high-risk assets will appreciate compared to low-risk ones. Thus large groups of assets start behaving in an extremely correlated and volatile fashion.

CORRELATION AND CAUSATION
It is very easy to find things that are correlated but have no causal relationship. For example, the movements in the share prices of Mitsubishi and Nissan are highly correlated. However, this does not mean that a movement in the price of Mitsubishi shares will give rise to a movement in Nissan’s. In fact, if all other economic (and other relevant) factors remained constant, but the Nissan share price fell (this could happen due any idiosyncratic reason, like a design flaw on a new model), you may actually expect the Mitsubishi share price to rise, as it captures market share from its competitor. The reason its share price movements are highly correlated is because the same set of external factors affect both companies in similar ways.

Correlation implies causation only if the correlation remains after the impact of all other factors has been accounted for. For example, if all economic, environmental and regulatory (etc) conditions remained constant over a six-month period, but the share prices still moved with a high correlation, then we would be pushed towards the conclusion that the movement in one price was causing the movement in the other (although we still would not know which was the cause and which the effect).

It is very hard to prove causation in economics, finance, and social science, because it is extremely hard, if not impossible, to perform a controlled experiment where other variables are held constant. It is much easier to prove causation in subjects like physics and medicine. Fortunately, from the point of view of a trader or risk manager, understanding the causation is less important than understanding the correlation (although if you understand the causation, this may help you search from highly correlated assets that can be used to hedge each other).

HOW CAN WE DEFINE CORRELATION?
Absolute levels or changes in levels?
A common mistake that people make is to look at the correlation between the absolute levels of two assets, instead of the correlation between the changes in these assets. In finance and economics, we normally think about price changes, rather than absolute price levels. So it makes sense to talk about the volatility of a price change, or the correlation between two price changes.

We can give a trivial example to show why considering the volatility of the asset levels is wrong. Consider a share whose values measured every month follow the pattern:

\[
PV_{t+1} = PV_t \times 1.01
\]

This theoretical stock has no volatility at all. Its price is simply drifting upwards at a constant rate of 1% per month. If you measure the volatility of the price changes, you will get result zero. However, if you look at the standard deviation of the levels, you will get a non-zero level.
We can easily extend our example to correlation. Consider the two log-normal assets below:

<table>
<thead>
<tr>
<th>Asset 1</th>
<th>Asset 2</th>
<th>Log change in:</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100</td>
<td>Asset 1</td>
</tr>
<tr>
<td>272</td>
<td>272</td>
<td>100%</td>
</tr>
<tr>
<td>272</td>
<td>272</td>
<td>0%</td>
</tr>
<tr>
<td>100</td>
<td>739</td>
<td>-100%</td>
</tr>
<tr>
<td>100</td>
<td>739</td>
<td>0%</td>
</tr>
<tr>
<td>100</td>
<td>739</td>
<td>0%</td>
</tr>
<tr>
<td>100</td>
<td>739</td>
<td>0%</td>
</tr>
</tbody>
</table>

In the first period, there was a large correlated change in both assets. In subsequent periods, there were no changes, apart from one perfectly anti-correlated log change. Both log changes are of the same magnitude. The correlation between the levels (measured using Pearson's formula) is 72%, but the correlation between the log-changes is zero! The zero level makes sense, if the only two changes that occurred were equal and opposite. Why is the correlation between the levels -72% then? This is because the second, anti-correlated change occurred when the absolute levels of the two assets were much larger, and thus had a much higher weight on the correlation of the levels than the initial change had.

While facile, this example serves well to demonstrate the dangers of looking at the wrong correlations.

**MEASURING CORRELATION**

As with all market parameters, we can estimate correlation in three ways:

- From the traded prices of instruments sensitive to the correlation
- From historical data
- Using economics and market knowledge to form an opinion on its value.

From the point of view of a trader, the first method, using tradable prices, is the best. This is the price at which the risk to the correlation can be hedged in the market. In the risk-neutral world, the trader should always mark his parameters to tradable prices. Unfortunately, there are not many liquid instruments that are traded inter-bank that are sensitive to correlation. Most correlation-sensitive instruments are not only traded with investors, but are quite often traded in the same direction. For instance, all the customer trades will result in the trader having the same directional exposure to the correlation parameter. Thus there is no price at which the bank can easily hedge its correlation exposure. Furthermore, these correlation-sensitive trades usually have exposure to other unhedgable parameters, and thus we have too many degrees of freedom to accurately determine the risk-neutral correlation from their prices.

Examples of potentially liquid instruments that have significant correlation exposure are quanto, spread options and correlation swaps.

In the absence of liquidly traded instruments, we have to rely on historical data and market knowledge. There are three major problems associated with using historical correlations to mark our models:

- The behaviour of assets can change over time, and thus future behaviour may not be the same as previous behaviour.
- There are sampling errors associated with the choice of a specific time-series. If we try to reduce the impact of sampling error by extending our sample further into the past, then we are assigning more weight to events further in the past that have less and less association with current conditions.

- Even if the past behaviour is expected to continue for the foreseeable future, this has not told us anything about the risk-neutral price where market participants may be prepared to trade the correlation. It has told us only about what we expect the real-world outcome to be.

When picking historical data, we have to ensure our fixing sources are as accurate as possible. A composite closing price of an illiquid instrument like credit default swaps (CDS) is likely to have a lot of measurement noise, as it is the average price reported by several market participants who all have wide bid-offers, and who may calculate their price at slightly different times of the day. However, the daily fixing of the USD ten-year swap rate, determined by ISDA, at a specific time, is likely to be very accurate and representative of a firm-tradable price at that moment. Any uncertainty adds noise to the calculation and will, on average, push the observed correlation closer to zero.

Another point to be aware of is to ensure the time-lag between the fixings of the two assets is as small as possible.

Imagine we are observing two assets, correlated at 60%. This correlation refers to the instantaneous changes in the two assets. Say that we observe each asset daily, but one at 1200hrs, and the other at 1600hrs. Consider a single observation period. Between 1200hrs and 1600hrs, we do not record any change in the second asset. Between 1600hrs and 1200hrs the next day, we record the changes on both assets. Between 1200hrs and 1600hrs, we record the changes only in the second asset. Hence, there is a four-hour window for each asset where there is no corresponding change in the other asset. Assuming there are no correlations between the moves in the two assets at two different times (which is a fair assumption, as otherwise markets would exhibit a predictive quality), this means that, out of the 24 hours, there was a four-hour period where no correlation is observed. The total correlation observed over many periods will thus be (60% * 20 + 0% * 4) / 24 = 50%. (We have made the assumption that there were also observations at the weekends, just to make the example simpler.)

This is illustrated at Figure 1.

![Figure 1 Time lag and asset-price fixing](image)

We can get round this problem in two ways. If we know what the time lag is, we can use the above analysis to deduce the impact of the zero-correlation period, and thus adjust the final answer to the level implied for synchronous observations. This has the disadvantage of introducing more random noise into the data, especially if the time lag is large. Alternatively, we could increase the time between observations, to reduce the relative size of the lag compared to the observation gaps. This has the disadvantage of decreasing the number of observation points. For example, if we observe correlation weekly, compared with daily, we have five times less observations. This problem can be circumvented by using a rolling observation window, of say five business days.
Figure 2 shows the historical correlation between the changes in the S&P 500 index, and the EURUSD exchange rate. The correlations are measured using a 90-business-day rolling window of synchronous daily observations. The correlation has been high and positive since the 2008 credit crisis began, until the end of 2012. Before the credit crisis, there was no material correlation. In 2013, the correlation fell. This can be explained economically. Between 2008 and 2012, the euro had been seen as much riskier and more vulnerable than the US dollar. Thus, when the crisis deepened, EURUSD was likely to fall, whereas it was likely to rise as the crisis alleviated. Clearly the S&P index would fall at times of crisis and rise during times of recovery. At the end of 2012, the US had budgetary problems (including the ‘fiscal cliff’). Europe began to recover from its economic woes. Thus, the euro stopped being seen as a lot more risky than the US dollar, and thus the correlation abated.

If we were looking at the historical behaviour of this correlation, with a view to using it to price a trade, we would have to think carefully whether we believed that the economic conditions that lead to the historical correlation levels would persist going forward.

This is a good example of the third bullet point made at the start of this section. If we do not understand the reasons behind an observed historical correlation, then assuming it is a good indicator for future behaviour is extremely dangerous.

CONCLUSION

Market valuations are influenced by a wide variety of factors and too often investors are familiar only with first-order factors. The reality is that the price of tradable instruments can and often does change as a result of changes in second-order factors, and the impact of correlation on value movement between two instruments is one such factor. We have discussed how this factor can change values and we can observe how changes in prices as a result of correlation impact make it important to understand what is the nature of any correlation and whether that is likely to influence future valuation.