Dynamic Capital Structure: the Case of Hufvudstaden

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Abstract

This paper introduces a new approach of testing capital structure hypothesis on a firm specific level. Johansen's procedure for cointegration testing is employed to test theories of optimal capital structure. The sample covers a firm with unique properties, Hufvudstaden, during the period 1938 until present. The approach of cointegration allows testing of long-run equilibrium between non-stationary time-series. We find empirical support that capital structure follow a dynamic equilibrium path. However, this equilibrium is more complex as posited by existing theories. The result is found for leverage measured as both book-value- and market-value-of-equity.

1 Introduction

Modigliani and Miller's (1958) paper created modern corporate finance and modern capital structure theory. In a world with complete capital markets they showed the irrelevance of a firms' leverage for its value of the firm. Although appealing, several researchers, has found the proposition of Miller's theories inadequate.[1]

A shortcoming of the existing empirical literature is that it is primarily characterized by cross-sectional studies. Although, panel-data studies have been conducted they do not capture the dynamics of the capital structure and their response to the determinants.

Most of the corporate capital structure models are based on the assumption that individual firms optimize their capital structure. It is in this context remarkable how industry specific or company specific studies have been neglected in the literature.

The contribution of the paper is that we examine the empirical relationship over time, between capital structure of a single firm, *Hufvudstaden AB*, in a specific industry and its determinants as posited by the existing theories. The following corporate finance theories are being tested: the Modigliani and Miller hypothesis (1963), the bankruptcy costs-tax shield hypothesis of Baxter (1967), and finally the agency cost hypothesis of Jensen and Meckling (1976) and Myers (1977)).

Hufvudstaden AB has been the dominating real estate company quoted on the Stockholm Stock Exchange, SSE, during the years 1938-1996.[2] The company has some rather unique features motivating a case study of its capital structure. First, *Hufvudstaden* has remained in the same line of business and still supplies the same product, office areas in the heart of Stockholm, as when established in 1926. Second, being a real estate company it represents a large amount of real capital to serve as collateral for creditors. Third, *Hufvudstaden* has always been profitable and dividend paying and it has not been involved in any mergers and acquisitions during the investigated period.[3]

The outline of the paper is as follows. The hypotheses to be tested are specified in section 2. The methodology and data are described in section 3. The results and the

[1] See Fischer et al (1989), Dammon and Senbet (1988), DeAngelo and Masulis (1980), Kim (1978), and Myers (1977), among others.

[2] *Hufvudstaden AB* alone has represented more than 60 percent of the total market value of all real estate companies quoted on the SSE during 1938-1996. See also Graflund (2000a).

[3] This statement is based upon a complete sample of all annual reports from *Hufvudstaden AB* 1926-1996. A reputation of dividends is a costly signal of earnings. According to MacKie-Mason (1990) dividend paying firms are able to issue equity without suffering the mistrust of investors as proposed by Myers and Majluf (1984).

empirical evidence are presented in section 4. Section 5 concludes the paper.

2 Corporate capital structure

The capital structure theory can be divided into four categories. First, trade-off models such as bankruptcy costs-tax shield hypothesis (Kim (1978)). Second, asymmetric information models such as agency cost hypothesis (Jensen and Meckling (1976), Myers (1977)). Third, signaling models of asymmetric information developed by Myers (1984) and Myers and Majluf (1984) and last models that demonstrate the irrelevance of capital structure (see Stiglitz (1974), Miller (1977) and Fama (1978)).

Most of the existing models in corporate capital structure theory are based on the findings of Modigliani and Miller (1958). Miller (1977) extended the model to incorporate personal taxes. However, Sarig and Scott (1985) question the existence of tax-induced financial leverage and points out there are no reason for a relationship between tax-induced clienteles and leverage. They argue that tax-induced dividend clienteles have been interpreted as tax induced financial leverage.

Myers (1977) argues in his asymmetric information model, that agency costs will arise due to creditor's inability to constrain the behavior of the corporations' management. Equilibrium will be established when the expected marginal cost of debt financing equals the expected marginal benefit of debt financing.

Kim (1978) shows that the existence of substantial costs associated with bankruptcy discourage debt financing. According to the model firms has a trade off between the potential costs of bankruptcy and the tax incentive of debt. Thus, firms' have an optimal capital structure and capital structure is important for the individual in these models.

The weakness of the above models is that they all are single period models and, thus, ignore the firms' dynamic behavior of the capital structure. Francis and Leachman (1994) point out that this weakness extends to most of the studies, which have addressed the question of optimal capital structure. According to them there is a lack of time series studies and the cointegration framework is able to capture dynamic behavior of firms. Fischer *et al* (1989) theoretically addresses the question of firms' dynamic optimal capital behavior. They argue that the often-used results of static cross-sectional models are questionable if firms follow a dynamic optimal behavior. Further they point out that firms do not have an optimal debt/equity mix. Instead they have a range over which their debt/equity mix is allowed to vary.

We assume that a high corporate tax will increase the debt ratio and we expect that the leverage of the firm will decrease if there are agency costs and bankruptcy costs. Given discussion in this section the following testable hypotheses emerge.

- H_1: There is an equilibrium relationship between agency costs and the corporate debt ratio.
- H_2: There is an equilibrium relationship between bankruptcy costs and the corporate debt ratio.
- H_3: There is an equilibrium relationship between debt related tax shield and the corporate debt ratio.
- H_4: There is an equilibrium relationship between agency costs bankruptcy costs, debt related tax shield and the corporate debt ratio.

3 Methodology

The idea is to test if there is equilibrium relationship between the level capital structure and the level of the explanatory variables. This can be done via the cointegration framework of Johansen (1988) and Johansen and Juselius (1990, 1992). The idea is to test hypothesis H_1 - H_3 in a bivariate model and to test hypothesis H_4 with a multivariate model. Thus our models are that there exist a linear combinations of the levels of the variables, I(1), such that the linear combination is stationary, I(0). If cointegration exists we are able to test the both the short run dynamics, α, and the long run dynamics, β.

3.1 Description of the proxy variables

The variables described in the capital structure theories are not observable. Thus, we have to use proxy variables to measure agency costs, bankruptcy costs and the firm's optimal capital structure. We extract our proxies from the findings in Taggart *et al* (1985), MacKie-Mason (1990), Francis *et al* (1994) and Asgharian (1997). All of our data are annual, covering the company *Hufvudstaden AB* during the period 1938-1996.

It is not the intention of this paper to investigate whether or not capital structure ought to be measured by its book or market v*et al*ue of equity. However, in recognition of this problem we utilize four measurements of capital structure in the analysis. Thus, the dependent variable, the capital structure or leverage is measured as ratios of *debt-to-book-value-of-equity* (DER), *long-term-debt-to-book-value-of-equity* (LDER), *debt-to-*

market-value-of-equity (DMER) and l*ong-term-debt-to-market-value-of-equity* (LDMER).[4] The use of *long-term-debt-to-equity* follows from Miller (1963) and *debt-to-equity* from Taggart *et al* (1985).

Tobin's Q (TQ) will be used as a rough measure of agency costs because it captures the changing relationship between future investment opportunities and existing assets (Taggart *et al* (1985)). We expect the agency costs to be inversely related to debt-equity ratio.

Taggart *et al* (1985) and Francis *et al* (1994) suggest the use of corporate-tax rate as a proxy of debt related tax shield, but this approach have been questioned by MacKie-Mason (1990).[5] Following MacKie-Mason (1990) investment tax credits will be used as a proxy for debt-related tax shield, with the difference here the tax shield (TS) is defined as the ratio of tax investment credits over total assets. High tax shields is expected to increase the probability of tax reduction, and the firm faces a lower expected marginal tax rate, thus the company is less likely to use debt.[6]

Finally, the rate of three-month t-bills (BILL) and the long-term bonds (BOND) will be utilized as proxy of the costs associated with debt and more generally, agency cost.[7] The return from t-bills and long-term bonds are from Frennberg and Hansson (1998) database. As the cost of debt increases the firm is expected to decrease leverage. A substantial gain using both BILL and BOND together is that it captures the expected inflation as well as financial risk premium.[8]

It is time to point out that the above, hypothesized effects are intuitively the most likely outcomes. These variables might as well have the opposite effect as indicated above making it difficult to separate the different effects of the variables (Taggart *et al* (1985)).

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[4] Many other studies employ the market value of debt. This is not applicable in this case as the corporate bond market in Sweden has been more or less non-existent. The financing of Swedish companies is mainly carried out via mortgages and by issuing equity.

[5] We quote MacKie-Mason (1990): "The statuary corporate tax rate has been nearly constant over many decades so there is insufficient time-series variation for testing". The actual corporate tax rate paid by Swedish corporations has, after tax reductions and investment credits, seldom exceeded 30 percent. Corporate tax rate refers to stipulated tax rate, in my case according to Swedish tax law: SOU 1928:370 §10:a Moment 2.

[6] This assumes the firm is profitable otherwise corporate tax does not matter. *Hufvudstaden AB* has been profitable during the investigated period 1938-1996.

[7] There are however studies that argue that the spread between corporate bonds of different rating is a more suitable proxy (Choe et al. (1992)).

[8] These variables are assumed to be exogenous for the individual company. The financial behavior of a single firm is not likely to affect the interest rates in the economy.

Table 1: Inference between Augmented Dickey-Fuller, ADF, and KPSS tests of unit roots.

		ADF H_0: Non stationary, unit root	
		Rejection	No rejection
KPSS	Rejection	Inconclusive	Conclusion: Unit root
H_0: Stationary	No rejection	Conclusion: Stationary	Inconclusive

The strength of the cointegration framework of Johansen (1988) and Johansen and Juselius (1990, 1992) is that we can identify the effects of individual explanatory variables.

4 Results

4.1 Unit roots

A necessary condition for cointegration tests is the presence of unit roots in the time-series of interest. The unit root tests have been reported to suffer from low power therefore we utilize both the KPSS-test (Kwiatoski, Philips, Schmidt and Shinh (1992))[9] aand standard Augmented Dickey-Fuller (ADF) statistics, without trend, to test the order of integration. The KPSS-test differs from ADF in that it has the null hypothesis of stationary and allows for error autocorrelation.[10] If the null hypothesis of the ADF test is not (is) rejected but the null hypothesis of the KPSS- test is (not) rejected, then variable is considered non-stationary (stationary). The sample size of 59 observations is not a problem according to Shiller and Perron (1985). They point out that the power of unit root test is based on the time length of the sample rather than the number of observations. The inference of the KPSS together with the ADF-test is showed in *table 1*.

The results of the KPSS and the ADF tests are reported in *table 2*. Since the unit root tests are pre-tests a 10% confidence level is employed, but we also choose to report the significance at 5% confidence level in *table 2*.[11]

KPSS-test rejects the null hypothesis at 5% level for all variables with the exception of DER. The variable DER cannot be considered to be stationary as it is cannot be rejected

[9] A number of four lags have been used in the Bartlet window of the KPSS test.

[10] The test of ADF follows from case 2 in Hamilton (1994) under the assumption that the data generating process includes a constant. The ADF was initiated with a model containing one lag. The Ljung-Box Q-statistics indicates that the residuals being white noise at 4, 8 and 12 lags.

[11] Maddala (1998) questions the power of the unit root tests. He suggests the use of 10-20% confidence level in the case of unit root tests.

Table 2: Augmented Dickey-Fuller, ADF, and KPSS-tests of unit roots.

	Variable							
	TQ	DER	LDER	DMER	LDMER	TS	RF	BYM
ADF	-1.48	-2.82^b	-2.51	-2.59	-2.33	-2.94^a	-1.73	-0.88
KPSS	0.82^a	0.23	0.69^a	0.97^a	1.11^a	0.48^a	1.09^a	1.14^a

Comment: *a* denotes significance at 5% level and *b* significance at 10% level.

by the ADF-test and it is rejected by the KPSS-test. Thus, the book-value-of-debt-to-equity-ratio (DER) will not be employed further in the analysis. Special attention is needed regarding the rejection of the tax-shield ratio. The variable is zero during the period 1938-1966 and 1990-1996. However, the variable is rejected by both the ADF -test and the KPSS test at 5% level. The result of the tests for TS is ambiguous leaving us with no clear answer how to proceed. Being aware of the problem the variable TS will be used in the models.

4.2 Bivariate results

The lag lengths of the VAR's in the bivariate and multivariate models have been determined by both minimizing Aikaike's information criteria and by ensuring there are no autocorrelation present in the residual vector.[12] The residuals of the cointegration relationship are not normal distributed. However, the "λ statistics"of the Johansen procedure is reported to be robust to the violation of normality (See Kim and Maddala (1998)).

table 3 presents the results of the bivariate cointegration models. Bivariate cointegration relationship cannot be found between tax shield, TS, and market-value capital structure proxy LDMER. The "λ max-" and the "λ trace- statistics" of *DMER* with *TS* present an ambiguous result and cointegration cannot be concluded. The results of the short and the long interest rates, BILL and BOND, in the bivariate models are consistent with the respect to the lag lengths. These models have overall few lags. LDER deviates from the market v*et al*ues of capital structure measures. Bivariate cointegration cannot be rejected for LDER with TS. The bivariate cointegration models LDER-TQ and LDER-TS have five lags as to one to two lags for the other bivariate models were cointegration is found.The findings are appealing as cointegration and lag lengths of the models can be explained with the use of market-value-of-equity or the book-value-of-equity as a mea-

[12]The presence of autocorrelation in the residual vector is an indicator of model miss-specification (Enders (1995)).

Table 3: Johansens test for cointegration: Bivariate models for Hufvudstaden

Models	H_0: $r = 0$ $\lambda_{\max}$	λ_{trace}
	Panel A	
LDER, TQ ($l = 5$)	11.82* [7.37]	14.01* [10.35]
LDER, TS ($l = 5$)	8.76* [7.37]	10.89* [10.35]
LDER, BILL ($l = 1$)	3.00* [2.98]	3.00* [2.98]
LDER, BOND ($l = 1$)	3.42* [2.98]	3.42* [2.98]
	Panel B	
DMER, TQ ($l = 2$)	14.51* [7.37]	15.76* [10.35]
DMER, TS ($l = 2$)	7.35 [7.37]	12.28* [10.35]
DMER, BILL ($l = 1$)	7.64* [2.98]	7.64* [2.98]
DMER, BOND ($l = 1$)	6.65* [2.98]	6.65* [2.98]
	Panel C	
LDMER, TQ ($l = 1$)	13.00* [7.37]	15.36* [10.35]
LDMER, TS ($l = 6$)	3.89 [7.37]	6.62 [10.35]
LDMER, BILL ($l = 2$)	8.15* [2.98]	8.15* [2.98]
LDMER, BOND ($l = 1$)	7.34* [2.98]	7.34* [2.98]

Comments: Astrix values reject the null hypothesis. 90% critical values within brackets. l indicates the number of lags in the VAR specification.

sure of capital structure ratio. The results provide support for hypothesis H_1-H_3 when LDER is used as a measure of capital structure. Hypothesis H_1 and H_2 is supported when DMER and LDMER are used. Thus, the support of hypothesis H_1 and H_2 is in this context robust to the measure of capital structure. We now turn our attention towards the multivariate models of cointegration.

4.3 Multivariate results

The multivariate cointegration results are reported in *table 4*. The presence of cointegration is indifferent to the measure of capital structure used in this study.[13] Thus this supports hypothesis H_4, the idea of a long run relationship between capital structure and the cost of debt, agency costs and tax shield. The presence of multiple cointegration vectors is found for capital structure measures LDER and DMER where as a unique cointegration relationship is established for LDMER. This further suggests the optimal capital structure is multivariate in its nature.

The coefficients of the cointegration vectors are presented in *table 5*. Support is found for both positive and negative relationships between capital structure measures and the proxy variables. The variable TS in the second cointegration vector of LDER does seem to be economically unrealistic. However, the economic significance of the vector should be interpreted with caution. If we discard this vector the following emerge: the proxy variables BILL and TQ has positive sign independent of the optimal capital structure measure. TQ has the highest beta value while the sign and the magnitude of TS vary the most.

The loadings α's, in *table 5* can be viewed as the average speed of adjustment to the equilibrium subspace. High coefficients indicate rapid speed of adjustment. There is however, a large variation between the magnitudes of the different α's and the cointegration vectors in *table 5*. Although, we find cointegration relationships irrespectively of which measure of capital structure is employed, only one cointegration vector exhibits significant value for all the α's: the first cointegration vector of multivariate model with *LDER*. This is appealing, as the highly significant α's capture the short-run dynamics.

table 5 reports the long-run matrix for each of ratios of optimal capital structure. The long-run matrix is the combined effect of the α's and the β's. These estimates further support the hypothesis of a multivariate approach in capital structure theory.

[13]For all of the multivariate cointegration model the eigen-values of the companion matrix lie within the unit circle. The data is not presented in this paper but they are available on request.

Table 4: Johansens test for cointegration: Multivariate models for Hufvudstaden AB

Model	H_0:	$\lambda_{\max}$	λ_{trace}
LDER ($l = 6$)	$r = 0$	46.44* [11.23]	70.20* [21.58]
	$r \leq 1$	21.16* [7.37]	23.76* [10.35]
	$r \leq 2$	2.60 [2.98]	2.60 [2.98]
DMER ($l = 4$)	$r = 0$	33.75* [11.23]	55.65* [21.58]
	$r \leq 1$	20.58* [7.37]	21.90* [10.35]
	$r \leq 2$	1.32 [2.98]	1.32 [2.98]
LDMER ($l = 3$)	$r = 0$	32.15* [11.23]	39.86* [21.58]
	$r \leq 1$	6.24 [7.37]	7.71 [10.35]
	$r \leq 2$	1.46 [2.98]	1.46 [2.98]

Comments: Astrix values reject the null hypothesis. 90% critical values within brackets
l indicates the number of lags in the VAR specification.

As we can see from *table 5* the eigenvector values of BILL and BOND are generally quite small as to the other eigenvalues and in the case of LDMER and DMER they seem to be close to zero. Thus, as BILL and BOND do not seem to contribute to the cointegration, a natural way to proceed is to test the restriction of β_{BILL} and β_{BOND} being zero. An advantage with the Johansen and Juselius cointegration framework is that it enables us to test restrictions on the parameter subspace. The test is an ordinary likelihood ratio test based upon the log-likelihood of the restricted and unrestricted model. The result of the test is showed in *table 6*.

If we measure capital structure as book-value-of-debt-to-market-value-of-equity we cannot reject the null hypothesis of the eigenvalues of BILL and BOND being zero. The measure of book value of equity, LDER, presents us with a strong rejection of the hypothesis. The latter is expected as the eigenvalues of BILL and BOND are close to one, see *table 5*.

Finally, we have to be aware of that there seems to be a trade of between the number of lags in the VAR-specification and the significance of the short-run dynamics. As the number of lags increase so does the memory of the process. One could argue that a shortcoming of this study is that it does not contribute to the answer of which are the economically appropriate lag lengths. If we take the lag length in to consideration the

Table 5: Eigenvalues, eigenvectors and weights of the multivariate models

LDER					
	LDER	TQ	TS	BILL	BOND
Eigenvector (β)	-1.00	1.49	0.92	1.01	-0.92
Eigenvector (β)	-1.00	-0.32	-24.37	-0.67	1.24
Loading (α)	-0.34* [-4.09]	0.24* [6.57]	-0.10* [-4.04]	-	-
Loading (α)	0.01 [0.30]	-0.02* [-2.27]	-0.03* [-3.59]	-	-
DMER					
	DMER	TQ	TS	BILL	BOND
Eigenvector (β)	-1.00	1.38	3.33	0.03	0.06
Eigenvector (β)	-1.00	1.75	0.62	0.19	-0.19
Loading (α)	-0.14 [-1.70]	-0.07 [-1.34]	-0.21* [-5.84]	-	-
Loading (α)	-0.15 [-1.17]	0.13 [1.59]	-0.01 [-0.16]	-	-
LDMER					
	LDMER	TQ	TS	BILL	BOND
Eigenvector (β)	-1.00	1.44	-0.17	0.16	-0.16
Loading (α)	-0.37* [-4.38]	-0.08 [-1.41]	-0.08 [-1.44]	-	-

Comment: t-values within brackets.

Astrix values reject the null hypothesis of $\alpha = 0$ at 5% level.

Table 6: Test of the hypothesis: No long -run impact of BILL and BOND in the multivariate models

	H_0: $\beta_{BILL} = \beta_{BOND} = 0$	
Model	χ^2_p	p-value
LDER ($p = 2$)	22.25*	0.00
DMER ($p = 2$)	1.92	0.38
LDMER ($p = 1$)	1.88	0.17

Comment: asterix values reject the null hypothesis at 5% significance level. p=degrees of freedom results of the individual multivariate model are vague, but together the results of a long-run equilibrium relationship indifferent to the measure of capital structure, supports the hypothesis of the capital structure being determined by several factors. However, the significance of the short-term, BILL, and the long-term interest rate, BOND, does depend on whether book- or market-value-of-equity is employed in the capital structure measure.

5 Conclusion

This study employs a new firm specific approach to test in order to test existing capital structure theories on a very long time series of newly constructed yearly data, 1938-1996. The result of our firm specific study supports the theories of a dynamic capital structure path over time. Further we employ a new proxy variable for tax shield.

Evidence is presented of equilibrium relationships in both bivariate cointegration models as well as in multivariate cointegration models.

The finding further supports the theory of a long-run relationship between the proxy variables of corporate tax, agency costs, cost of capital, cost of long-term and total debt and capital structure. This also suggests capital structure being more complex as to the tested theories.

The number of cointegration vectors and the number of lags in the multivariate cointegration models depend on whether or not market-value- or book-value-of-equity is used as measure of leverage. The different measures of capital structure are found to exhibit different properties. However, we cannot conclude which measure of capital structure that should be preferred.

The use of long-term-debt-to-book-value-of-equity ratio in the multivariate model presents us with significant parameters for both the short- and the long run dynamics.

The results of this study are that capital structure, for this firm, does follow a dynamic equilibrium path. Hence, we cannot reject any of the theories suggesting an optimal capital structure. The findings justify the use of the cointegration framework on capital structure relationships and this ought to be applicable on other companies as well as industries.

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