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INTRODUCTION

Business portfolio planning models have received wide-spread acceptance in the last decade. Haspeslagh estimated that 36 percent of companies in the Fortune "1000" used some form of portfolio planning in 1979 [14]. The simplest, most quantitative, and best known portfolio model has been defined by the Boston Consulting Group (BCG). This model is based on a set of fundamental concepts concerning the firm and its business units. Theoretical criticisms of the BCG model have appeared in numerous other papers [7, 10, 16], but the underlying empirical support for the BCG model has not been explored. The goal of this paper is to try to remedy this oversight by constructing and implementing a test of the basic BCG concepts. The results of this test should determine if any of the BCG concepts deserve consideration in portfolio planning.

This paper starts with a brief discussion of the BCG approach to planning. In particular, we present the fundamental concepts of the BCG methodology and describe the resulting portfolio matrix. Then we relate a statistical hypothesis to each of three fundamental concepts and define a profitability model to test the hypotheses. Next we summarize the data necessary to estimate the econometric model and present the results of the analysis. We conclude by evaluating the empirical results and their implications for the portfolio planning.

THE BOSTON CONSULTING GROUP'S PORTFOLIO MODEL

The BCG literature states, "the real measure of management's success is the increase in the present value of future cash payoff" [4]. This implies that the firm should follow a discounted-cash-flow maximization rule. Thus, the goal of the BCG model is to maximize the long-run profitability (present value) of the firm's business units. The investment strategies of each unit are the basic control variables used to optimize the return on the portfolio of business units. These strategies are based on the position of the various units in the portfolio matrix.

There are four fundamental concepts that form the foundation of the BCG matrix approach to planning.[1] They are: (1) the separability of the firm into independent business units, (2) the limitation on corporate resources, (3) the existence of the experience curve, and (4) the importance of the industry growth rate [7]. These ideas are used to structure a planning matrix and define optimal strategies.

The business-unit concept implies that the firm can define strategies for each unit without having to consider their effect on the other business units. This allows the firm to subdivide itself into a meaningful portfolio of businesses. The actual definition of each unit should attempt to capture all the possible synergies while still maintaining a significant subdivision of the firm into component parts.

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[1] The BCG also assumes that price will decline with costs in the long run and seems to ignore the risk of a strategy [7].

The limitation on corporate resources requires the firm to make all its strategic decisions simultaneously, because investment in one unit reduces the funds available to the other units of the firm. The BCG expects the firm to try to build a balanced portfolio of business units and use cash from its mature businesses to fund the investment in its growth business. This concept implies that the firm must pass over some attractive investment projects because the necessary investment resources are not available.

The experience curve implies a negative relationship exists between costs and cumulative output. This suggests that relative market share will have a positive effect on profitability, because the business with the largest equilibrium share (and thus the most cumulative output) must have the largest margin.[2] The large margin will allow the high-share units to generate cash that can be reinvested in the business or transferred to other units. This relationship between share and profitability is the most important concept in the portfolio model because it serves to identify the most profitable type of business unit.

The BCG portfolio model also defines a relationship between the industry growth rate and the investment in each unit. The BCG observes the firm must invest heavily in high-growth industries to

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[2] Other explanations can be offered for the relative-market-share/profitability relationship, so the portfolio model can be valid even if the experience curve does not exist [16].

finance the increase in output that is needed to maintain market share.[3] Also, additional investment is required to gain share in a high-growth industry [2]. But little investment is necessary in low-growth industries, because the market is mature. Thus, only high-growth units will require substantial cash for investment. If the unit cannot generate enough funds internally, the firm will have to inject cash into the unit to maintain share. Eventually the unit's product will mature and the industry growth rate will decline [4]. This will lower the unit's demand for investment funds and allow the unit to generate a substantial cash flow for the firm, if a dominant position has been attained. The BCG model recommends development of this type of high-share/low-growth business.

The final two concepts suggest that the investment strategy followed by each unit should depend on its relative market share and industry growth rate. Thus, the BCG has defined a matrix to classify business units by these characteristics. As we have seen, the relative market share of a unit is a proxy for cash generation and the industry growth rate estimates cash use. A share of between one and one-and-a-half times the share of a unit's largest competitor and a growth rate of around 10 percent

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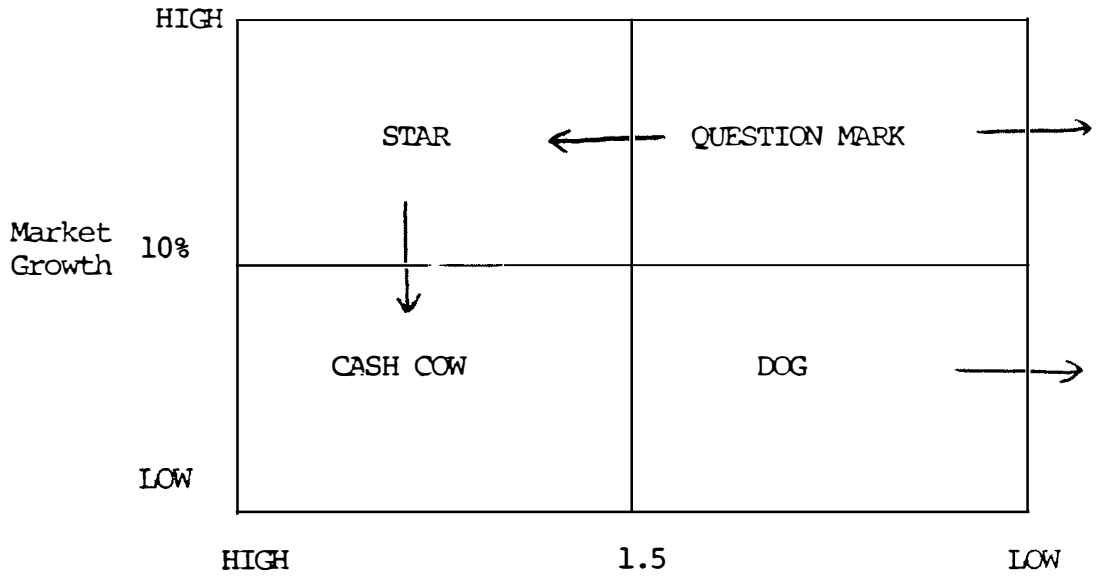
[3] The investment can be in the form of new plant and equipment, working capital, advertising, research-and-development expense, or even foregone earnings due to selling at discount prices. Since market share leads to higher future returns (due to the experience curve), all the indirect costs of maintaining or gaining share are capital expenses.

are used to divide the business units into different cells. The BCG model suggests that the firm allocate the cash generated by each business, to maximize the long-run profitability of its portfolio subject to the required balance in cash generated and used.

The desired movement in the portfolio matrix is illustrated in figure 1, with the BCG's title for each type of unit in the appropriate box. Hedley notes "the first goal should be to maintain position in the 'cash cows' but to guard against the frequent temptation to reinvest in them excessively" [15, p. 11]. Next, the firm should invest to preserve the market share of the "stars." Any surplus funds are invested in the best "question marks" to acquire additional market share. The firm invests in "stars" and selected "question marks" in the hope that they will become "cash cows" when their market growth rate decreases. The "dog" and the remainder of the "question mark" businesses are managed to generate cash or are divested from the portfolio, because the BCG model suggests further investment will never yield a future cash return [3]. Thus, the BCG model advises the firm to use the excess funds from the "cash cow" units to finance investment in high-growth units, with the goal of creating new "cash cows" when the industry growth rate slows. This "ability of the diversified company to redirect its cash flow internally is extremely important" [4]. It allows the corporation to continue to grow and earn profits as its individual business units move through the stages of the product life cycle.

Figure 1

The BCG Portfolio Matrix



A TEST OF THE FOUNDATIONS OF THE BCG PORTFOLIO MODEL

The portfolio planning model relies on the four fundamental concepts isolated in the previous section. These concepts are rarely supported with empirical evidence, probably due to the normative nature of the BCG model. But three of the four concepts have direct implications for the profitability of a firm.[4] We have already noted that the experience curve generates a relationship between relative market share and profitability. Also, the business-unit concept requires the profitability of a firm to be independent of the interrelationships bewteen the various business units of the firm. Finally, the limitation on investment resources implies that a balanced portfolio can increase the profitability of the firm. In the following three subsections, we will describe the three hypotheses in more detail, discuss the relevant evidence from existing studies, and define a variable that can be incorporated in a profitability model. Then we will present the overall model and discuss a set of control variables. This statistical analysis of firm profitability should be able to determine if the BCG concepts have any empirical support.

The Business Unit

The business-unit hypothesis implies that synergy between the business units does not exist. Thus the profitability of each

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[4] The fourth concept (relating growth and investment) is really little more than a tautology, so a test is unnecessary.

unit is independent of the rest of firm. This hypothesis contradicts the relatedness theory of diversification, a theory that advises a firm to diversify into areas similar to its main lines of business. Rumelt found that firms with related diversification strategies were significantly more profitable than the average firm [19]. This suggests that the firm can take advantage of some operational synergies between individual business units. Carter used the Herfindahl numbers-equivalent index for firms with a centralized organizational structure as a proxy for relatedness [6]. He found that these firms are slightly more profitable than analogous firms with a multidivisional (noncentralized) structure, but the difference was not significant. Thus, the existing weak evidence suggests that the independent-business-unit hypothesis should be rejected. But it may be possible to construct another test of the hypothesis.

A quantitative measure of the operational synergy between business units requires some definition of relatedness. The Standard Industrial Classification (SIC) code can be used to define business units in the same two-digit SIC industry as related. Scherer [20, p. 60] notes that the SIC-code system emphasizes similarities in the production process, so most of the potential for manufacturing synergy should be captured. But the measure will not necessarily incorporate marketing relationships. The actual variable must also give some consideration to the share of a firm's sales in a SIC group, to proxy the potential size of the

synergy. The approach, used to measure synergy in a group, computes the product of the number of possible synergistic business units in a group and the square of the percentage share of a firm's sales in an industry classification. This variable gives more weight to industry groups where the related opportunities or the level of the firm's sales offers a chance for significant synergies.

$$REL = \sum_{i=1}^{20} (n_i - 1) (\bar{S}_i)^2$$

where

n_i = the number of the firm's business units in the i'th two-digit SIC industry

$\bar{S}_i$ = the total sales of the firm's business units in the i'th industry group, divided by total firm sales.

This variable is equal to zero if the firm does not operate more than one business in each SIC industry and is large for a diversified firm that operates a number of business units in a single SIC industry group. The BCG hypothesis of minimal operational synergy between units cannot be rejected if the variable has an insignificant coefficient in the profitability model.

The Limitation on Investment Funds

The limitation on investment funds implies that internal financing is valuable to the firm, since it allows the firm to generate additional funds not available in the capital market. Thus, internal financing may make it easier for a firm to undertake some new profitable projects that require large capital

investments. The portfolio model suggests that a balanced group of cash-generating and cash-using units will allow the firm to finance profitable projects with internal funds. The overall balance in the corporate portfolio is difficult to measure but should be proxied by a diversification index. Thus, a positive relationship should exist between diversification and profitability. The diversification index may also pick up other capital market imperfections that allow a diversified firm to acquire capital at lower costs [20, p. 107]. A few studies have incorporated diversification variables in firm profitability models, with mixed results. Two studies of food-processing firms failed to find any general synergistic effects [17, 24]. But Carter has reported a significant positive relationship between the numbers-equivalent Herfindahl index and profitability [6]. This suggests that diversification may increase the profitability of a firm. Additional evidence may confirm this hypothesis.

A measure of diversification must incorporate some consideration of both the number of business units in the firm and their size. A standard measure of diversification is given below [1].

$$DIV = 1 - \sum_{j=1}^{m} (S_j)^2$$

where

S_j = the share of the firm's sales in the j'th four-digit SIC industry.

The diversification variable can range from zero (for a firm in a single market) to approximately one (for a well-diversified firm). The financial-synergy hypothesis implies the diversification variable should have a positive sign in the profitability model.

The Experience Curve

The experience curve implies that the profitability of a business is proportional to its relative share of the market. This relative-market-share/profitability hypothesis has some initial support from a few BCG firm and industry case studies [9]. Also, an aggregated form of the relationship has substantial econometric support. Relative market share had a significant positive effect on profitability in a Federal Trade Commission (FTC) study [24] and in a later study by Imel and Helmberger [17].[5] Both papers controlled for industry concentration but only had data for firms in agricultural processing industries. A number of other studies have found that absolute market share is a significant determinant of profitability at either the firm [11, 22] or business-unit level [18]. This relationship could be caused by the omission of relative market share from the model. Finally, various PIMS studies found that relative and absolute market share were related to profitability [12, 21].

The existing studies support offer some support for the BCG relationship between relative market share and profitability. But

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[5] Relative share was defined by dividing market share by the concentration ratio.

the industrial-organization literature either uses a narrow set of industries [17, 24] or absolute instead of relative market share [11, 18, 22]. Also, most of the studies use firm data instead of business-unit data. The PIMS study uses a sample of 1,000 business units but suffers from a number of econometric difficulties [20, 21]. Thus, another study would be useful to add to the piecemeal support of the relative-market-share/profitability hypothesis.

The relative market share of a business is defined as the ratio of the unit's share to the industry concentration level.[6] Then the overall firm share measure is the weighted average of each unit's share. It can be calculated as

$$RMS = \sum_j S_j \, RMS_j$$

where

S_j = the share of the firm's sales in the j'th four-digit SIC industry

RMS_j = the relative market share of the firm in its j'th business.

This variable will be relatively large for firms that tend to dominate their industries and small for firms that hold a marginal position in each market. The share variable should have a

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6 The BCG measure of relative share (the share of the firm divided by the share of its largest competitor) is not used, because it would not approximate the relative cost position of the leading firm in a regression model.

significant positive effect on profitability if the relative-market-share/profitability relationship is valid.

The Specification of the Model

The three hypotheses can all be tested with a single profitability equation. We will try to explain the performance of a diversified firm as a function of relatedness, diversification, relative market share, and a set of control variables. The following equation will be estimated to test the hypotheses:

$$(2)\quad R = a_1 + a_2\ REL + a_3\ DIV + a_4\ RMS + a_5\ F(A) + a_6\ AD/S + a_7\ RD/S + a_8\ C4 + a_9\ G + a_{10}\ K/S$$

where

R = a measure of the profitability of the firm

REL = the relatedness index of the firm

DIV = the diversification index of the firm

RMS = the average relative market share of the firm

F(A) = a measure of the firm's size

AD/S = the advertising-to-sales ratio

RD/S = the research-and-development-to-sales ratio

C4 = the average four-firm concentration ratio of the firm's industries

G = the average growth rate of the firm's industries

K/S = the capital-to-sales ratio.

The control variables are incorporated in the model to account for differences in the market position of the business

units of each firm. Firm size is included to investigate the residual effect of absolute size on profitability. It is measured by the inverse of the logarithm of assets (net of investments in unconsolidated subsidiaries) [13]. Shepherd [22] notes that the effect of size on profitability is indeterminate because large size may be associated with higher costs, in addition to higher revenues. The advertising-to-sales ratio and the research-and-development-to-sales ratio are included to test the effect of these variables on profitability. Scherer [20, p. 388] observes that an oligopolistic market structure may lead to either investment in product-differentiation advertising and increased profits or overinvestment in advertising and reduced profits. An analogous argument could be made for the research variable. Thus, the sign of these variables is theoretically indeterminate. Comanor and Wilson [8] have found a positive advertising effect, and Scherer notes that this finding "has been replicated using diverse profitability measures and firm or industry samples" [20, p. 286]. Thus, a positive sign is expected for advertising. Imel and Helmberger [17] reported that research and development intensity had a significant positive effect on profitability. Therefore, a positive sign should also be expected for the research variable. The capital-to-sales ratio is included in the model, to account for interindustry variations in capital intensity, when a return-on-sales variable is used to measure profitability. The ratio should have a positive sign, since the firm's return on sales does not consider the capital stock. A

few industry variables are also included in the study. Concentration should increase the profitability of every firm in the industry, if it acts as a proxy for shared market power. Therefore, a positive sign is expected. The percentage increase in industry sales is included to allow growth to affect industry profits. The sign of the growth variable is indeterminate. If growth is a proxy for undercapacity, high growth should be linked to high profitability. But the portfolio theory suggests that the investment necessary in high-growth industries could reduce the measured short-run profitability of these businesses. Thus, a negative relationship could be found. In conclusion, the basic BCG hypotheses will be supported if we find the following:

1) The relatedness variable is insignificant;
2) The diversification variable is significant;
3) The relative-market-share variable is significant.

ESTIMATION OF THE MODEL

The regression model requires a complicated data set, to test the three hypotheses. The construction of the file required merging the 1978 Economic Information System (EIS) data, 1976-78 Compustat financial information, and 1977 census data on four-digit SIC industries. Each data set contributed to the calculation of the variables used in the regression model. The EIS tape defined the firm's market share and the percentage of its sales in a given industry. The Compustat file provided profit, sales,

asset, advertising, and research-and-development data. The actual values for these variables were calculated by averaging the 1976, 1977, and 1978 observations, using the GNP price deflator to express all the data in 1977 dollars. The Census data defined the concentration ratio and the value of shipments for each four-digit SIC industry. Concentration was used to calculate relative market share from the EIS share variable, and the value-of-shipment data for 1972 and 1977 was used to compute the industry growth rate.

The data set initially used firms with 1977-78 domestic manufacturing sales of over half a billion dollars. Then all the firms that did not appear on the Compustat tape were deleted. Other firms were deleted if the EIS measure of sales was not approximately equal to the Compustat sales. This eliminated the firms with substantial foreign sales and left us with a data set of 131 firms.

Advertising and research-and-development data were not available for all the firms on the Compustat tape. To avoid losing more observations, we constructed estimates of the advertising and the research-and-development intensities for each firm, based on line-of-business industry data [25].[7] The available Compustat variables were modeled with the estimates and the relationships were used to project the missing data. This process allowed us to keep the entire data set.

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[7] The line-of-business data were supplemented by additional information to define values for each four-digit SIC industry [23, 27].

Two profitability measures--the return on sales and the return on equity--were used as dependent variables.[8] Since the dependent variable is defined at the firm level, a weighting scheme is required to calculate the business-unit-based explanatory variables. Carter notes that the weights should be consistent with the profit measure used in the model [6]. The return-on-sales variable implies the firm can use a simple sales-share weighting system. But the return-on-equity variable requires the weights to be based on the equity of the unit. Individual equity measures for each business unit are not available, so we used the two-digit industry capital/output ratio to estimate a capital-share measure from the sales/share data.[9] This weighting system approximates the equity share of each business. Thus, the two dependent variables have slightly different sets of independent variables.

The profitability model was estimated with ordinary-least-squares (OLS), and the results for the two dependent variables are presented in table 1. A graphical analysis of the error terms indicated that heteroscedasticity was a problem, so a generalized-least-squares (GLS) formulation was computed.[10] These

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[8] The return-on-sales measure incorporates both profits and interest expense, while the return on equity only includes profits.

[9] The necessary data were taken from tables A-1 and A-2 of [26].

[10] Following an earlier FTC study, the fourth root of assets was used as the correction factor for the data [24].

Table 1.--Regression Results for OLS Model

	Return on Equity	Return on Sales
REL	-.0009	.0003
	(-.50)	(.4)
DIV	.0007*	.0002*
	(3.5)	(2.5)
RMS	.1025*	.054*
	(2.1)	(3.1)
$1/\text{Log}_{10}A$	.3807*	.169*
	(2.8)	(3.0)
AD/S	.7267*	.376*
	(2.1)	(3.0)
RD/S	.7780*	.446*
	(2.2)	(3.5)
C4	-.00001	-.0001
	(-.03)	(-1.0)
G	.03467*	.0186*
	(2.4)	(3.4)
K/S	---	.0726*
		(10.5)
Constant	-.1068	-.0910*
	(-1.7)	(-3.3)
SMSE	.018	.005
R^2	.2136	.5147

SMSE is the ratio of the standard error of the regression to the mean of the dependent variable.

*Statistically significant at the $\alpha = .05$ level.

coefficients are similar to the OLS results and are given in table 2.

Relative market share had a significant positive effect in all the equations. The coefficient in the GLS return-on-equity equation implied that a 10-percent gain in average share will increase profitability by 1.5 percent. Thus, a firm that dominates the industries of its major business units should be more profitable than its competitors. This conclusion supports the basic market-share goal of the BCG model.

The relatedness variable was insignificant in all the equations. This suggests that diversification into different lines of business in the same two-digit industry group does not generally offer the firm superior returns. Thus the independent-business-unit concept may be valid. But the lack of a relationship could also be caused by an incorrect measure of relatedness. A detailed study of relatedness may be able to identify all the potential synergistic relationships between four-digit SIC industries and allow a better test of the hypothesis.

The diversification measure had a significant positive effect on the performance of the firm. This implies that diversified firms are more profitable than single-business firms, so capital market imperfections limit the profitability of single-unit firms. Thus, it is possible that the firm faces a constraint on investment funds.

Table 2.--Regression Results for GLS Model

	Return on Equity	Return on Sales
REL	-.0004	.0003
	(-.2)	(.4)
DIV	.0009*	.0003*
	(4.7)	(3.9)
RMS	.133*	.064*
	(2.9)	(3.9)
$1/Log_{10}A$	.458*	.198*
	(3.5)	(3.8)
AD/S	.830*	.452*
	(2.5)	(3.8)
RD/S	.870*	.447*
	(2.6)	(3.7)
C4	-.00008	-.0001
	(-.31)	(-1.1)
G	.0329*	.0220*
	(2.1)	(3.9)
K/S	---	.0730*
		(12.5)
Constant	-.1533*	-.113*
	(-2.6)	(-4.5)
SMSE	.101	.027
CORR	.2088	.6074

SMSE is the ratio of the standard error of the regression to the mean of the dependent variable.

CORR is the square of the correlation between the dependent variable and the predicted values for the dependent variable. It is equivalent to the R^2 in OLS.

*Statistically significant at the $\alpha = .05$ level.

The coefficients on the control variables are also of interest. Both the advertising and the research-and-development variables had strong positive impacts on the profitability measures. As Carter has noted, this result can imply that advertising (and research and development) raises the profitability of a business or that profitable businesses have higher advertising (and research and development) budgets [5]. The size variable had a significant effect on all the return measures. This suggests that overall size has a negative effect on profitability after controlling for the diversification and efficiency advantages.[11] The weighted industry growth rate was also positively linked to the performance of a firm. Thus, the positive disequilibrium-profit effect outweighs any profit-reducing effects of growth. Concentration failed to increase the profitability of the firm in either of the equations. This implies that a group of large firms will not necessarily be able to collude well enough to generate monopoly profits. Finally, the capital-to-sales variable had the expected positive effect. All of these results are consistent with some previous profitability studies.

CONCLUSION

This paper has discussed the basic BCG concepts of the business unit, the limitation on corporate funds, the experience curve, and the connection between growth and investment. The most

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[11] Shepherd found the same effect in his study [22].

important concept is the experience curve and the resulting relative-market-share/profitability hypothesis. The empirical evidence discussed in this paper supports this BCG theory. Thus, portfolio planning models should give serious consideration to the relative market position of a business unit.

Two other BCG concepts are also compatible with the econometric analysis presented in this paper. The relatedness variable was insignificant, indicating that the independent-business-unit hypothesis cannot be rejected. Also the significant diversification measure implies that the investment limitation may be valid. But some conflicting statistical evidence exists, and alternative explanations can be offered for our empirical results, so no strong conclusions should be drawn for the other BCG concepts. Thus it is possible that a few empirical problems exist with the basic BCG concepts. These problems would add to the theoretical shortcomings of the BCG portfolio model and further limit its general applicability.

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