THE RELEVANCE OF ORGANIZATION CAPITAL FOR MARKET CAPITAL RETURNS: AN EXTENDED STUDY

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Abstract

This paper extends the existing findings on the theory of "organization capital" proposed by Lev at al. (2009) through a reproduction analysis on newer data, with a different estimation method. A new empirical perspective is proposed, where the intrinsic relationship of the different profitability measures is analyzed in order to offer a survey over the average firm's capacity of generating excess returns in relation to the closest neighbor, based on its uniqueness. Nevertheless, the analysis seeks to define how profitable unique skills and knowledge are in comparison to the companion portfolio's, which characteristics are pervasive and how the time-lags of return on investments in knowledge vary between the individual and aggregate levels.

Keywords: Organization capital, intellectual capital, stock value, portfolio theory, excess returns

Introduction

The "organization capital" concept proposed by Lev at al. (2009) withholds that unique structural and organizational designs, as well as business processes generate sustainable competitive advantages. The paper builds most of its methodology on Fama and MacBeth's (1973) article, where a portfolio model is evaluated for elasticity and linearity in its ability of predicting future market returns. Although a reliable financial analysis uses hourly or daily stock data, much can be learned by extending the analysis performed by Lev at al. (2009) and formulating a model which can elaborate further on its findings.

In this paper, Lev at al.'s (2009) analysis is reproduced and due to the poor statistical results of the original study, an additional model is proposed to further investigate the ability of organization capital to generate abnormal returns. This new estimation model is formulated on basis of multiplicative errors to extend the existing findings and verify the profitability the portfolio and organization capital theories by applying a new statistical approach and including additional portfolio variables. The model is estimated on basis of a generalized method of moments model, to account for the time-lag trap often encountered in economic studies and to analyze the previous findings further through a new methodological perspective. Nevertheless, this extended model allows for further understanding of the previous findings of both Lev at al. (2009) and Fama and MacBeth (1973) concerning the linearity of risk and returns in portfolio theories, and the ability of stock market data to explain abnormal returns and returns to scale. Nevertheless, this paper has the ambition of visualizing the existing differences in the capacity of firms of generating abnormal returns by re-tabulating the different firm classes' competitiveness ranks and aiding in the decision-making processes related to firm value and portfolio-based returns models in something more than the competitive equilibrium (i.e. "perfect competition" model) of generating economic rents based on resources' best abilities.

The remainder of this paper is organized as follows. The methodology and elaboration process of the reproduction analysis and its results are discussed in section two. The extended analysis model and methodological approach are discussed in section three, along with the formulation of hypotheses. The new empirical evidence is presented in section four, whilst the fifth section concludes the paper.

Methodology and Elaboration Process

The elaboration process follows the sampling procedure described in Lev at al. (2009). Financial data were collected from the database Compustat, but no data could be gathered from CRSP. Therefore, all analyses in this paper build on the stock data available in the Compustat. Data were selected for the period 1971 to 2012, a total of 358,101 annual observations. No monthly data is contended in this study.

The data was first deflated to monetary values based on base year 2013. After the calculation of growth rates and exclusion of firms with sales and total assets of less than 5 million USD, the sample consists of 68,661 annual observations. The composition of the data sample was determined on basis of the NAICS 2007 industrial classification standard and the eighteen industries included are presented in Table 1 along with the number of observations used in the market respectively the extended analyses.

TABLE 1: Industry distribution Number of observations

Industry name	Market	Extended
Accommodation and Food Services	1,143	311
Administrative Support, Waste Management and Remediation Services	1,124	366
Agriculture Forestry Fishing and Hunting	136	39
Arts Entertainment and Recreation	193	71
Construction	1,134	339
Educational Services	110	34
Finance and Insurance	8,294	957
Health Care and Social Assistance	702	49
Information	5,513	794
Manufacturing	25,539	11,817
Mining Quarrying and Oil and Gas Extraction	2,294	539
Other Services (except Public Administration)	136	71
Professional Scientific and Technical Services	1,336	411
Real Estate and Rental and Leasing	1,068	38
Retail Trade	5,094	2,520
Transportation and Warehousing	3,192	137
Utilities	7,591	0
Wholesale Trade	2,869	1027
Total	68,661	19,520

The market analysis consists of estimating regression models to obtain the industry-specific measures of $AbSales_{it}$, $AbCost_{it}$, $AbProfit_{it}$ and organization capital OC_{it}, in agreement with the process described in the source article. For a detailed description of the variables, please see Appendix 1. A constant return to scale Cobb-Douglas production function was used to model the firms' output:

$$SALE_{it} = a_{0it}\, PPE_{it}^{b1it}\, EMP_{it}^{b2it}\, e_{it} \qquad (1),$$

where $SALE_{it}$ represents the revenues of firm i in year t, PPE_{it} net plant, property and equipment, $EMPi_{it}$ the number of employees and e_{it} is the error term. The constant a_{0it} is the productivity parameter, modeled as a function of the instrumental variable SGA_{it}, as follows:

$\log(a_{0it}) = b_{0t} + b_{0st} \log(SGA_{it})$ (2),

where SGA_{it} represents the selling, general and administrative expenses, computed by capitalizing and amortizing the annual SGA_{it} expense over three years, as follows:

Adjusted SGA_{it} = 1/n (SGA $Expense_{it}$ + SGA $Expense_{it-1}$ + … + SGA $Expense_{it-(n-1)}$) (3),

where n=3.

The applied production model allows hence for the two types of contributions described in Lev at al. (2009), namely a) the contribution common to all firms (b_{0t}) and b) the firm-specific contribution of organization capital to revenue ($b_{0st} \log(SGA_{it}/SGA_{it-1})$).

TABLE 2: Descriptive statistics of the variables used to estimate organization capital

Variable[a]	Mean	Median	1^{st} Q	3^{rd} Q	Std. Dev.
$SALE_{it}$ (\$ millions)	56.88	14.87	6.53	40.61	167.41
$COST_{it}$ (\$ millions)	47.87	12.16	5.27	33.37	150.83
EMP_{it} (thousands)	242.90	80.03	31.07	224.60	582.60
PPE_{it} (\$ millions)	26.37	4.74	1.23	18.91	81.18
SGA_{it} (\$ millions)	9.80	2.22	0.77	6.74	28.22
$Log(SALE_{it}/SALE_{it-1})$	-2.198	-2.215	-2.295	-2.121	0. 3980
$Log(COST_{it}/COST_{it-1})$	-2.243	-2.218	-2.303	-2.124	0.4474
$Log(EMP_{it}/EMP_{it})$	-2.230	-2.292	-2.331	-2.224	0.7594
$Log(PPE_{it}/PPE_{it-1})$	-2.203	-2.243	-2.311	-2.145	0.4860
$Log(SGA_{it}/SGA_{it-1})$	-2.278	-2.214	-2.289	-2.133	0.6603

[a] Variable definitions are provided in Appendix 1.

The market models were estimated by substituting equation (2) into equation (1) and by taking logarithms of the annual changes:

$$\log(SALE_{it}/SALE_{it-1}) = b_{0t} + b_{0st} \log(SGA_{it}/SGA_{it-1}) + b_{1t} \log(PPE_{it}(PPE_{it-1}) + b_{2t} \log(EMP_{it}/EMP_{it-1}) + \log(e_{it}/e_{it-1}) \quad (4).$$

This equation was estimated annually and cross-sectionally for all eighteen industries to obtain the firm-specific monetary measures of organization capital to revenues (OC_{it}). Table 2 presents the descriptive statistics of the variables used to predict the revenues under the average efficiency assumption without organization capital, which were subtracted from the firms' actual revenues to obtain the measure of $AbSale_{it}$, i.e. the contribution of organization capital to revenue of firm i in year t. A similar procedure was followed for the growth rate of costs and the calculation of $AbCost_{it}$ as the difference between the firms' actual costs and the computed costs without organization capital.

The relationship of $AbProfit_{it} = AbSale_{it} + AbCost_{it}$ was further applied in the calculation of the firms' organization capital measures (OC_{it}) by capitalizing and amortizing $AbProfit_{it}$ over five years scaled by the total assets in year t, as described in equation (3).

The computed organization capital measure (OC_{it}) was thereafter related to the five future years of firm performance, through the calculation of the growth rates of operating income ($OIGrowth_{it}$) and sales ($SALEGrowth_{it}$). The size and book-to-market adjusted excess returns were computed using the portfolio approach, where the firms were grouped by their book-to-market ratio into five equal groups each year. The groups were labeled "A" to "E", where "A" represents the highest book-to-market quintile and "E" the lowest one. The size breakpoints were determined by classifying the companies into five equal groups, where a label of "L" represents the largest companies, "M" middle-sized companies and "S" small companies, with "LM" and "MS" as intermediary lables. The annual excess returns ($ABRET_{it}$) were calculated as the difference between the firms' book-to-market measures and the respective companion portfolio's average book-to-market intensity.

The ten years survival requirement was nevertheless followed by assuring that the firms included in the extended analyses had an organization capital value estimate (OC_{it}) and that performance data was available for the future five years. The final sample consists of 19,520 unbalanced observations and their industrial distribution can be found in Table 1 under the column "Extended". The majority of the firms included in the stydu are high-level book-to-market companies (A), of size large (L). Table 3 presents the descriptive statistics of the organization capital and firm performance measures used in the extended analyses.

TABLE 3: Descriptive statistics of organization capital and firm performance

Variable[a]	Mean	Median	1st Q	3rd Q	Variance	Std. Dev.
Organizational capital variables						
OC_{it}	-0.000042	-0.000338	-0.005355	0.005048	0.000234	0.015303
OC_{it} ($ millions)	1.000076	0.999662	0.994659	1.005061	0.000244	0.015626
Operating performance and market performance						
$OIGrowth_{it+1}$	0.022621	0.013376	-0.003800	0.035968	0.115933	0.340489
$SALEGrowth_{it+1}$	0.222361	0.120642	0.018531	0.276653	1.372184	1.171402
$ABRET_{it}$	-0.220315	0.000000	0.000000	0.000000	1.111192	1.054131
$CUMABRET_{it+1}$	-0.451434	-0.804920	-1.202349	0.092937	370.198678	19.240548
Firm characteristics						
$Size_{it}$	3.175822	0.000000	0.000000	10.032277	1.111192	1.054131
$RDCAP_{it}$	-2.755021	-2.688356	-3.189963	-2.161611	1.001837	1.000918
EP_{it}	0.833375	0.000000	0.000000	0.402929	2.835816	1.683988
D_EP_{it}	0.119369	0.000000	0.000000	0.000000	0.105139	0.324251
BM_{it}	4.205889	0.000000	0.000000	12.577997	42.917021	6.551108
VOL_{it}	0.576157	0.000000	-3.376082	1.589700	24.806013	4.980564
R_OC_{it}	0.554000	0.600000	0.300000	0.800000	8.45240	2.90730

[a] Variable definitions are provided in Appendix 1.

Reproduction of the Previous Analyses

The first part of this analysis consists of reproducing the univariate analyses described in Lev at al. (2009). The univariate analyses of operating income ($OIGrowth_{it}$), sales ($SALEGrowth_{it}$), abnormal returns ($ABRET_{it}$) and cumulative abnormal returns ($CUMABRET_{it}$) indicate the same findings as the original paper in the case of the operating income and sales, cf. Tables 4 and 5. The trend of firms in the top decile of their industry-year rank (R_OC_{it}) of having higher growth rates of operating income and sales is obvious and statistically significant in all cases.

TABLE 4: Univariate analyses of operating performance $OIGrowth_{it+i}$.

Portfolio of OC_{it}	i is years after portfolio formation				
	i = 1	i = 2	i = 3	i = 4	i = 5
1:Bottom	0.0209	0.0503	0.0821	0.1158	0.1575
2	0.0414	0.0730	0.0813	0.1255	0.1471
3	0.0139	0.0303	0.0525	0.0764	0.1023
4	0.0168	0.0366	0.0571	0.0807	0.1044
5	0.0181	0.0363	0.0682	0.1000	0.1291
6	0.0193	0.0421	0.0648	0.0925	0.1343
7	0.0208	0.0434	0.0664	0.0914	0.1218
8	0.0216	0.0429	0.0710	0.1079	0.1411
9	0.0239	0.0506	0.0796	0.1294	0.1817
10:Top	0.0291	0.0623	0.1061	0.1432	0.2053
Top minus Bottom	0.0082*	0.0120*	0.0240*	0.0274*	0.0478*
t-value	-3.57	-2.13	-2.44	-2.56	-2.87

TABLE 5: Univariate analyses of operating performance $SALEGrowth_{it+i}$.

Portfolio of OC_{it}	i is years after portfolio formation				
	i = 1	i = 2	i = 3	i = 4	i = 5
1:Bottom	0.2162	0.4970	0.8651	1.2727	1.7058
2	0.2537	0.5210	0.7436	1.1139	1.4944
3	0.1693	0.3553	0.5781	0.8325	1.1094
4	0.1816	0.4022	0.6292	0.8900	1.2080
5	0.1791	0.3847	0.7028	1.0181	1.3780
6	0.2324	0.4659	0.7206	1.0207	1.4496
7	0.2007	0.4373	0.7062	0.9952	1.2961
8	0.2336	0.4927	0.7577	1.0700	1.4647
9	0.2476	0.5564	0.8871	1.3555	1.8713
10:Top	0.2990	0.6681	1.0886	1.6023	2.3538
Top minus Bottom	0.0828*	0.1711*	0.2235*	0.3297*	0.6480*
t-value	-3.74	-3.23	-2.58	-2.74	-3.80

In disagreement with the source article, the results could not be reproduced for the abnormal returns univariate analyses $CUMABRET_{it}$ and $ABRET_{it}$, cf. Tables 6 and 7. Herein, there are no significant differences between the means of the top and the bottom-ranked firms' levels.

TABLE 6: Univariate analyses of future cumulative excess returns $CUMABRET_{it+i}$.

Portfolio of OC_{it}	i is years after portfolio formation				
	i = 1	i = 2	i = 3	i = 4	i = 5
1:Bottom	-0.5996	-1.8417	-2.5167	-2.9537	-3.0971
2	-1.1461	0.3137	1.8455	1.9536	1.6690
3	-0.7021	-2.4899	-5.2223	-7.1874	-7.9176
4	0.2028	0.9566	0.5486	-0.7263	-0.6885
5	-0.9783	-4.3585	-7.4646	-10.1974	-13.2982
6	-0.2506	-0.5329	-0.9716	-1.3696	-2.0881
7	0.3677	5.0570	4.3298	3.8633	3.1912
8	-0.9726	-1.4829	-2.5511	-3.9108	-5.4767
9	-0.7925	-1.9173	-3.1063	-4.6522	5.3460
10:Top	0.2182	0.0025	-2.8964	-5.0371	-6.7363
Top minus Bottom	0.8178	1.8441	-0.3797	-2.0834	-3.6391
t-value	-0.84	-0.81	0.19	0.90	1.23

TABLE 7: Univariate analyses of future annual excess returns $ABRET_{it+i}$.

Portfolio of OC_{it}	i is years after portfolio formation				
	i = 1	i = 2	i = 3	i = 4	i = 5
1:Bottom	-0.5996	-1.2421	-0.6750	-0.4370	-0.1435
2	-1.1461	1.4598	1.5318	0.1082	-0.2847
3	-0.7021	-1.7877	-2.7325	-1.9650	-0.7303
4	0.2028	0.7538	-0.4080	-1.2749	0.0378
5	-0.9783	-3.3802	-3.1062	-2.7328	-3.1008
6	-0.2506	-0.2823	-0.4387	-0.3980	-0.7185
7	0.3677	4.6893	-0.7272	-0.4665	-0.6721
8	-0.9726	-0.5102	-1.0682	-1.3597	-1.5660
9	-0.7925	-1.1249	-1.1890	-1.5459	9.9983
10:Top	0.2182	-0.2157	-2.8988	-2.1407	-1.6992

Top minus Bottom	0.8178	1.0263	-2.2238	-1.7037	-1.5557
t-value	-0.84	-0.61	1.25	1.47	1.58

The second phase of the reproduction analysis consisted of estimating panel data models of the growth rates based on the two multivariate models described in Lev at al. (2009).

The first model analyzes the capacity of organization capital to contribute to future growth while controlling for several major factors:

$$Growth_{it+i} = a_0 + a_1\ R\_OC_{it} + a_2\ Size_{it} + a_3\ DIV_{it} + a_4\ RDCAP_{it} + a_5\ EP_{it} + a_6\ D\_EP_{it} + a_7\ BM_{it} + e_{it} \quad (5),$$

where growth is represented by the operating income ($OIGrowth_{it}$) respectively sales ($SALEGrowth_{it}$) growth rates. Please see Appendix 1 for variable descriptions. The fitted multivariate panel data ordinary least squares regressions indicate agreement with the original analyses, cf. Table 8. R_OC_{it} was found to be statistically significant for all five years after the portfolio formation, in similarity with most of the included variables. There was not enough data available in the collected sample to form the ratio of dividend to total assets variable DIV_{it}, so this variable is lacking from the analyses and the results.

TABLE 8: Multivariate linear panel data regression analyses.

Dependent variable is OIGrowth$_{it+i}$ - i is years after portfolio formation

	i = 1		i = 2		i = 3		i = 4		i = 5	
	Coef.	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**	**Coef.**	**t-value**
Intercept	0.0244	1.0784	0.0974*	2.5107	0.1044.	1.9170	0.2109**	2.6412	0.2636**	2.6822
R_OC_{it}	0.0096**	3.2501	0.0133**	2.6216	0.0144*	2.0072	0.0348***	3.3265	0.0458***	3.5671
$Size_{it}$	-0.0006	-0.3555	-0.0052.	-1.8512	-0.0065.	-1.6665	-0.0124*	-2.1575	-0.0132.	-1.8726
$RDCAP_{it}$	0.0044***	4.4670	0.0074***	4.4356	0.0106***	4.5079	0.0151***	4.3882	0.0193***	4.5880
EP_{it}	-0.0030***	-4.5881	-0.0060***	-5.3999	-0.0086***	-5.4308	-0.0105***	-4.6062	-0.0124***	-4.3857
D_EP_{it}	-0.0071*	-2.0310	-0.0179**	-2.9942	-0.0280***	-3.3516	-0.0353**	-2.9062	-0.0473**	-3.1756
BM_{it}	0.0014*	2.0275	0.0022.	1.7689	0.0032.	1.8739	0.0030	1.2106	0.0027	0.8823
Adj R^2	0.0567		0.0539		0.0447		0.0303		0.0246	

Dependent variable is SALEGrowth$_{it+i}$ - i is years after portfolio formation

	i = 1		i = 2		i = 3		i = 4		i = 5	
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Intercept	0.3430**	2.5994	0.9659***	3.5630	1.5254***	3.4584	2.0009**	3.1968	2.2569**	2.9851
R_OC_{it}	0.0601***	3.4722	0.1482***	4.1689	0.1943***	3.3591	0.2745***	3.3428	0.3468***	3.4966
$Size_{it}$	-0.0153	-1.6062	-0.0500*	-2.5524	-0.0899**	-2.8200	-0.1273**	-2.8134	-0.1355*	-2.4794
$RDCAP_{it}$	-	-6.2379	-	-6.4255	-0.0949***	-5.6602	-0.1640***	-6.8924	-0.2012***	-6.9993
EP_{it}	-0.0007	-0.1740	-0.0053	-0.6814	-0.0170	-1.3543	-0.0298.	-1.6777	-0.0516*	-2.3967
D_EP_{it}	-	-3.9991	-0.1198**	-3.0285	-0.1860**	-2.8900	-0.2358**	-2.5809	-0.3363**	-3.0469
BM_{it}	-0.0060	-1.4453	-0.0153.	-1.8034	-0.0181	-1.3108	-0.0213	-1.0870	-0.0230	-0.9682
Adj R^2	0.0512		0.0627		0.0480		0.0455		0.0470	

Dependent variable is CUMABRET$_{it+i}$ - i is years after portfolio formation

	i = 1		i = 2		i = 3		i = 4		i = 5	
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Intercept	-18.9893	-1.5142	-52.0928	-0.8349	-62.3919	-0.9217	-52.1970	-0.7240	-42.9840	-0.5673
R_OC_{it}	2.6682	1.3800	10.1745	1.0576	10.9952	1.0535	6.0807	0.5471	2.5707	0.2201
$Size_{it}$	0.9576	1.0089	4.1602	0.8810	3.8968	0.7606	4.6040	0.8438	4.5800	0.7987
VOL_{it}	0.1719*	2.0198	0.7013.	1.6563	0.7366	1.6036	0.7368	1.5060	0.6735	1.3097
EP_{it}	-0.5047	-1.3765	-0.7365	-0.4038	-1.2605	-0.6370	-0.4081	-0.1936	-0.0249	-0.0112
D_EP_{it}	-0.2602	-0.1261	-2.0647	-0.2011	-0.6952	-0.0624	-5.2254	-0.4405	-6.7580	-0.5420
BM_{it}	0.4766	1.1760	0.0266	0.0132	0.9308	0.4255	-0.3707	-0.1592	-0.9933	-0.4057
Adj R^2	0.0148		0.0074		0.0072		0.0061		0.0056	

Variable definitions are provided in Appendix 1.Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1.

The second model proposed by the authors relates the five future years' cumulative excess returns to the industry-year rank of the organization capital of the firms, along with diverse other control factors:

$$CUMABRET_{it+I} = a_0 + a_1\ R\_OC_{it} + a_2\ Size_{it} + a_3\ BETA_{it} + a_4\ VOL_{it} + a_5\ EP_{it} + a_6\ D\_EP_{it} + a_7\ BM_{it} + e_{it} \quad (6),$$

where $CUMABRET_{it+I}$ is the sum of excess returns adjusted for companion size and book-to-market from year t to year t + i. The $BETA_{it}$ variable was computed but was not included in the regression output and is therefore omitted from the results of the fitted multivariate ordinary least squares panel data regression analysis presented in Table 8. Herein, only the variance of the previous four years' returns (VOL_{it}) was found to be significant, and only during the first two years, in disagreement with the original analyses which found support for most variables for all the analyzed years.

In summary, in spite of the outlined differences, a major problem of both the original and reproduced analyses is the poor statistical support of the regressions, cf. the adjusted R^2 levels. Therefore, in order to extend the previous findings, an extended model is proposed.

An Extended Regression Model

In the financial perspective, focus lies on creating maximum financial turnover, for both the firms and their stakeholders. As the output variables are concerned with profitability, the proposed model

$$CUMABRET_{it} = lag(AbProfit_{it},n)^{\beta 1} + lag(OC_{it},n)^{\beta 2} + lag(EMP_{it},n)^{\beta 3} + lag(Size_{it},n)^{\beta 4} + lag(VOL_{it},n)^{\beta 5} + lag(PPE_{it},n)^{\beta 6} + lag(OIGrowth.i1_{it},n)^{\beta 7} + lag(SALEGrowth.i1_{it},n)^{\beta 8} + lag(p.OIGrowth.i1_{it},n)^{\beta 9} + lag(p.SALEGrowth.i1_{it},n)^{\beta 10} + lag(p.OC_{it},n)^{\beta 11} + lag(p.BM_{it},n)^{\beta 12} + lag(p.EP_{it},n)^{\beta 13} + lag(p.Size_{it},n)^{\beta 14} + e^{\varepsilon}_{it} \quad (7)$$

contends both the firms' and the portfolios' characteristics. Such an analysis offers a survey over the intrinsic relationship of the growth rates, along with the opportunity of testing the common portfolio membership profitability expectation. Nevertheless, the proposed estimation procedure approaches the time-lag of returns to investment from a different perspective than the source article, yet by serving the same purpose as the original analyses which have a poor statistical support in both the reference article and this reproduction study.

Hypotheses

The applied portfolio methodology provides a suitable base of both evaluating and comparing the member firms, although a comparison of the companies is not the main purpose of analysis. The major intent is to evaluate how firms with similar traces perform by themselves in relation to other member firms in the companion portfolio through a) the inclusion of the organization capital measure as a differential proxy and b) longitudinally, to correct the often misleading variations in short-term corporate value observations and define how these aspects vary in their delay on investment from an aggregated perspective.

Weak linkages between the average firm's profitability and the benefits of its corporate stakeholders are hence analyzed in relation to the closest competitors. By making them equally important and complementary, the variance of the effects of knowledge, skills and capabilities on profit can be expected to differ due to a) variation in implementation practices within the internal business systems and b) by year, due to different economic conditions and advances in e.g. technology and research which are common to all firms.

Departing from Lev at al.'s (2009) article, I first hypothesize that due to the assumed heterogeneity of the companies' skills and knowledge, results should be pervasive for companies with high organization capital measures, i.e. over both time and space:

H_1*: *organization capital is a pervasive measure of asymmetric information returns and it exhibits positive excess financial returns

H_2*: *the effects of organization capital are not relative to closest-neighbor firms, but unique and therefore pervasive

H_3*: *the effects of organization capital are traceable regardless of the applied estimation method.

The source article further suggests that reported operating income and sales information can sometimes be misleading and that therefore organization capital is a more robust measure. A last factor of interest is thus the intrinsic relation of the used profitability measures:

H_4*: *the measure of organization capital is robust and indicates the profitability level more precisely than operating cash flow and sales, at both the individual firm level and for firm groups with similar characteristics.

This last hypothesis differs from previous results since such an extended aggregated analysis allows for the study of all parts, both independent and dependent variables in the same analysis of longevity, on newer financial data and through a different estimation method.

Estimation Procedure

Since no valid results could be obtained for the $BETA_{it}$ variable described in Lev at al. (2009) in the reproduction analysis, the suggested solution relates previous investments to current values by incorporating estimation of log-differenced data. This procedure is equivalent to estimating growth rates expressed as estimates of the slope coefficient (World Bank 2013). This model offers hence an improvement in relation to most previous studies of this kind by defining novel effects in data which are widely available to the stakeholders, while sorting out previous issues of the prevailing time-delays in return on investment and the longevity of intangible assets. The analysis contends the flows of knowledge, allowing for the pervasiveness of knowledge, skills and uniqueness to be captured in relation to exceptional monetary value, as well as in the characteristics of the companion portfolio.

Stochastic Error Representation

The model builds on a restricted Cobb-Douglas production function, which is widely applied in analyses of corporate production based on inputs and outputs. A general Cobb-Douglas production function (Cobb and Douglas, 1928) $y = AK^{\alpha}L^{\beta} + \varepsilon$ can be an appropriate representation of the production systems since in reality, the effects of the inputs are limited. Yet, the production function is not an isolated equation but rather embedded in a system of equations derived from hypotheses about the behavior of entrepreneurs and market structures. Therefore, the stochastic errors might not be independent of each other and the applied estimation procedure should recognize this.

A common difference between the additive and multiplicative error-estimation approaches is that the relative marginal elasticities of α_K and β_L do not agree in magnitudes (Hrishikesh, 2008, pp. 10-11). Fitting the model with generic additive errors assumes the same variability around the model in all areas of the data, i.e. homoscedasticity. However, the normal distribution assumption of the errors of the function, $y = AK^{\alpha}L^{\beta} + \varepsilon$, where ε is a random error, does not carry over efficiently to its expected stochastic representation. To make linear estimation of a Cobb-Douglas function practical, variables should undergo variance-stabilizing transformations through e.g. logarithmic scaling. Yet, zero or close to zero values in the datasets might have an undesired effect on the estimation of the model. In “U-shaped” curved cases, like in economic theory, the variability might be greater near the peak of a model. Therefore, in such a case, a multiplicative error structure may be more appropriate.

Additive errors are commonly added to the model after the transformation of the variables to logarithmic scales, i.e. $y = AK^{\alpha}L^{\beta} + \varepsilon$, is transcribed to $\log(y) = \log(A) + \alpha \log(K) + \beta \log(L) + \varepsilon$. A non-linear representation, $y = f(K,L) = AK^{\alpha}L^{\beta}$ is therefore proposed, as it can be solved through logarithmic transformation and multiplicative errors which are a product of their means, so that $y = AK^{\alpha}L^{\beta}\varepsilon^{u}$. This form is commonly used when it is suitable to express change as a percentage instead of a constant amount, which is useful in this study due to the concern with the magnitude of the exhibited returns on investment.

A multiplicative non-linear expression like the one proposed herein translates hence to a linearized form $\log(y) = \log(A) + \alpha \log(K) + \beta \log(L) + \log(\varepsilon)$ in order to be solvable with ordinary least squares. The Cobb-Douglas multiplicative function is especially suitable for this scope since the function is asymptotic to the axes no matter what level of output is chosen and is therefore homothetic, not making it possible to produce anything without all the specified inputs available. Multiplicative error type modeling nevertheless allows for testing an important theoretic tenet of intellectual capitals' dynamics by supporting a non-zero combination of all specified inputs, since intellectual capital theory argues that value is obtained through the combination of the intellectual capitals and not only by their individual contribution (Saint-Onge, 1996; Edvinsson and Malone, 1997; Bukh and Mouritsen, 2005).

Logarithmic transformation is in itself monotonically increasing. In general, any homothetic function (e.g. Cobb-Douglas) is a monotonically increasing transformation of a homogeneous function (Hrishikesh, 2008, p. 28). This characteristic comes with the following restrictions: a) the scale elasticity for homothetic production functions depends only on the output level, b) the elasticity of substitution is 1 and c) the constant elasticity of scale is $1/(1 + \rho)$.

Estimation Model

Croissant and Millo (2008) specify that the unobserved effects model of first difference offers an opportunity of analyzing the data as growth rates even when the errors are autocorrelated. By removing the time-invariant individual components and by first-differencing the data, i.e. lagging the model and subtracting the time-invariant components, the intercept and the individual error components are eliminated. When the fixed model's errors are uncorrelated, usually the first difference model's errors are correlated with approximately $cor(e_{it}, e_{i,t-1}) = -0.5$ and any individual effect is wiped out when differencing. When the individual errors are not autocorrelated, the dynamic generalized method of moments model is a robust estimation technique for the differenced variables and it offers the possibility of applying instrumental variables to overcome exogeneity and perform the analyses based on intrinsic variance. Nevertheless, by applying panel data research design instead of regular or time-series multiple regressions, the collected data can be reliably analyzed across time and space, i.e. from both the cross-sectional and longitudinal perspectives, as well as multiplicatively in the errors, solving hence both discussed issues simultaneously.

Results

Table 9 presents the results from the cross-sectional and longitudinal regression models of the profitability of the companies, in the presence of the additional firm and companion portfolio characteristics described in equation (7). The results indicate the percentages of increase or decrease in the analyzed output as the inputs are increased by one percent when all other variables are held constant. Since the coefficients measure the elasticity of the output in relation to input changes, the negative signs indicate positive effects on corporate value and elastic capacities for absolute values bigger than 1. The coefficients' significance is indicated by the significance codes. The gmm models are estimated with different lags and since the independent variable is the growth rate in the following year, "lag 0" corresponds to a contemporaneous setting. Lags "1" to "4" indicate the effects of the one respectively to four years old investments on the output.

In the same year as the investments, the effects of the net income ratio (EP_{it}) and size (ibid) are beneficial for abnormal returns, with values of -0.28 respectively -0.15 percent.
One year after, returns due to the levels of EP_{it} and size are still value-giving and of approximately the same magnitude. In addition, the previous year's operating income growth ($OIGrowth.i1_{it}$) is the most profitable and elastic (-7.52). Returns are also generated due to the companion portfolio's level of growth in sales ($p.SALEGrowth.i1_{it}$) at a magnitude of -1.72 percent, which also is elastic, whilst the levels of firm sales ($SALEGrowth.i1_{it}$) act negatively on the returns, with 1.19 percent.

Two years after, abnormal returns are heavily driven by the organization capital level of the firms (OC_{it}), -17.86 percent, along with the maintained benefits from size (-0.16). The companion portfolio's aggregated organization capital level ($p.OC_{it}$) acts negatively on the abnormal returns of the average member firm, which can be seen as a side-effect of competitiveness and important economic catalyst. The variance of the returns over the previous years (VOL_{it}) slightly diminishes the capacity of generating returns, by 0.24 percent.
Three years after, the variance of the returns over the previous years (VOL_{it}) acts negatively on abnormal returns, (0.22 percent), just as the operating income growth of the previous two years ($OIGrowth.i1_{it}$). An interesting fact here is that although the average member firm's operating income is negative, the aggregated level of operating income in the companion portfolio ($p.OIGrowth.i1_{it}$) generates elastic benefits for the member firms (-40.23 percent).

Four years after, inelastic benefits are obtained by the level of net income (EP_{it}), -0.54 percent. $AbProfit_{it}$, the unamortized component of OC_{it}, and the variance of the previous years' returns (VOL_{it}) act negatively, by 4.87 respectively 0.31 percent. This emphasizes the importance of amortization in economic analyses to maintain the robustness of the measures.

TABLE 9: Generalized method of moments panel data regressions. Dependent variable is CUMABRET$_{it+1}$.

	lag = 0		lag = 1		lag = 2		lag = 3		lag = 4	
	Coef.	z-value	Coef.	z-value	Coef.	z-value	Coef.	z-value	Coef.	z-value
AbProfit$_{it}$	0.3733	0.5246	-0.9164	-1.0411	1.9646	1.0784	-0.2697	-0.2107	**4.8659.**	1.8844
OC$_{it}$	-5.5323	-0.4614	-31.8761	-0.6055	**-17.8619***	-2.2383	12.9473	0.6467	-1.6752	-0.1262
EP$_{it}$	**-0.2849****	-2.6248	**-0.2941***	-2.0747	-0.2050	-0.9890	-0.1301	-0.6030	**-0.5406***	-1.9801
EMP$_{it}$	0.3339	0.7456	-0.1886	-1.1954	-0.3843	-0.8240	0.0404	0.0673	-0.4516	-0.7485
Size$_{it}$	**-0.1542***	-2.2271	**-0.1131***	-2.0884	**-0.1608***	-2.2282	-0.0949	-0.8189	-0.1727	-0.8793
VOL$_{it}$	0.0707	1.6008	0.0785	1.5482	**0.2406***	2.1141	**0.2178***	2.0635	**0.3077.**	1.8632
PPE$_{it}$	-0.2594	-0.8046	0.1437	1.2381	0.2869	0.8514	-0.0076	-0.0184	0.3974	0.8298
OIGrowth.i1	0.4218	0.1108	**-7.5169.**	-1.6870	4.5138	0.6220	**15.8861.**	1.8701	-24.5357	-1.5837
SALEGrowth.i1$_{it}$	0.0003	0.0006	**1.1850***	2.0278	0.1137	0.0812	-0.8790	-0.5007	-0.1071	-0.0834
p.OIGrowth.i1$_{it}$	1.9802	0.2246	-1.3941	-0.1605	-3.7410	-0.4517	**-40.2253***	-1.9970	-18.3602	-0.9832
p.SALEGrowth.i$_{it}$	0.7245	1.1439	**-1.7212***	-2.3948	-1.0082	-0.7806	0.0102	0.0041	0.3430	0.3132
p.OC$_{it}$	-2.7754	-0.1571	52.5398	0.6741	**42.8365***	2.1043	-40.4542	-0.8032	-18.9136	-0.5920
p.BM$_{it}$	0.1818	1.4922	0.0700	0.5116	-0.0891	-0.2773	-0.0476	-0.2046	-0.0953	-0.2736
p.EP$_{it}$	0.1482	0.6514	0.0474	0.2257	0.2443	0.3222	-0.1367	-0.4289	0.7727	1.2395
p.Size$_{it}$	-0.1834	-1.4463	-0.0354	-0.2869	0.0759	0.2703	0.0331	0.1975	-0.0648	-0.1671
Sargan test	χ^2 (81) 30.00 (1.000)		χ^2 (80) 23.53 (1.000)		χ^2 (81) 65.80 (0.890)		χ^2 (81) 83.92 (0.390)		χ^2 (81) 53.58 (0.992)	
AR(1)	-3.07 (0.001)		-2.80 (0.003)		-2.07 (0.019)		-2.01 (0.022)		-1.90 (0.028)	
AR(2)	1.18 (0.118)		0.63 (0.263)		0.985 (0.162)		0.94 (0.172)		0.26 (0.396)	
Wald coefficient test	χ^2 (15) 60.11 (2.4171e-07)		χ^2 (15) 55.04 (1.7587e-06)		χ^2 (15) 39.72 (0.0004)		χ^2 (15) 35.78 (0.001)		χ^2 (15) 39.98 (0.0004)	

Variable definitions are provided in Appendix 1.
Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1.

In summary, benefits due to the unique skills and characteristics are obvious two years after the investments. Yet, value erosion occurs due to the skills present in the portfolio.

All models were fitted after close considerations of the methods outlined by Croissant and Millo (2008), who specify that the choice of the suitable panel model depends on the properties of the error term. All models are validated with the built in tests, with robust values against autocorrelation and heteroskedasticity. It can be read from the model diagnostics that the Hansen-Sargan tests of overidentifying restrictions indicate a reliable use of instruments (the first to fifth differences of labor in this case), by rejecting the null hypotheses at high p-values, ranging from 0.390 to 1.000. The hypothesis being tested with the Hansen-Sargan test is that the instrumental variable is uncorrelated with the residuals and therefore is an acceptable and healthy instrument. The Arellano-Bond tests of serial autocorrelation AR (1) indicate that no autocorrelation is present in the original errors, at p-values lower than 0.05 and the AR (2) tests indicate that the first lag variables are autocorrelated, just as they should be, at p-values higher than the 95 percent confidence interval. The Wald tests of the coefficients indicate that the null hypotheses of a 0 difference between the coefficients can be rejected at p-values smaller than 0.05, meaning that the estimators are relevant.

The elasticity of scale of the restricted Cobb-Douglas production function is the sum of the coefficients. The elasticity of scale defines the ratio of the proportionate increase in output to the proportionate increase in inputs.

TABLE 10: Univariate analyses of returns to scale. Dependent variable is $CUMABRET_{it+1}$.

Portfolio of OC_{it}	lag = 0	lag = 1	lag = 2	lag = 3	lag = 4
1:Bottom	-0.3984	-1.2039	-1.5044	-0.4117	-0.9793
2	-0.2292	-1.2530	-1.0921	-1.0576	-1.8544
3	-0.8049	-0.7276	-0.9348	-0.4481	-0.6852
4	-0.8137	-0.7547	-0.8238	-0.6157	-0.7000
5	-0.8228	-0.7330	-0.7357	-0.6908	-0.7185
6	-0.8271	-0.7926	-0.7415	-0.8312	-0.7681
7	-0.8062	-0.7701	-0.6022	-0.9226	-0.7398
8	-0.8480	-0.7360	-0.5451	-1.0853	-0.7978
9	-0.8565	-0.7241	-0.3594	-1.2240	-0.7505
10:Top	-0.7582	-0.6993	0.0396	-1.8821	-1.0189
Top minus Bottom	-0.3598*	0.5046*	1.5440*	-1.4703*	-0.0396
t-value	7.92	-18.51	-33.40	32.59	0.39

It can be observed from Table 10 that the returns to scale are lower than 1 in the same year (lag 0) and that the firms of all organization capital ranks exhibited decreasing returns to scale, although net income (EP_{it}) and size acted positively in the results described in Table 9. Thus, doubling the investments in the respective inputs did not lead to a doubling of the abnormal returns immediately.

The first year after the investments, the regression analysis supported the elasticity of operating income ($OIGrowth.i1_{it}$) and realized sales levels of the companion portfolio ($p.SALEGrowth.i1_{it}$) of the previous year, cf. Table 9. Table 10 shows that the negative effect of the previous year's sales levels of the average firm ($SALEGrowth.i1_{it}$) and the positive effects of operating income ($OIGrowth.i1_{it}$) and size were not as successfully balanced in the excess returns of the bottom-ranked firms. The top firms managed to capitalize more efficiently in these conditions, although at diminishing returns to scale.

The table further indicates that returns due to organization capital (OC_{it}) are positive two years after (lag 2), and this only for the top ranked firms. This value is supportive of the findings of Lev at al. (2009) which could not be reproduced in the analyses presented in

Tables 6, 7 and 8. It is nevertheless the single positive returns to scale value and the differences are diminishing in agreement with the R_OC_{it} rank of the firms, just as in the original analyses. In addition, it is noteworthy that in the regression analysis, the companion portfolio's level of organization capital ($p.OC_{it}$) acts negatively on the cumulative excess returns, and that in spite of the existing competitiveness, the top-ranked firms managed to attain higher returns to scale than their lower-ranked companions.

During the third year after the investments, it seems that the lower-ranked firms benefit more from the positive effects of the previously generated levels of operation income of the companion portfolio ($p.OIGrowth.i1_{it}$) than the top-ranked companies, although the operating income level of the average member firm ($OIGrowth.i1_{it}$) is acting negatively.

During the fourth year, the difference between the differently ranked firms has phased out and the seemingly diminishing returns from the unamortized profit component of organization capital ($AbProfit_{it}$) and previous returns' variance (VOL_{it}) acting negatively did not result in a statistically significant difference between the excess cumulative returns of the firms.

In order to visualize how the dynamics of organization capital varied during the analyzed years, the marginal rates of organization capital are computed for both the individual firms and the portfolios. Table 11 indicates the results, from where it can be read how the capacity of the individual firms of different ranks varied in comparison to the portfolios' organization capital benefits. All results are statistically significant for the analyzed years.

TABLE 11: Univariate analyses of organization capital marginal rates. Dependent variable is $CUMABRET_{it+1}$.

Portfolio of OC_{it}	lag = 0	lag = 1	lag = 2	lag = 3	lag = 4
1:Bottom	0.5446 | -0.5138	0.0973 | -0.3784	0.3753 | -0.9200	-0.2720 | 0.8688	0.0352 | 0.4062
2	0.2345 | -0.2178	0.0419 | -0.1604	0.1616 | -0.3901	-0.1172 | 0.3684	0.0152 | 0.1722
3	0.1462 | -0.1358	0.0261 | -0.1000	0.1008 | -0.2432	-0.0730 | 0.2297	0.0094 | 0.1074
4	0.0839 | -0.0777	0.0150 | -0.0572	0.0578 | -0.1391	-0.0419 | 0.1313	0.0054 | 0.0614
5	0.0338 | -0.0318	0.0060 | -0.0235	0.0233 | -0.0570	-0.0169 | 0.0539	0.0022 | 0.0252
6	-0.0120 | 0.0110	-0.0022 | 0.0081	-0.0083 | 0.0198	0.0060 | -0.0187	-0.0008 | -0.0087
7	-0.0673 | 0.0616	-0.0120 | 0.0454	-0.0464 | 0.1104	0.0336 | -0.1042	-0.0044 | -0.0487
8	-0.1319 | 0.1203	-0.0236 | 0.0886	-0.0909 | 0.2154	0.0659 | -0.2034	-0.0085 | -0.0951
9	-0.2286 | 0.2117	-0.0408 | 0.1559	-0.1576 | 0.3790	0.1142 | -0.3580	-0.0148 | -0.1674
10:Top	-0.5465 | 0.5137	-0.0976 | 0.3783	-0.3766 | 0.9198	0.2730 | -0.8687	-0.0353 | -0.4061
Top minus	-1.0911* | 1.0274*	-0.1949* |	-0.7519* |	0.5450* | -	-0.0705* | -
t-value	59.93 | -222.21	59.93 | -222.21	59.93 | -222.21	-59.92 | 222.21	59.93 | 222.21

*Individual firm OC marginal rates are indicated to the left, portfolio OC marginal rates to the right.

In general, the average top-ranked firm's marginal returns on its organization capital value are phased out by a portfolio belonging, whereas the opposite is true for the bottom-ranked firms, for which there are financial benefits of being associated with similar firms.

For the sole year where the returns to scale were positive for the top-ranked firms and the variables OC_{it} and $p.OC_{it}$ were significant in the regression analysis, i.e. lag 2, Table 11 clearly indicates how the marginal rates vary by rank and individuality vs. portfolio belonging. It can be observed that the marginal rates of the average firm increase along with the level of organization capital and that the marginal rate of -0.38 of the top ranked firms is below zero, i.e. profitable. On the portfolio side, it can be observed that the benefits of individual capabilities are eroded in the higher organization capital ranks. These results are in agreement with the findings presented in Table 9, where the individual skills (OC_{it}) were beneficial whilst the competition with similar firms expressed through the portfolio belonging ($p.OC_{it}$) eroded the excess returns.

Conclusion

The purpose of this study was to first reproduce and thereafter extend the findings of Lev at al. (2009). The performed analyses supported the original findings to a great extent, although with the minor limitation of not having dividend data available. Given the fact that the sample companies experienced two economic crises during the analysis period, it is worthwhile to mention that organization capital was found to have a delayed and positive effect on excess returns, in agreement with the source article. Likewise, one could argue that in spite of the regularly slower growth of larger companies, the top-ranked industry-year companies capitalized on unique capabilities to a higher degree than their lower ranked companions and that the developed organization capital measure was robust in capturing this phenomenon.

In addition, some new findings could be generated on this slightly different data sample (newer financial years and divided by the NAICS 2007 industrial standard), with a different estimation method and survey perspective. The results indicate that the companion portfolio's skills can be daunting for some firms and that stakeholders should therefore not blindly assess the value of a firm only based on its characteristics and earnings level. The major risk lies as identified in the analyses in the levels of other firms' exceptional skills and knowledge.

The level of operating income, more commonly known as cash flow dedicated to maintenance and growth of operations, was important one year after the investments. Especially noteworthy was the finding that although the effects of operating income diminish from one to three years after the investment, the level of cash flow present in the portfolio is a gold mine. The sales levels of the companion portfolio also brought excess returns for the average firm in the respective portfolios, although the average firm's sales level from the previous year was found to be a noticeable risk factor. Firm size had beneficial effects until two years after an investment, although inelastic ones. The variance of the previous book-to-market returns acted as a risk factor after two years from the investment, whilst the operating income was steadily value-giving.

This study makes thus several contributions to existing literature. First, this study contributes to management theory through new and convincing evidence of differences in financial and market value of firms, across firms of different sizes, and across industry types. Second, the extended modeling presents an accurate and complete picture of both the time and space dimensions of knowledge management, where the delayed returns on investment are successfully linked to future values, facilitating hence the estimation of future returns and understanding about the dynamics of the measure of organization capital. Third, the suggested statistical representation of the production function applies multiplicative error structures based on the assumption that non-zero contributions of the respective intellectual capitals are not possible in practice, which is applied on the data from a different perspective than previous analyses.

In conclusion, the effects of the measure of organization capital were traceable through this new perspective as well, and similar results could be supported on basis of the new findings as in the reference article. Organization capital is a robust measure and its relation to sales and operating income ratio should definitely be taken into account when assessing firm value.

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Appendix 1 – Variable Definitions

$AbCOST_{it}$ - Predicted cost and actual cost;

$AbProfit_{it}$ - $AbSALE_{it}$ + $AbCOST_{it}$;

$ABRET_{it}$ - Annual excess return adjusted for the companion size and book-to-market portfolio returns;

$AbSALE_{it}$ - Actual sale minus predicted sale without organization capital;

BM_{it} - Book value of equity divided by market value of equity;

$COST_{it}$ - Cost of goods sold plus the selling, general and administrative expenses;

$CUMABRET_{it+i}$ - Cumulative excess returns, ABRET cumulated from year t to year t + i;

D_EP_{it} - Indicator variable that equals one if net income divided by market value of equity is less than 0, and zero otherwise;

EMP_{it} - Number of employees;

EP_{it} - Net income divided by market value of equity if the ratio is greater than 0, and zero otherwise;

OC_{it} - Organization capital, computed by capitalizing and amortizing AbProfit over five years scaled by total assets;

$OIGrowth_{it+i}$ - Average difference between operating income in year t+i minus operating income in year t, scaled by total assets in year t;
PORTFOLIO - Categorical variable to indicate a firm's book-to-market, size and organization capital industry-year rank classification;
PPE_{it} - Gross plant, property, and equipment;
R_OC_{it} - The industry-year based decile rank of organization capital OC_{it};
$RDCAP_{it}$ - Research and development expenditure plus capital expenditure, scaled by sales;
$SALEGrowth_{it+i}$ - Average difference between sale in year t+i minus sale in year t, scaled by total assets in year t;
$SALE_{it}$ - Sales revenues;
SGA_{it} - Selling, general, and administrative (SG&A) capital computed by capitalizing and amortizing the SG&A expenses over three years;
$SIZE_{it}$ - Log of market value of equity;
VOL_{it} - Variance of the annual returns of a firm (book-to-market value) over the previous four years.