THE RELATIONSHIP BETWEEN THE PERFORMANCE OF THE ECONOMY AND THE COST OF CONSTRUCTION OF EDUCATIONAL BUILDINGS IN EGYPT: A PRELIMINARY STUDY.

Mohamed Salama, Ammar Kaka and Chris Leishman

School of the Built Environment, Heriot Watt University, Edinburgh, EH14 4AS, UK

The relationship between macro, international and local economic variables and the construction industry outcomes in Egypt is investigated. In 1992, Egypt launched a national project for the construction of educational buildings. This involved the construction of 1500 standardised design schools every year. From 1999, Egypt started to experience unfavourable economic conditions, ultimately leading to two currency devaluations during the period 2001-2003. The value of the fixed exchange rate currency settled at nearly 50% of its previous value. This research draws on a unique panel dataset in which each observation describes the cost and specification of an educational construction project. This allows design factors to be effectively standardised. The dataset is rich in variation in terms of economic variables. This permits the analysis to examine the impact of both economic variables and local factors on project cost. The paper concludes by mapping out future and ongoing work aimed at establishing and developing an analytical tool likely to have considerable value to planning authorities and construction industry stakeholders.

Keywords: building economics, educational buildings, Egypt, macro-economic variables.

INTRODUCTION

Egypt is an emerging country where a third of the population is under the age of 14. Only some 57% of its 75 million inhabitants can read and write. With thousands of years of civilisation, Egyptians want to equip the next generation with the skills to enrich the economy and create wealth.

During the period from 1992-2003 ‘The General Association of Educational Buildings’ (GAEB) built a total of 13350 schools contributing to more than a third of the total number of schools of Egypt ; 36332 schools with about 15 million students (of which 48% are girls) equating to about 21% of the population.

GAEB applied standard designs for different key-stages. Each Key stage had few standard designs to fit different locations. This meant that the same design was applied to many schools in different locations. The concept of standard design has been a trend the government introduced to other sectors like health services buildings and state housing.

Moreover, the Egyptian government intend to carry on with the same project due to the prevailing demand triggered by what seems to be ever lasting uncontrolled growth in population.

Salama, M, Kaka, A and Leishman, C (2005) The relationship between the performance of the economy and the cost of construction of educational buildings in Egypt: a preliminary study. *In:* Khosrowshahi, F (Ed.), *21st Annual ARCOM Conference*, 7-9 September 2005, SOAS, University of London. Association of Researchers in Construction Management, Vol. 2, 731-40.

Over few decades, Egypt has been burdened by the consequences of so many years in war and under a political system that very much controlled the economy. Despite the different reform programmes attempted since the 80's, the Egyptian government is still facing huge challenges.

The construction industry is one of the main constituents of the Egyptian economy and contributes to about 4.7% GDP. Needless to mention the great social role construction plays given it is a labour intensive industry.

The recent privatisation of several cement factories led to an unprecedented fluctuation in cement prices. Local and foreign investors competed to acquire the lucrative business especially with the introduction of new environmental regulations in most of the southern Europe countries once used to be the main producers of cement in the international market and main exporters to the Egyptian markets. As a consequence the construction market witnessed a period of price instability which extended over three years with prices fluctuating from as low as 100L.E. per ton to as high as 280 L.E. per ton (sometimes within the same month). Prices were set on day per day basis with no defined or even predictable pattern.

The steel producers with heavy debts, mainly to national banks, forced the government to intervene by imposing new taxes (dumping tax) on all steel imports. They claimed that this was the only way they can pay their debts and justified their right to be protected against what they described as subsidised exports. This created Oligopoly and coupled by the two devaluations of the currency, prices increased nearly three folds in three years (1100L.E/ton in 2001 - 3000L.E./ ton in 2003).

With steel and cement contributing to more than 40% of the total cost of school buildings, cost estimating and price forecasting became very hard. Yet the major challenge was faced by contractors with already significant work in progress and bound by firm price contracts to public sectors like GAEB

PROBLEM IDENTIFICATION

The problem in fact lies in a three dimensional perspective:

1. The economic turbulence through which Egypt has been struggling to survive did exist since the mid seventies. The government being the policy maker does not seem to have a structured approach to study the different relationships necessary to ensure the effectiveness of using the construction industry as one of the tools to regulate the economy. This had severe implications on both; contractors and projects. The GAEB had to adjust prices every year from 1999 until 2004 that indicates a reflective and reactive rather than planning role.
2. In Egypt, contractors, a majority of them being small or medium size companies, lack the expertise to any reasonably accurate cost estimating. The detailed economical appraisal of the current situation is far beyond their capabilities. The contractors, who have recently suffered huge financial repercussions due to delayed payments in 1999, were faced by another shockwave over the period 2001 until 2003 due to the devaluation of the currency. This led to a notable increase in bankruptcy cases and the delay or complete stop of some projects.
3. The slow down of the construction industry in Egypt (being labour intensive) caused serious social implications due to massive layouts. Needless to mention the slow down featured in the so many intermediate industries.

The government advocating new standard design for education, health and housing projects has offered researchers an unprecedented opportunity to investigate such relationship. The standard design eliminates many variables related to the product, hence focusing more on the effect of macroeconomic variables on the cost of construction.

The aim of this research is to provide both the planning authorities and the contractors with a structured approach for modelling the relationship between the different governing economic factors and the cost of construction. This preliminary study is the firs step to developing a model that aims to enhance the accuracy of cost estimating especially in dire economic conditions.

LITERATURE REVIEW

Through out the development of economics subject area, the questions examined by various schools are usually those, which are of contemporary relevance at a particular point in time in a given set of circumstances. (Raftery 1991).

Hence, reviewing the literature on building economics, a wide majority of previous work is either country or region specific. Among the countries covered in the literature, for example, are Ghana and Tanzania (Ofori,1984), Singapore (Ofori, 1998), Greece (Dawood, 2000), Taiwan (Wang and Mei, 1998), Portogal (Lopes and Ribeiro, 2000), Subsaharan Africa (Lopes, Ruddock and Ribeiro, 2002), Libya (Omar and Ruddock, 2001), Malyisia (Ruddock, 2002), UK (Rawlinson and Raftery,1997; Akintoye, Bowen and Hardcastle, 1998; Fitzgerald and Akintoye, 1995 and others), Hong Kong (Ng et al, 2000; Tse and Ganesan, 1997), and Indonesia, (Kaming, 1997)

There is a clear gap in the literature in covering the Egyptian case. The aforementioned literature emphasises the need for a specific investigation in order to derive a relationship between the macroeconomic variables and the cost of construction projects in Egypt due to different underlying circumstances and prevailing trends

Cost estimating of construction projects has been an important concern of many researchers. In establishing the relationship between determining factors and cost, (Trost and Oberlender, 2003; Ling et al., 2004) applied the ordinary least square regression approach and chose the best model based on the coefficient of multiple determination or the R^2 value.

Kaming et al (1997) applied the factor analysis, and extracted ‘factors’ or ‘components’ out of the original variables. Chan et al. (2001) grouped a large number of variables into the reduced number of ‘factors’ whose loadings indicate the relative importance of each factor.

Moreover, regression analysis, used in this paper, has been applied by many researchers; Neale and McCaffer (1974); Ashworth et al. (1980); McCaffer et al. (1983); Fellows, (1988); Akintoye and Skitmore (1994); Songer and Molenaar (1997); Konchar and Sanvido (1998); Smith (1999); Ameen et al (2003) and others.

Ruddock (2002) addressed the crucial problem of the quality of statistical data and the limitations of existing data sources. In pursuance of Ruddock’s recommendations, macroeconomic data used in this paper are based on recent official statistics to ensure validity and reliability.

.

AIMS AND METHODOLOGY

The study focuses on the construction costs for education buildings in Egypt. A sample of 122 schools built in the period from 1995-2003 was collected. The sample included schools built in different locations in 13 governorates (provinces), spreading from Upper Egypt (Luxor, Qena) to the Northern Coast. The main characteristics of the standardised design applied may be summarised as follows:

1. the main building is a multiple of a fixed module
2. the skeleton specifications are the same in terms of material and statement of work
3. the finishing specifications are the same in terms of material used

The elimination of the foundation, landscape and other facilities that vary from one school to the other aimed at focusing the light on the super structure of the main building meanwhile reducing the number of project variables; hence, we may be able to emphasise the effect of the macroeconomic variables.

The macroeconomic variables investigated are the GDP, interest rates, exchange rates

($ vs. L.E.) both official and unofficial rates . The study also included US. GDP and interest rates due to the strong ties between both countries in terms of economic influence. The Egyptian currency like some other Middle-East currencies is srongly related to the U.S. Dollar.

The model is estimated using ordinary least squares (OLS) regression. To normalise the data, and to aid interpretation of the coefficients, a log-log functional form is used. The underlying objective is to test the hypothesis that macro and international economic variables are significant predictors of project cost even after accounting for project specific design differences.

EMPIRICAL RESULTS

The simple initial model includes the natural log of project cost as the dependent variable. A vector of explanatory variables measure variation in project size and design while a set of macro economic variables proxy economic trends and conditions both in Egypt and in the United States. Variables describing economic conditions in the latter effectively proxy import / export conditions between Egypt and abroad. All time series macro variables are also measured in natural logs.

Table 1 Preliminary estimation results

Variable	Label	Coefficient	t statistic		Tolerance
Constant		-4.114	-0.355		
L_PCSK	Plain concrete in skeleton	0.051	1.315		0.312
L_RCSK	Reinforced concrete in skeleton	0.378	2.318	**	0.031
L_DOORS	No of doors	0.025	0.269		0.086
L_WIND	Area of windows	0.138	1.833	*	0.102
L_SBRI	Brick work in sq m	0	-0.004		0.129

L_CBRI	Brick work in cu.m.	0.113	0.991		0.087
L_PLAST	Quantity of plastering	0.196	1.28		0.036
L_PAINT	Quantity of Paint works	-0.071	-3.14	***	0.463
L_ILLUM	No of illum. points	0.119	2	*	0.171
L_UGDP	US GDP	1.15	1.205		0.028
L_EXO	Exchange rate to $, official rate	-0.221	-0.772		0.097
L_URI	U.S. interest rate level	1.017	0.852		0.218
L_EUGDP	Egy/US. GDP	-0.196	-0.232		0.073
L_OFUN	Official/unofficial exchange rate	-0.615	-0.837		0.156
L_EUROI	Egy/US. Interest rate	-0.392	-0.858		0.203
R Square		0.948			
Adj. R Square		0.935			
F statistic		72.891	***		

The final column in table 1 indicates the tolerance of each explanatory or independent variable with respect to the set of other explanatory variables. The measure represents the residual or unexplained error that results when the other explanatory variables are used to predict the independent variable. For example, the tolerance of L_RCSK (0.031) shows that an R square of 0.969 results when the other explanatory variables are used to predict L_RCSK. The tolerance measures are very low for a number of the explanatory variables suggesting the presence of multicollinearity. The strong explanatory power of the model coupled with low t statistics is also suggestive that this is the case. The result is that the coefficients and corresponding t statistics cannot be relied upon as unbiased estimates.

One possible solution to the possibility of multicollinearity is to drop combinations of variables that are highly collinear with other predictors. However, the approach adopted here is to further explore the collinearity with the set of explanatory variables using principal component analysis. One advantage of this approach is that information from all of the original variables can potentially be retained in the resulting factor scores.

The principal component analysis uses Varimax factor rotation to maximise the meaning of the factor scores (new variables). This method of rotation tends to result in factor scores that load heavily on a relatively small number of original variables. To further aid interpretation of the new factors, two separate rounds of principal component analysis are undertaken using only physical descriptors of project size in round one of the analysis and only macro economic variables in the second round.

Table 2 Loading matrix for the project specific variables

	Component	
Variable	1	2
L_PCSK	0.861	0.165
L_RCSK	0.858	0.457
L_DOORS	0.794	0.512
L_WIND	0.787	0.500
L_SBRI	0.826	0.361
L_CBRI	0.878	0.389
L_PLAST	0.87	0.418
L_PAINT	0.303	0.926
L_ILLUM	0.759	0.518
Initial Eigenvalues	7.392	0.540
Initial % of Variance	82.138	6.002
Rotated % of Variance	62.259	25.882

The results of the first round of factor analysis suggest very strong correlation within the set of project specific variables. A single component or factor accounts for more than 80% of the variance or information contained within the original set of variables. In order to retain as much information as possible about the physical description of each construction project, the eigenvalue threshold is set at 0.5 rather than 1.0 and this results in the creation of two principal components. On Varimax rotation these respectively describe 62% and almost 26% of variance in the original set of 9 variables. Table 2 sets out the rotated component loading matrix.

The rotated factor loading matrix shows that factor 1 loads heavily on a number of project specific variables including plain concrete, reinforced concrete, number of doors, number of windows, square metreage of brickwork, cubic metreage of brickwork, quantity of plasterwork and number of lighting points. The second factor loads primarily on quantity of paintwork although quantity of reinforced concrete, number of doors, number of windows and number of lighting points are also correlated with this factor.

A second round of factor analysis focuses on the macro economic variables as noted earlier. This round of analysis also results in the creation of two uncorrelated principal components or factor scores as shown in table 3.

Table 3 Loading matrix for the macro economic variables

Variable	Label	Component 1	Component 2
L_EGDP	Egy. GDP	0.614	0.767
L_UGDP	US GDP	0.607	0.781
L_EXO	Official exchange rate	0.905	0.361
L_EXU	Unofficial exchange rate	0.828	0.522
L_URI	US int. rate	0.116	-0.949
L_ERI	Egy int. rate	-0.938	-0.258
L_EUGDP	Egy GDP/US GDP	0.606	0.726
L_OFUN	Off. ex. rate/unoff. Ex. rate	-0.275	-0.892
L_EUROI	Egy int. rate/US int. rate	-0.984	0.071
Initial Eigenvalues		6.697	1.752
Initial % of Variance		74.408	19.468
Rotated % of Variance		50.597	43.279

The factor analysis shows that the 9 macro economic variables can be reduced to an uncorrelated set of 2 principal components or factor scores. Together these contain more than 93% of the variance or information in the original set of 9 correlated variables. Table 3 sets out the loading matrix following Varimax rotation.

The loading matrix shows that factor 1 loads heavily on GDP for Egypt and the United States and both the official and unofficial exchange rates and negatively with the interest rate level of both Egypt, and the Egyptian interest rate level relative to that of the United States. The second factor loads mainly on Egypt and US GDP and inversely on US interest rates as well as the ratio of the official to unofficial exchange rates.

The final model estimation substitutes the four new factor scores in place of the original sets of project specific and macro economic variables. The results are shown in table 4

Table 4 Final estimation results

Variable	Coefficients	t statistics		Tolerance
Constant	13.41	670.325	***	
Macro factor score 1	0.098	4.443	***	0.961
Macro factor score 2	0.076	3.838	***	0.983
Project specific factor score 1	0.553	27.395	***	0.995
Project specific factor score 2	0.217	10.76	***	0.962
R Square	0.929			
Adjusted R Square	0.925			
F statistic	233.915	***		

The results clearly show the dominant influence of project specific factors in the determination of total project costs. Given the log-log specification of the model, the coefficients can be interpreted as elasticities. In other words, a 100% increase in the “size” of a project gives rise to an approximately 77% rise in project costs (summing the elasticities of the two project specific factor scores). Meanwhile, both of the macro economic factor scores are statistically signifiance at 1% but have much lower coefficients or elasticities. However, some generalisable predictions can be made about the role of the macro economic factors in the determination of project costs:

A 100% rise in factor 1 would give rise to an approximately 10% rise in project cost. As noted earlier, macro economic factor 1 represents US and Egyptian GDP, the exchange rate (relative value of Egyptian currency) and the inverse of the Egyptian interest rate level. The most interesting finding is that project costs tend to rise when the Egyptian interest rate decreases relative to US interest rates, all other things being equal.

Meanwhile, a 100% rise in factor 2 would give rise to an approximately 7.6% rise in project cost. This factor partly reflects divergence between the official and unofficial exchange rates given that this factor loads on unofficial, but not official exchange rates. The implication is that an increase in factor 2 represents an increase in the unofficial exchange rate (number of Egyptian currency units required to purchase a dollar) with respect to the official fixed rate. This gives rise to an increase in project costs. The results therefore suggest that project costs increase when economic conditions call for a devaluation in the Egyptian currency and where those conditions are not met by an official devaluation.

CONCLUSIONS AND FURTHER DIRECTIONS

The paper has investigated the relationship between the macroeconomic variables and the cost of school buildings in Egypt. The findings may be summarised as follows:

- Not surprisingly, project costs are dominated by project specific variables.
- Macro economic variables are statistically significant.
- It is worth remembering that the underlying variation in macro economic variables is smaller than project specific variables (i.e. the data contain variation in project sizes) but the variation in a short-time series will be limited for the macro variables.

Also, for further directions:

- Future specifications of the model will include lagged time series variables in an attempt to capture dynamic adjustment.
- Consideration will be given to extending the length of time series.
- Consideration will be given to the identification of locational (probably regional)variables

REFERENCES

Ameen, J R M, Neale, R H and Abrahamson, M (2003) Regression analysis & increased costs. *Construction Management and Economics* **21**ɗɛɟħ□ɛgɟ

Akintoye, A , Bowen, P and Hardcastle, C (1998) Macro-economic leading indicators of construction contract prices. *Construction Management and Economics*, **16** (2), 159-75

Akintoye, A and Skitmore M (1994) Models of UK private sector quarterly construction demand, *Construction Management and Economics*, **12**(1), 3- 13.

Ashworth, A, Neale, R H and Trimble, E G (1980) An analysis of some builders’ estimating. *The Quantity Surveyor*, **36**(4), April 1980, 65–70.

Chan, P C A, Ho, C K D and Tam, C M (2001) Design and build project success factors: multivariate analysis. *Journal of Construction Engineering and Management*, 127(2), 93–100.

Dawood, N (2000) Forecasting of cost indicies in the Greek construction industry: a joint methodology approach. . *In:* Akintoye, A (Ed.), *16th Annual ARCOM Conference*, 6-8 September 2000, Glasgow Caledonian University. Association of Researchers in Construction Management, Vol. 2, 597-604.

Fellows, R F (1987) Towards the prediction of escalation on UK building projects. In *Proceedings of the CIB W-55 Symposium*, Copenhagen, Vol. B**,** 57- 66.

Fitzgerald, E and Akintoye, A (1995) The accuracy and optimal linear correction of UK construction tender price index forecasts. *Construction Management and Economics*, **13** (6), 501-10

Kaming, P F K, Olomolaiye, P.O., Holt, G and Harris, F C (1997) Factors influencing construction time and cost overruns on high-rise projects in Indonesia. *Construction Management and Economics*, **15**(1), 83–94

Ling, F Y Y , Chan, S L, Chong, E and Lee, P E (2004) Predicting performance of design–build and design–bid–build projects. *Journal of Construction Engineering and Management*, 130(**1**), 75–83.

Lopes, J and Ribeiro, F L (2000) The construction industry in Portugal: macroeconomic analysis and future trends. *In:* Akintoye, A (Ed.), *16th Annual ARCOM Conference*, 6-8 September 2000, Glasgow Caledonian University. Association of Researchers in Construction Management, Vol. 1, 167-76.

Lopes, J, Ruddock, L and Ribeiro, F L (2002) Investment in Construction and Economic Growth in Developing Countries. *Building Research and information*, Vol. 30 No.3, p152 – 159.

Neale, R H and McCaffer, R (1974) Regression analysis as a contractors' estimating tool. *Proceedings of the 'Research and Development in Estimating' Conference*, Loughborough University of Technology, March.

Ng, S T, Cheung, S O, Skitmore, R M, Lam K C, and Wong, L Y (2000) Prediction of tender price index directional changes. *Construction Management and Economics*, **18** , 843-852

Ofroi, G (1984) Improving the construction industry in declining developing economies. *Construction Management and Economics*, **2** (2), 127-32

Ofori, G (1998) Sustainable construction: principles and a framework for attainment – comment. *Construction Management and Economics*, **16** (2), 141-45

Omar, A and Ruddock, L (2001) Housing Policies and Strategies: The Experience of Libya, *Proceedings of the RICS Construction Research Conference 'Cobra'*, Sept. 2001, Glasgow, p614 -624.

Raftery, J (1991) *Principles of Building Economics*.Oxford: BSP

Rawlinson, S and Raftery, J (1997) Price stability and the business cycle: UK construction bidding patterns 1970-91. *Construction Management and Economics.* **15**(1), 5-18

Ruddock, L (2002) Measuring the Global Construction Industry: Improving the Quality of Data. *Construction Management and Economics*, **20**(7), 553 – 556.

Ruddock, L (2002) The Influences of Economic Growth and Urbanisation on Retail Values in Malaysia, *Proceedings of the Second International Postgraduate Research in the Built and Human Environment*, Salford

Smith, S D (1999) Earthmoving productivity estimation using linear regression techniques. *Journal of Construction Engineering and Management, ASCE,* **125**(3), 133–40.

Songer, A D and Molenaar, K R (1997) Project characteristics for successful public-sector design–build. *Journal of Construction Engineering and Management, ASCE,* **123**(1), 34-40.

Trost, S M and Oberlender, G D (2003) Predicting accuracy of early cost estimates using factor analysis and multivariate regression. *Journal of Construction Engineering and Management, ASCE,* **129**(2), 198–204.

Tse, R Y C and Ganesan, S (1997) Causal relationship between construction flows and GDP: evidence from Hong Kong. *Construction Management and Economics.* **15**(4), 371-376

Wang, C H and Mei, Y H (1998) Model for forecasting construction cost indices in Taiwan. *Construction Management and Economics,* **16**(2), 147-157