M.Sc. Projects from Adam Ostaszewski for Summer 2012

1. Mathematical Aspects of the Theory of the Firm

Background required: The course MA409 Continuous-time optimization. It would be helpful, but not essential, to have some very basic knowledge of the economics of the firm and a general idea about what 'shares' are. Of course students following the options offered by the Dept. of Finance will be at an advantage (or if they have followed MA310 or an equivalent).

Students will profit at the start from looking at the following two text-books:

Dixit, A.K., and Pindyck, R.S., (1994), "Investment Under Uncertainty", Princeton University Press.

and

S. Howell et al. (2001), "Real Options", Prentice-Hall.

Project 1.1 Market Value versus Book-Value (Using databases like Compustat, Datastream, or Amadeus)

What is the functional relation between a company's market value and its current earnings and /or book-value. Since the firm has the option to alter its business strategy the simplest model is an options based valuation. At its simplest this predicts a

convex functional dependence. Research from databases implies some more structure to the shape. The basic paper which needs to be read is:

Burgstahler, D., Dichev, I., Earnings, Adaptation and Equity Value, Accounting Review, 72,2,(1997) 187-215

Questions to consider: alternative curve fitting to the one in the paper, comparison of data coming from other accounting standards (this may be harder to arrange, given earlier dissertations), or a more specific explanation of the option-valuation which could be worked out under my supervision. The student would have to absorb this paper and attempt a better explanation. For the more curious and motivated student, a grasp of the following recent paper would be a boon.

Ashton, D.,Cooke, T. Tippett, An Aggregation Theorem for the Valuation of Equity under Linear Information Dynamics, J. Business Finance & Accounting, 30 Nos 3&4 (2003) 413-440.

Project 1.2 Debt-Equity ratio of Firm

The mathematical theory of the optimal amount of debt taken on by a firm is modelled in the following paper:

Leland, H. E., Corporate Debt value, Bond covenants, and Optimal Capital Structure, J. of Finance, Vol 49, No 4 (Sep. 1994),1213-1252.

The student could explain this work, look at precursors and later literature. The qualitative properties of some of the graphs in the Leland paper could do with a proper mathematical discussion using considerations based on calculus. This can be supported by numerical calculations using Maple. The Leland paper is somewhat muted in its discussion of the impact on its findings of some of the key assumptions

(like dividend policy, and prioritization of debt) and the student could re-consider some of the few established claims in this area of the paper by re-calculating what happens when the assumptions are altered. (Leland does provide hints.) Useful additional descriptive contributions would include information on the debt/equity ratio in various countries/sectors.

Project 1.3 Dividend Policy

The question of what information is signalled by a firm when it is offering dividends as a result of an equity issue with an uncertain payoff is considered in:

Bhattacharya S., Imperfect information, dividend policy, and "the bird in the hand" fallacy, Bell J. Economics, Vol 10 (1979),259-270

The student would attempt at recreating the argument and computing optimal policies.

There is now a sizeable literature on dividend policy around, e.g.

Jeanblanc-Picque, M., Shiryaev,A.N., Optimization of the flow of dividends, Russ. Math. Surveys, 50 (1995)257-277

and this could be researched and also summarized.

This project, in contrast to the others, is more theoretical and thus involves somewhat more reading.

Project 1.4 The "well-tempered" firm

Pardon the private pun on Bach. There is a well-established and still growing literature on optimal behaviour of a firm controlling its revenues through optimal investment and divestment in some one input (raw-material or capital). A partial survey of such switching models should be attempted. Some kind of modelling, or simulation (using Maple), can be attempted (as well as attempting to solve differential equations numerically) by following through a theory paper such as the following:

Abel, A.B., and Eberley, J.C., (1996), "Optimal Investment with Costly Reversibility", *Review of Economic Studies*,

as well as

Abel, A.B., Dixit, A.K., Eberley, J.C. and Pindyck, R.S., (1996), "Options, the Value of Capital, and Investment", *Quarterly Journal of Economics*.

and the fairly recent follow-on:

Eberly, J. and Van Mieghem, J. (1997), "Multi-factor Dynamic Investment under Uncertainty", *J. Economic Theory*, 75, 345-387.

For someone wanting a challenge: optimize over a more restricted admissible class of investment response functions (e.g. linear in the state variable).

One possibility is to work out a discrete time multi-period model of firm activity. This would follow familiar lines, as developed in the Binomial Model of Finance (due to Cox-Ross-Rubinstein). This project could therefore involve some computer work apart from an explanation the background ideas.

2. Investment Options (aka: 'Real Options')

Project 2.1 Real Options: applications ... like Real Estate

This project is an opportunity to examine how the mathematics associated with valuing financial options can be used to value non-financial assets. One example is the value of a piece of land (real estate). Its value is clearly based on 'Planning Permission' permitting what might be built upon it. For instance, the type of building and the expected rental income depending on when development costs are to be committed and the optimal time to build within the Planning Permission horizon.

Tien Foo Sing, 'Optimal timing of a real estate development under uncertainty', *Journal of Property Investment & Finance* 19(2001)35-52.

Note the website access to this article at:

http://www.lyons.co.za/docmanager/presentations/200222112641.pdf

The above paper could be re-worked. It can be simplified to an extent that will enable a one variable argument to work satisfactorily. The partial differential equation at the centre of the above paper could be attacked using numerical methods and it would be interesting to check its solution against Tien Foo Sing's proposed theoretical solution based on a simplification of the boundary conditions. This has been done in past dissertations using three different techniques, but there is still some scope for numerical work on this.

See also

Trigeorgis,L., 'Real Options in Capital Investment, Models, Strategies, and Applications', Praeger,1995.

Project 2.2 Real Options: some strategic issues

This project combines valuation with some game theory. At its simplest it concerns a market *duopoly* in which each of the two firms may have to face the need to exercise its option to fold: to abandon activity. Since this exit improves the remaining agent's prospects, there is scope for hanging on in hope of gaining the monopoly benefits. There is a burgeoning literature on this subject. I have in mind a recent paper by William Perraudin as the focus for the dissertation. It seems to me it would be possible to vary some of the modelling assumptions and to deduce qualitatively similar features. This topic would involve both theoretical modelling and some numeric simulations.

Project 2.3 Voluntary Corporate Disclosure: optimal exercise of the options to disclose.

'An early finding in the corporate disclosure literature provided by Grossman and Hart (1980) and Grossman (1981) has become known as the unravelling result. In a class of models, if rational agents (managers of firms) that hold private information choose to withhold disclosure to interested outsiders such as investors, then those interested parties will follow what we term a '*minimum principle of valuation*': they discount the value of the firm down to the lowest possible value consistent with whatever discretionary disclosure is made. Once agents recognize this, they will have an incentive to make full disclosure. The contribution of Dye (1985) was to provide a rationale for why this full disclosure unravelling result might not occur. He showed that the qualitative features of an optimal disclosure policy for management may take the form of a policy dependent on a cutoff in which management disclose only if the information

is sufficiently good, otherwise they do *not* disclose. The new friction he introduces to explain movement away from the unravelling scenario is that investors might not be able to distinguish agents holding undisclosed information from agents not holding the undisclosed information. In such a setting investors seeing non-disclosure have to temper their inferences concerning the likelihood of a manager having observed bad news and choosing not to disclose (that is choosing to "sit on" bad information) by the fact that non-disclosure may have arisen instead because management were in fact uninformed. This provides us with one clear rationale for why management may choose to not disclose information. Jung and Kwon (1988) developed the Dye result by presenting comparative statics for instance showing how the level of the cutoff depends on q (the probability that the manager is informed). Intuitively speaking, they explain how if a manager is informed with a higher probability q (closer to one), it is rational for the investor seeing non-disclosure to assign a higher (conditional) probability that the manager was informed of a poor (below cutoff) realization rather than that the disclosure arose from lack of information.'

One can interpret management's choice of whether to disclose discovered value, or not, strategically as an optimal exercise of an embedded *option* to report value.

One stream of research starting with Penno (1997) has developed new insights under the assumption that rather than the manager perfectly observing firm value with probability q, instead the manager observes firm value imperfectly – with superimposed noise. Thus in this class of model the precision (noise level) of the signal that the manager observes becomes a critical determinant of disclosure strategy. Further extensions of this noisy observation literature involve allowing multidimensional signalling as in Hughes and Pae (2004), or allowing repeated independent observation (sampling) as in Pae (2005).

This project involves a reappraisal of Pae (2005) by altering the modelling assumptions, e.g. replacing Pae's normal distributions of underlying value and of noise (with

known means and variances) by say gamma distributions or log-normal ones. For motivation and background see my paper with Miles Gietzmann *Value Creation with Dye's Disclosure Option: Optimal Risk-Shielding with an Upper Tailed Disclosure Strategy* either on my webpage **http://www.maths.lse.ac.uk/Personal/adam/**

or pick it up from **http://www.springerlink.com/content/c541384437v40165/fulltext.pd**

Here are some literature references:

Baiman , S. and Verrecchia, R.E., , *The Relation among Capital Markets, Financial Disclosure, Production Efficiency , and Insider Trading,* Journal of Accounting Research , 34 No. 1, 1-22, (1992)

Cosimano, T.F., Jorgensen, B.N. and Ramanan, R., "*Discretionary Disclosure Over Time*", Working Paper, (2002)

Dye, R.A. "*Disclosure of Nonproprietary Information*", Journal of Accounting Research, 23, 123-145, (1985)

Einhorn, E., Ziv,A., "*Inter-temporal Dynamics of Corporate Voluntary Disclosure*", Working Paper TAU, (2005a).

Einhorn, E., Ziv,A., "*Intra- and Inter-temporal Dynamics of Corporate Disclosure and Operating Activities*", Working Paper TAU, (2005b)

Grossman,S., and Hart, O. "*Disclosure Laws and Take-over bids*" Journal of Finance 35, 323-34, (1980)

Grossman,S., "*The Informational Role of Warranties and Private Disclosure about Product Quality*" Journal of Law and Economics 24, 461-483, (1981)

Hughes, J.S., and Pae, S.,"*Voluntary Disclosure of Precision Information*", Journal of Accounting and Economics, 37, 261-289, (2004)

Pae, S.,"*Selective Disclosures in the Presence of Uncertainty about Information Endowment, Journal of Accounting Economics*", 39, 383-409, (2005)

Penno, M.C., "*Information Quality and Voluntary Disclosure*", The Accounting Review, 72, 275-284, (1997)

Woon-Oh Jung and Young K. Kwon, "*Disclosure When the market Is Unsure of Information Endowment of managers*", Journal of Accounting Research, 26,1, 146-153, (1988).

Project 3. Bargaining Theory Project

Project 3.1 The commitment game

Background reading:

The book:

Muthoo, A. (1999). "Bargaining Theory with Applications", Cambridge University Press.

The paper:

Muthoo, A. (1996). "A bargaining model based on the commitment tactic", *Journal of Economic Theory*, April , **69,** 134-152.

This topic concerns bargaining theory. One pre-requisite is of course a course in game theory, but more specifically knowledge of the Rubinstein's alternating-offers model. There are a number of variations on the standard Rubinstein model, many of them described in Muthoo's book on Bargaining Theory. One of these is a study by Muthoo of the effects of 'commitment tactics', cited above. His model uses the Nash Bargaining axioms to resolve conflicting claims and assumes a progressive penalization of a bargainer who revokes his commitment. I have written up ... a variation on this theme. In the new circumstances the two parties negotiate explicitly by way of the Rubinstein structure, moreover, the penalization is identical for both players and importantly discontinuous (a *fixed* charge, or none, according as a revocation occurs or not). The topic offered involves looking at alternatives to this game, like unequal

fixed charges, or linear interpolations of the *fixed* charge (smoothing the jump from no charge to fixed charge in a linear fashion).

Some literature needs to be absorbed, and there will be plentiful scope for computer assisted investigations using Maple.

Project 4. Analysis: regularly varying functions

The standard text is : N. H. Bingham, C.M. Goldie, J.L. Teugels, *Regular variation,* 2nd edition, Encycl. Math. Appl. 27, Cambridge University Press, Cambridge, 1989 (1st edition 1987).

A function $f : \mathbb{R} \to \mathbb{R}$ is regularly varying if the limit

$$g(\lambda) := \lim_{x \to \infty} f(\lambda x)/\, f(x)$$

exists for all $\lambda > 0$. The limit function g must satisfy the Cauchy functional equation

$$g(\lambda\mu) = g(\lambda)g(\mu) \qquad \forall \lambda, \mu > 0,$$

Subject to a mild regularity condition, the Cauchy equation forces g to be a power:

$$g(\lambda) = \lambda^{\rho} \qquad \forall \lambda > 0.$$

Then f is said to be *regularly varying* with *index* ρ, written $f \in R_\rho$.

Recent work on the classical theory has clarified its connections with infinite combinatorics on the real line and in Euclidean space, and beyond (see my homepage). This project would involve writing a resumé of the basic theory and a discussion of either some application of the theory (e.g. the Central Limit Theorem) or a generalization (e.g. Karamata index for functions on $\mathbb{R}^2$).