**FULL PROPOSAL (FP)**

**Section A: Project Overview Start Date:** November 2014 **Completion Date:** June 2015

1. **Project Name:** (*up to 15 words)*

Quantifying the impact of systemic risk on capital requirements for interrelated financial institutions and sectors.

1. **Project Summary:** (*up to* *150 words).*

The proposed project aims to quantify the impact of systemic risk and contagion effects on capital requirements for interrelated financial institutions and sectors.

Adverse events in one financial institution or sector have flow-on impacts on related institutions or sectors. Further, external economic and financial shocks simultaneously affect multiple institutions and sectors. This project assesses the effectiveness of group and industry-wide stress testing in the presence of systemic risks and contagion effects. The project also proposes methods to analyse and, if necessary, adjust results of stress testing.

The project and its methodological developments have implications for how APRA and industry can enhance their stress testing procedures and learn more from results of this testing. The aim is to improve solvency monitoring and capital setting.

1. **Project Team:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title** | **First Name** | **Surname** | **Position** | **School** | **Faculty** | **Institution** | **Team Position** | **Email** |
| Prof | Piet | De Jong | Professor of Actuarial Studies | Department of Applied Finance and Actuarial Studies | Faculty of Business Economics | Macquarie University | Leader | piet.dejong@mq.edu.au |
| A/prof | Geoffrey | Loudon | Associate Professor in Applied Finance | Department of Applied Finance and Actuarial Studies | Faculty of Business Economics | Macquarie University | Principal researcher | geoff.loudon@mq.edu.au |
| Mr | Weihao | Choo | Senior Consultant, Ernst & Young [PhD student] | Department of Applied Finance and Actuarial Studies | Faculty of Business Economics | Macquarie University | Principal researcher | chooweihao@gmail.com |

1. **Budget** (cash request only):

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Year 1** | | **Year 2** | | **Year 3** | | **Total** | |
| **CIFR** | **Member** | **CIFR** | **Member** | **CIFR** | **Member** | **CIFR** | **Member** |
| 90,410 | 90,410 | 0 | 0 | 0 | 0 | 90,410 | 90,410 |

1. **Relevant CIFR Key Area of Interest** (see [www.cifr.edu.au](http://www.cifr.edu.au) - indicate one and justify in up to 100 words)**:**

Systemic Risk 🗹 Financial Market Developments 🞎 Market and Regulatory Performance 🞎

Assessing systemic risk in Australia requires a coherent methodology implemented in the Australian financial system context. A number of methodologies have recently been proposed to assess systemic risk (see references later). The current project aims to critique, improve upon and test these methodologies, and apply and implement the improved technologies in the Australian context.

Present regulations are based on "standalone" standard approaches such as Value-at-Risk where individual industries are analysed on a standalone basis using similar stress scenarios. Non-standalone approaches factoring in systemic risk may lead to different capital requirements, uncover systematic biases and tighten or amplify confidence intervals around capital requirements in line with the economic cycle. Both over and underestimation of capital requirements across the economic cycle impose costs on the economy and hence it is important to balance conflicting aims given potential external shocks and systemic biases.

1. **This proposal may be of interest to** (indicate one or more, justify in up to 100 words and include mention of any such organisation you have already consulted with and the names of relevant personnel)[[1]](#footnote-1)**:**

APRA 🗹 ASIC 🗹 RBA 🗹 Treasury 🞎 ASX 🞎 ABA 🞎 FSC 🞎 ASFA 🞎 ICA 🞎 AFMA🞎 ACCC 🞎 Other \_\_\_\_\_\_\_

The current proposal arises out of target areas identified by CIFR and drawn to our attention by Professor David Gallagher:

* + Assess the level of systemic risk in the Australian economy and in the ADI, insurance and superannuation industries, and identify potential domestic and external shocks to the Australian economy, and potential methods to protect against or remediate these shocks.
  + Assess the effectiveness of stress testing in group structures as a means of enhancing the resilience of the group, and entities within the group, to financial and economic shocks and limiting intra-group contagion.
  + Consider how APRA and industry could enhance their stress testing procedures and learn more from the results of this testing.

*Contact with other individuals*

APRA - Charles Littrell. On 4 March 2014 the Team Research Leader met the Mr Charles Littrell of APRA to discuss the CIFR target research areas. The discussion ranged over a number of topics related to the same and the attitude APRA may take to any proposals. The discussion also canvassed the need to design appropriate quantitative methodologies and data bases for any empirical assessments. A follow up meeting between Charles Littrell and the two of the team occurred in July 2014.

1. **Capability Paragraph** (detail the relevant capabilities of the team in up to 150 words)**:**

*Piet de Jong*

Forty years' experience in the quantitative modelling uncertainty and risk including risks arising in insurance (general and mortality), time series dynamics, finance, capital allocation, cost/benefit modelling.

*Geoff Loudon*

Extensive experience in conducting and supervising empirical research in finance. Research area includes financial risk management and security pricing, modelling inter-relations among risks, returns and underlying factors, especially during times of market crisis. Expertise in financial econometrics including application of regime-switching models; multivariate GARCH style models; stochastic volatility estimation; etc.

*Weihao Choo*

Fully qualified actuary (FIAA) with extensive industry experience in stress testing and capital modelling, liability valuation, portfolio monitoring and pricing, investment modelling, and business planning. Academic research expertise as evidenced in two publications in international journals (exceptional for someone his age). Presently finishing PhD while working in industry. PhD research relates to risk measurement and capital modelling and allocation.

**Section B: Project Objectives, Significance and Policy Implications**

*Include a discussion of the research question and objectives of the project. Consideration should be given to the significance of the project and any policy implications (Maximum two pages).*

**Our starting point for the proposed research is the recent literature, CIFR targeted areas and APRA aims and functions.**

This recent literature includes Adrian and Brunnermeier (2011), Acharya et al. (2012), Acharya et al.(2012) and Brownlees and Engle (2010). The proposed research aims to extend and apply these techniques particularly in relation to the entities regulated by APRA. Thus our broad aim is to develop, implement and bring to bear recent developments in stress testing on the aims of APRA and the CIFR targeted research areas detailed above.

*Improved measures of contagion and systematic risk*

CoVaRq as proposed in Adrian and Brunnermeier (2011) is a basis for proposed measures of contagion, exposure and systemic risk. It suffers from a number of drawbacks:

* Couched in terms of VaRq  containing the scale of the original measurements. It is worthwhile to have measures and techniques robust to scale variations.
* Conditioning on VaR0.5 is undesirable and relatively intractable. In our proposal we reference stress with respect to the unconditional VaRq. This permits a more transparent analysis and estimation.
* Our proposed approach separates out scale effects and interdependence effects and aims to relate these separately to external variables including shocks and drivers of systemic risk. Thus VaRq movements due to scale are disentangled from movements due to dependence with separate driver responses.

*Significance of the project and policy implications*

Understanding the impact of external shocks and their propagation through the financial system is vital for managing and remediating systemic risk. Effective regulation is dependent upon the development of a robust and reliable set of appropriate risk measures. We propose new measures of systemic risk that relate marginal and joint distributions separately to external drivers. This allows for more cogent and coherent stress testing as it includes the estimation of contagion effects, exposure effects and systemic risk across related entities and different financial sectors. Improved stress testing, estimation of risk effects and transmission of shocks through the financial system will make for more cogent prudential policy, prudential margin setting and better identify sources of risk to the financial system.

**Section C: Data, Method and Outputs**

*Include a detailed discussion of the data needed for the project, the proposed method and the outputs (Maximum two pages).*

*Data*

We will employ publicly available data from DataStream and central banks. This will be supplemented as necessary from data published by APRA and other regulators.

*Method*

The technical background and path to improved stress testing in the context of contagion and external shocks is based on the following definition

(1)

It is shown that (1) is a more robust and extensible definition than has been proposed in the literature and more readily amenable and useful to empirical work.

The properties and extensibility of the proposed basis is uncovered by initially considering and uniform random variables on [0, 1]. Then Define  as the of given exceeds its :

(2)

The left hand side equals

where is the joint distribution (copula) of and . Rearranging yields

. (3)

If and are independent then and If then and Thus if and are non-negatively related,

In terms of  define the contagion effect of on as

(4)

Thus is the change in of given becomes -stressed as a proportion of the change if For positively dependent random variables with the lower and upper limits attained under independence and perfect dependence, respectively. If and are negatively dependent then . Negative dependence is not to be studied in great detail in this project. Note.

Furthermore we may define quantities such as measuring the impact of a non distressed state in . For brevity we do not dwell on these constructs in this writeup although the ramifications and potential uses of these constructs will be investigated in the research.

*Contagious stress effects for financial variables and the contagion matrix*

Capital requirements are set with respect to actual variables on actual scales rather than on percentiles. Suppose and are the marginal distributions of and with and . Then the contagion effect of on 𝑥 is defined as the change in when becomes -distressed:

where denotes differentiation and is the hazard of at If is linear then the approximation is exact. Hence it is appropriate to scale such thatis linear in the tail. Rescaling has no effect on the copulas connecting variables.

If is a vector then is the (non-symmetric) matrix with entries and

where is the number of components in

*Econometric implementation*

The above development sets out our framework for linking bivariate copulas and marginals to external variables and shocks to study the impact of the same on stresses within the system and the contagious effects of crises. Proposed econometric analysis will implement and extend Brownlees and Engle (2010).

*Expected outputs*

* Preparation of an industry style report for APRA and other interested regulatory bodies.
* Seminar presentations of report to APRA and other interested regulatory bodies.
* Preparation of academic papers to be presented at relevant conferences and submitted to high ranked, peer-reviewed, international journals.

*Bibliography*

Acharya, V., R. Engle, and M. Richardson (2012). Capital shortfall: A new approach to ranking and regulating systemic risks. The American Economic Review 102 (3), 59-64.

Acharya, V., L. Pedersen, T. Philippon, and M. Richardson (2012). Measuring systemic risk. Technical report.

Adrian, T. and M. K. Brunnermeier (2011). Covar. Technical report, National Bureau of Economic Research.

Brownlees, C. T. and R. Engle (2010). Volatility, correlation and tails for systemic risk measurement. New York University, mimeo.

**Timetable for the delivery of Outputs**

|  |  |  |
| --- | --- | --- |
| **Date** | **Output** | **Details *(of proposed Output)*** |
| June 2015 | Submission of Journal Paper | A\*/A Article detailing modelling and econometric advances |
| June 2015 | Industry Report | Presentation to APRA and industry on policy implications of analyses |

**Section D: Research Record and References**

1. **Research Record**

*Include details of up to 10 career best relevant publications for the Team Leader and each Principal Researcher*

***Piet de Jong****, Team Leader.*

The following 10 selected publications (in no particular order) detail expertise in designing and, where appropriate, implementing tools to quantify, assess and model uncertainty related to finance, demographics and economics.

De Jong, P. (2012). Modeling dependence between loss triangles. North American Actuarial Journal 16 (1), 74-86.

De Jong, P. (2006). Forecasting Runoff Triangles. North American Actuarial Journal 10 (2), 28.

De Jong, P. (1989). Smoothing and interpolation with the state-space model. Journal of the American Statistical Association 84 (408), 1085-1088.

De Jong, P. (1991). The diffuse Kalman filter. Annals of Statistics 19 (2),1073-1083.

De Jong, P. and P. Boyle (1983). Monitoring mortality: a state-space approach. Journal of Econometrics 23, 131-146.

De Jong, P. and N. Shephard (1995). The simulation smoother for time series models. Biometrika 82, 339-350.

De Jong, P. and S. Ferris (2006). Adverse selection spirals. Astin Bulletin 36 (2), 589-628.

De Jong, P. and G. Heller (2008). Generalized Linear Models for Insurance Data. Cambridge University Press.

De Jong, P. and C. Marshall (2007). Mortality projection based and the Wang transform. ASTIN Bulletin (1), 149-162.

De Jong, P. and J. R. Penzer (1998). Diagnosing shocks in time series. Journal of the American Statistical Association 93 (442), 796-806.

***Geoff Loudon****, Principal Researcher*

The following 10 selected articles detail expertise in econometric and time series analysis in finance financial risk and regulation.

Liu, J., Loudon, G., Milunovich G., Linkages between international REITs: the role of economic factors, Journal of Property Investment & Finance, 30 (5), 2012, 473-492.

Dean, W., Faff, R., Loudon, G., Asymmetry in return and volatility spillover between equity and bond markets in Australia, Pacific-Basin Finance Journal, 18 (3), 2010, 272-289.

Hobbes, G., Lam, F., Loudon, G., Regime shifts in the stock-bond relation in Australia, Review of Pacific Basin Financial Markets and Policies, 10 (1), 2007, 81-99.

Loudon, G., Okunev, J., White, D., Hedge fund risk factors and the Value-at-Risk of fixed income trading strategies, The Journal of Fixed Income 16 (2), 2006, 46-61.

Loudon, G., Is the risk-return relation positive? Further evidence from a stochastic volatility in mean approach, Applied Financial Economics 16 (13), 2006, 981-992.

Loudon, G., Financial risk exposures in the airline industry: evidence from Australia and New Zealand, Australian Journal of Management 29 (2), 2004, 295-316.

Loudon, G., Watt, W., Yadav, P., An empirical analysis of alternative parametric ARCH models, Journal of Applied Econometrics 15 (2), 2000, 117-136.

Loudon, G., Foreign exchange exposure and the pricing of currency risk in equity returns: Some Australian evidence, Pacific-Basin Finance Journal 1 (4), 1993, 335-354.

Loudon, G., The foreign exchange operating exposure of Australian stocks, Accounting and Finance 33 (1), 1993, 19-32.

Loudon, G., American put pricing: Australian evidence, Journal of Business Finance and Accounting 17 (2), 1990, 297-321.

***Weihao Choo****, Principal Researcher*

An early career researcher with demonstrated capabilities

Choo, W. and P. De Jong (2010). Determining and Allocating Diversification Benefits for a Portfolio of Risks. Astin Bulletin 40 (1), 257-269.

Choo, W. and P. De Jong (2009). Loss reserving using loss aversion functions. Insurance Mathematics and Economics 45 (2), 271-277.

1. **Grants**

*Include details of up to 5 most recent relevant research grants for the Team Leader and each Principal Researcher*

*Piet de Jong, Team Leader*

Most of my research requires limited equipment and other funds - and a lot of time and concentration. Despite this I have held a number of research grants mainly to facilitate my ongoing research program: - While at Macquarie University 2003-2014 (Professor of Actuarial Studies) I have held grants from Macquarie University (jointly funded with APRA) and the Institute of Actuaries. Again this has led to my more recent A\* international publications including a jointly authored book published by Cambridge University Press.

While at the London School of Economics (Reader in Statistics) from 1995-1998. I held NSERC operating grants. Again this led to a number of highly cited A\* international academic publications.

While at the University of British Columbia from 1982-2001 (Professor of Statistics) I held NSERC operating grants to facilitate my ongoing research program. These are equivalent to ARC discovery grants except that the grant is based on performance rather than detailed aspirations to research one or other issue. The individual research program and operating grant led to many highly cited publications in A\* international academic journals.

While at the University of Amsterdam (Visiting Research Fellow) in 1987 I was funded under the Dutch government's ZWO initiative. This led to a number of world class highly cited academic publications.

*Geoff Loudon, Principal Researcher*

No recent grants

*Weihao Choo, Principal Researcher*

Early stage researcher. Just now finishing PhD.

**Section E: Detailed Budget and Justifications**

*Include details of each budget item with a justification of why the item is essential to the completion of the project (max one page).*

*Basis and cost for teaching support request*

The project has a very short time frame for such an extended topic. The particular nature of this project requires this additional time of the team leader de Jong and the principal researcher Loudon to ensure the output of the projects are delivered to CIFR on time and on scope. This will require particularly intense work at critical stages during the second half of 2014.

De Jong requests funding for four months teaching support, during the first half of 2015. This will free up additional time for him to be more fully involved in the project than otherwise possible and to give effective direction to the project. Loudon requests funding for two months worth of teaching support, during the first half of 2015. This will free up additional time for him to be more fully involved in the project than otherwise possible.

De Jong

* 5 months teaching support (2 courses) 2x $23,253 = $46,506

Loudon

* 5 months teaching support (1 course) $23,253

*Basis and cost for RA request*

A research assistant at the top of the Level 6 band is required for data analysis and assistance with programming. His or her tasks will be supervised by the researchers, and the appointment would be at the top of the Level 6 band for 3 days per week for the duration of the project. The tasks are twofold. The first is to gather appropriate data and secondly to program and test methods in R.

RA

* Salary 3 days per week plus on costs of 28% = 66,487(3/5)(1.28)=$51,062
* 30% infrastructure =51,062(0.3)=$15,319

*Basis for Fellowship request*

The fellowship will facilitate one of the researchers (Weihao Choo) to devote appropriate time to the project. Weihao is critical to the project as he has been researching related areas with De Jong, for his PhD and papers currently under development. At present Weihao is working for in Singapore and finishing his PhD. He is returning to Sydney Australia in the second half of 2014. The Fellowship will enable him to devote appropriate time to the project and fund his essential involvement and is basically at Level A for 6 months with appropriate on-costs.

*Basis for Travel request*

Present research at two conferences - one international and the other local and practitioner oriented. Workshopping the paper with industry practitioners and researchers is required to maximise the impact of this research. Note the budget for each conference is an average of $2,500 per participation (2 participations in total).

Consortium Member: Macquarie University

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Expenditure** | **YEAR 1** | | | | **YEAR 2** | | | | **YEAR 3** | | | | **Total** | | | |
| **$** | | | | **$** | | | | **$** | | | |
|  | Cash (CIFR)[[2]](#footnote-2) | Cash (Member)[[3]](#footnote-3) | In kind | Other[[4]](#footnote-4) | Cash  (CIFR) | Cash (Member) | In kind | Other | Cash  (CIFR) | Cash (Member) | In kind | Other | Cash  (CIFR) | Cash (Member) | In kind | Other |
| Staff  *De Jong*  *Loudon* | 23,253  11,626 | 23,253  11,626 |  |  |  |  |  |  |  |  |  |  | 23,253  11626 | 23,253  11626 |  |  |
| Equipment |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Data |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Travel | 5,000 | 5,000 | 3,000 |  |  |  |  |  |  |  |  |  | 5,000 | 5,000 | 3,000 |  |
| Fellowships  *Choo* | 25,000 | 25,000 | 15,000 |  |  |  |  |  |  |  |  |  | 25,000 | 25,000 | 15,000 |  |
| Scholarships |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Research Assistant | 25,531 | 25,531 | 15,319 |  |  |  |  |  |  |  |  |  | 25,531 | 25,531 | 15,319 |  |
| Other costs |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Total** | 90,410 | 90,410 | 33,319 |  |  |  |  |  |  |  |  |  | 90,410 | 90,410 | 33,319 |  |

**Section F: CERTIFICATION BY TEAM LEADER**

I certify that:

* All the details on this FP are true and complete;
* I have notified CIFR of any actual or potential conflicts of interest I may have in relation to the FP and I undertake that, if the FP is successful, I will notify CIFR of any conflicts of interest which arise subsequent to the submission of the FP;
* I will notify CIFR if there are any changes in my circumstances which may impact on my eligibility to participate in, or ability to perform, the project subsequent to the submission of this FP;
* In participating in this FP, I consent to CIFR copying, disclosing and otherwise dealing with information contained in the Proposal, for the purpose of considering this proposal and making decisions as to the funding round;
* All information contained in the FP is both current and accurate;
* The work proposed in this project is not funded elsewhere;
* The work proposed is unique and that it has not been fully or partially completed elsewhere; and
* All named researchers have agreed to participate and agree to an immediate CIFR announcement should funding be approved.

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|  |  |  |  |  |
| **Signature** |  | **Name, Position** |  | **Date** |

**Certification by Organisations contributing to the project**

I certify that:

* My organisation supports the FP and will contribute the resources outlined in the FP.
* Teaching support is requested in the FP the Organisation approves the support.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
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| **Signature** |  | **Name, Position** |  | **Date** |

1. Researchers are strongly encouraged to **contact relevant** **industry associations**, **regulators or** **financial sector participants** to obtain support for their proposal before it is submitted. [↑](#footnote-ref-1)
2. Cash (CIFR) represents any cash contribution being requested. If more than one Consortium member is requesting CIFR funding then a separate budget table is required for each. [↑](#footnote-ref-2)
3. Matched member contributions need to be in line with the Funding agreement. [↑](#footnote-ref-3)
4. Other funding sources include industry or regulator partners and Non-Consortium Institutions. [↑](#footnote-ref-4)