RESEARCH NEWSLETTER

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Editorial

An important problem managing technology is the financing of technological advance and innovation. We can often read about firms' technology managers, including interestingly, those of large firms, reporting that they have more projects that they would like to undertake than funds to spend on them. We can think of a number of reasons for this phenomenon, such as low expected returns due to an inability to capture the profits from an invention, the uncertainty and risk associated with the project, and over-optimism on the part of managers. Research to date has not fully settled the question of how much weight to put on each of these factors in explaining the phenomenon nor on the extent of the funding gap, although there seems to be more robust evidence on the gap in the case of smaller firms. Interestingly, economists have long held the view that innovative activities are difficult to finance in a freely competitive market. Support for this view in the form of economic-theoretic modelling is not difficult to find, and the idea itself was often alluded to by Schumpeter - not really surprising. The argument proceeds as follows. The primary output of innovation investment is the knowledge of how to make new goods and services, and this knowledge is nonrival, meaning that use by one firm does not preclude use by another. To the extent that knowledge cannot be kept secret, the returns on investment in knowledge cannot be appropriated by the firm undertaking the investment, and therefore such firms will be reluctant to invest, leading to the underprovision of R&D and other innovation investments in the economy. This argument has been developed, tested, modified, and extended in many ways. Moreover the empirical support for the basic point concerning the positive externalities created by research is widespread, mostly in the form of studies that document a social return to R&D that is higher than the private return. This line of reasoning has been widely used by policymakers to justify such interventions as the intellectual property system, government support of innovative activities, R&D tax incentives, and the encouragement of research partnerships of various kinds. But what if entrepreneurs face financing constraints generated by asymmetric information on the quality of the innovation project? Entrepreneurs are better informed about the quality of their own projects than are lenders, whose valuation of projects reflects average project quality. This may raise the rate of return required by lenders so high that it becomes unprofitable for an entrepreneur without sufficient internal funding to undertake an economically viable project. Can we in this case justify public intervention in the form of public funding to alleviate the problems caused by adverse selection. Perhaps more interestingly, what are the effects of public funding on capital costs related to innovation projects as well as on the incentives of market-based financiers to finance innovation projects - given that an entrepreneur's observation of receipt of a subsidy for an innovation project actually constitutes an informative signal as to the quality of the project as perceived by market-based financiers. These are crucial questions, and recent theoretical research has made some progress in answering them. In particular, under certain plausible conditions, public R&D subsidies can reduce financing constraints. And, if market-based financiers can observe that a project has received a public subsidy, then this observation increases

the success probability of the project in the eyes of the market-based financier, which reduces the cost of external capital for subsidized projects. These are interesting and encouraging results and clearly indicate that further research in this area is well motivated as well as highly rewarding.

Jouko Vilmunen

Demographic transition, taxes and sustainability of public finances: simulations of alternative policies to smooth the tax burden across generations

A number of developed countries are starting to grey, some – like Finland – sooner than others. Moreover, as these countries advance in age, the worst may not be the physical impact but rather the impact on economic health. How exactly will these economies fare given that, relative to the present, there are, in the not so distant future, perhaps twice as many elderly persons relying on just 15 per cent more workers for their financial support? This support will be delivered primarily through publicly funded programmes, such as Social Security and Medicare in the USA, which, in many countries, will start paying benefits to baby boomers in just a few years from now. One of the key problems facing the present governments is that the underlying funding gap could be very non-trivial so that, given the current and future benefits, the implied increase in effective taxes would sharply increase the lifetime tax burden and labour supply disincentives of current and future generations.

The projections for the US economy discussed by Gokhale and Kotlikoff (2000)

are in this context highly suggestive.[1] To eliminate the funding gap in the USA, without cutting current or future benefits, requires an immediate and permanent 10 percentage point increase in the Federal Insurance Contribution Act (FICA) payroll tax – currently 15.3 per cent of total payroll. As it is, today's newborns in the USA are projected to hand over about a quarter of their lifetime earnings to the government in taxes net of transfers. A 10 percentage-point payroll tax hike would raise this lifetime net tax rate to more than one-third. It would also substantially raise the marginal tax rates of US taxpayers, most of whom are currently paying nearly 50 cents of each dollar earned to the federal and state governments. Since the economic costs of tax distortions increase with the square of the tax rate, moving workers from 50 per cent to 60 per cent effective marginal net tax rates increases the tax-system excess burden due to distortion of the labour supply by 44 per cent. Furthermore, one should bear in mind that delay in implementing reform will necessitate even larger tax increases or benefit cuts in the future.

While these calculations indicate that the excess burden of distorting taxes can be large, they do not reveal the full dynamic macroeconomic implications of using these taxes to fill the funding gap. Furthermore, because the US economy is large and not so open, lessons drawn from studying the macroeconomic effects of alternative policies for closing the US funding gap may have to be scrutinized for application to a small open economy like Finland. In any case, it is clearly worthwhile to learn about these dynamic macroeconomic effects in a small open economy by reading a forthcoming Bank of Finland discussion paper "Government Funds and Demographic Transition – Alleviating Ageing costs in a Small Open Economy" by Helvi Kinnunen. As the author notes, population ageing is one of the hottest policy

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1   Gokhale Jagadeesh – Kotlikoff Laurence (2000), Medicare, Social Security, and the Calm Before the Generational Storm, *mimeo*, Boston University.

issues in almost all of the European countries. That the average old-age dependency ratio in Europe is projected to double over the coming four decades gives one a taste of the underlying demographic trends. European countries do not differ in these broad demographic trends, but do display differences in the extent and timing of major demographic shifts. Many European countries are set to encounter the initial shifting in the late 2020s. Finland is already grappling with the big changes. Current demographic trends in Finland will raise the old age dependency ratio from the present 25 per cent to about 40 per cent by 2015, after which the ratio will begin to level off at roughly 45 per cent.

As the author notes, policy measures have been taken in Finland to address the underlying pressure on the financing of the pension liabilities. The pension system has been reformed. A series of smaller revisions to the system were implemented in the 1990s, and in 2005 some more fundamental changes were introduced: labour supply incentives were strengthened and benefit ratios were effectively lowered by tying them to life expectancy and to expected retirement time. A second fundamental change was an increase in the degree of funding of the pension system as well as a reduction in government indebtedness. These latter measures increased government net financial wealth effectively to 30 per cent of GDP in 2006 from -20 per cent of GDP in the early 1990s. According to current projections, government funds will increase further to some two and a half times total wages by 2030, and will remain at that level even after the demographics have stabilized. Despite all this, sustainability of public finances will require increases in pension contributions and taxes.

Kinnunen focuses on simulating the role of public funding in intertemporal smoothing of the implied tax burden of population ageing and on studying the small open economy effects of these policies. A number of similar simulations on the effects of pension reforms have been performed in the

literature, which tempt one to the conclusion that the implied deadweight losses from tax increases depend on how tightly households perceive the link to be between taxes or contributions and benefits. The earlier referred-to simulations suggest that if households see the link as a tight one, the efficiency losses in terms of employment can be very small indeed. In the Finnish case, the outcome is not obvious since, as argued by Kinnunen, the perceived link between taxes and benefits is very weak or even absent. Furthermore, many of the referred-to simulations use a closed-economy macro-model, whereas Kinnunen uses the Bank of Finland's dynamic general equilibrium model, which is a modification and extension of Mark Gertler's (1999) model of a life-cycle economy.[2] Gertler's model, in turn, is a generalization of the model of finite horizons by Olivier Blanchard (1985),[3] in that, instead of simply assuming a constant periodic probability of an agent dying, as in Blanchard, Gertler's model posits a constant periodic probability for a worker to retire and, conditional on retirement, a constant periodic probability of an agent dying. The model also allows for a non-zero labour supply for retirees. More importantly for the issue at hand, the Bank of Finland model incorporates a fairly detailed structure of government finances. Also, the model has been calibrated using Finnish data. In particular, the population dynamics in the model are based on calibration using Finnish population data.

So, what do the simulation results suggest about the dynamic macroeconomic effects of using public funding to smooth tax increases called for by the funding gap due to population ageing? First of all, on a transition path to an older steady-state population public funding can be used to spread over time, and even reduce, the tax-related ageing costs. From the perspective of labour market

2   Gertler Mark, Government debt and social security in a life-cycle economy (1999), *Carnegia-Rochester Conference Series on Public Policy*, 50.
3   Blanchard Oliver (1985), Debt, Deficits and Finite Horizons, *Journal of Political Economy* 93.

tightness, lower taxes stimulate labour supply just at the right time, ie when the labour markets suffer from substantial tightness. Increased use of public funds helps to reduce the pressure on wages when the population is ageing, which in turn tends to sustain higher employment and productivity growth. The authors also find that, given the collective nature of public funding, no redistribution of wealth between workers and retirees could be observed. All in all, the model experiment promises perhaps even substantial welfare gains from using public funding to reduce the pressure for employing distortionary taxes to close the funding gap. Furthermore, given the small open economy setup, even temporary tax cuts may have long-term effects on factor prices that would imply a more labour-intensive production structure for the economy. Surely we will see more results from experiments like that of Kinnunen being published in the future. These will use dynamic macro-models tailored to the specific questions one is seeking to answer. It may turn out that it is not easy to compare these models and hence it may be difficult to get an informed debate on the results of the various simulations. However, it behooves researchers to continue working with these models and doing the simulations. Established and well known principles are being followed in constructing these dynamic optimizing models, and this will ensure a common approach and language among researchers for their debate on simulations related to crucial policy issues such as the funding of pension and social security systems.

Are subsidies called for when adverse selection hinders the financing of innovation?

Investment in innovation is special. More specifically, from the perspective of investment theory, innovation investment has a number of characteristics that make it different from ordinary investment. First and foremost, perhaps most of the R&D portion of such

investment is in the wages and salaries of highly educated scientists and engineers. Their efforts create an intangible asset – the firm's knowledge base – from which profits will flow in future years. To the extent that this knowledge is "tacit" rather than codified, it is embedded in the human capital of the firm's employees and is therefore lost if they leave or are fired. As emphasized in the literature, this has an important implication for the conduct of R&D investment. Since the resource base of the firm can be critically affected if such workers leave or are laid off, firms tend to smooth their R&D spending over time, in order to avoid having to lay off knowledge workers. Interestingly, this in turn implies that R&D spending at the firm level typically behaves as if it involves high adjustment costs. Two consequences follow, one substantive and one that affects empirical work in this area. First, in equilibrium the required rate of return to R&D may be relatively high simply to cover the adjustment costs. Second, it will be difficult to empirically measure the impact of changes in the costs of capital on such investment, because these effects can be weak in the short run due to the sluggish response of R&D to any changes in its cost.

A second noteworthy feature of R&D investment is the degree and nature of uncertainty associated with its output. Importantly, this uncertainty tends to be greatest at the onset of a research project, which implies that an optimal R&D strategy has an option-like character and really should not be analysed in a static framework. R&D projects with small probabilities of great success in the future may be worth continuing even if they do not pass an expected-return test. The uncertainty here can be extreme, and not a simple instance of a well-specified distribution with finite mean and variance. Actually, there is evidence that the distribution of profits from innovation can take the form of a Pareto distribution, for which the variance does not exist. Consequently, standard risk-adjustment methods will not work well in this case. From

the perspective of the financing of investment in innovation, uncertainty has the important characteristic that as investments are made over time, new information arrives, which may modify the uncertainty. This implies that the decision to invest in any particular project is not a once-for-all decision, but needs to be reassessed throughout the life of the project. In addition to making such investment a real option, the sequence of decisions complicates the analysis by introducing dynamic elements into the interaction of financier (within or outside of the firm) and innovator.

These considerations concerning the effects of uncertainty on the financing of innovation projects are of course highly relevant. But equally important are concerns about the effects of asymmetric information about the quality of an innovation project between entrepreneur and financier, which can result in a higher cost of external funds compared to internal capital, and thus create a funding gap. The funding gap can in turn prevent small and new technology-based entrepreneurial firms, in particular, from undertaking economically viable innovation projects. This observation has provided the grounds for government intervention in the form eg of direct subsidies for R&D, aimed at reducing the financing constraints of technology-based start-ups. However, there are relatively few contributions to the theoretical literature that analyse the interaction between financing constraints and R&D subsidies. In a forthcoming Bank of Finland discussion paper "Adverse Selection and Financing of Innovation: Is There Need for R&D Subsidies" Tuomas Takalo and Tanja Tanayama contribute to the existing literature by analysing the effects of an R&D subsidy program implemented by the government under financial constraints generated by asymmetric information.

There is now a vast literature in this area, thanks to Akerlof's famous contribution on the lemons problem, which singles out adverse selection as a major source of financing constraints. Entrepreneurs have better information about the quality of their own projects than do lenders, whose project valuations generally reflect average project quality. This may raise the rate of return required by lenders so high that it becomes unprofitable for an entrepreneur without sufficient internal funding to undertake an economically viable project. As the authors note, the two interrelated solutions to the adverse selection problem that have been proposed are signaling and financial intermediation. That an entrepreneur has a stake in the project could serve as a credible signal of the quality of the project. Reputation may also reduce financing constraints, because over time borrowers who manage to acquire good reputations encounter less severe informational problems. Financial intermediaries such as banks could in turn alleviate financing constraints through information gathering because, relative to atomistic markets, they may have a cost advantage in screening and monitoring loan applicants. In particular, it has been argued that venture capital and related organizations can, through intensive screening and monitoring, overcome informational problems and mitigate capital constraints.

For various reasons – many of which are discussed in detail by Takalo and Tanayama – the proposed solutions may fail to eliminate financing constraints, especially in the case of science and technology-based start-ups. Most of these originate from informational problems that are particularly severe in financing R&D projects, as these projects typically involve soft information that is hard to verify. Facing these problems, governments in several countries have intervened, often via direct R&D subsidies, to reduce financing constraints. Government programs that allocate direct subsidies are based on specific selection schemes, where the selection is accomplished via ex-ante screening of the applications. Takalo and Tanayama, building

on Holmstöm and Tirole (1997),[4] develop a model of innovation finance in which capital-constrained entrepreneurs may be able to tap a public agency (in addition to private sources) for funding. They specifically analyse whether R&D subsidy policies can ease financing constraints due to adverse selection. The authors show that under certain circumstances, they can. Interestingly, the effect comes through two channels. First, the subsidy itself reduces capital costs related to innovation projects by reducing the required amount of market-based funding. Second, the observation that an entrepreneur has received a subsidy for an innovation project provides an informative signal to private investors in the market. In effect, Takalo and Tanayama study whether a subsidy by a public agency could act as a certification for an unknown entrepreneur and improve her possibilities to secure funding from private markets. The novelty here seems to be, as the authors rightly emphasize, that the idea of certification by a trusted financial intermediary is rigorously applied to the public funding of corporate R&D. It is now well known from the literature that the effects of subsidies on entrepreneurs' finance under asymmetric information critically depend on the assumed distribution of the project returns. More specifically, adverse selection can generate too much lending instead of financing constraints. Also in the model of Takalo and Tanayma, the beneficial effects of subsidies are more limited if adverse selection generates overinvestment rather than financing constraints. However, as they note, the aforementioned literature abstracts from the signaling role of subsidies as well as from the social benefits of R&D. The paper by Takalo and Tanayama is of great interest in that it provides a new perspective on the effects of public R&D subsidies on the funding of innovation projects. It is also an ingenious application of the Holmsröm-Tirole framework, which has already been applied in

4   Holmström Bengt – Tirole Jean (1997), Financial Intermediation, Loanable Funds, and the Real Sector, *Quarterly Jounal of Economics*, CXII, 663–691.

a variety of other interesting ways in the area of corporate or entrepreneurial finance. There is still much to learn, not only about the subject matter – the effects of public intervention on the financing of innovation projects – but also about the modeling framework itself. Hence, this line of research should clearly be further pursued.

Jouko Vilmunen

Monetary policy rules for emerging economies

Since Taylor's (1993) landmark contribution, researchers have made numerous attempts to devise simple decision rules to aid a central bank in gauging its policy actions. These rules assume that the central bank's policy interest rate depends on a few economic variables, eg the gaps between observed and targeted inflation rates and between potential and actual output. Although it is not possible to reduce central bank behaviour to such a simple equation, these rules can be quite useful in analysing policy and in communicating it to the general public. While many studies on monetary policy rules focus on the developed OECD countries, recent years have also witnessed some efforts at estimating various monetary policy rules for developing countries.

A number of research projects are under way at the BOFIT. In these projects monetary policy rules will be estimated for the major emerging economies. In a recent study, Tuuli Koivu, Aaron Mehrotra and Riikka Nuutilainen examine China's monetary policy using McCallum's (1988) monetary policy rule. The McCallum rule is based on control of the monetary base, which is set in accord with the gap between targeted and actual growth rates of nominal aggregate output. The rule is used to model central bank behaviour, especially where the money stock still plays a key role in the conduct of monetary policy.

China's central bank (People's Bank of China, PBC) sets annual targets for the growth

of two monetary aggregates and, in certain years, for credit growth. The PBC has controlled the money supply via reserve requirements and lending to commercial banks, as well as market liquidity via open market operations. In contrast, there has been a gradual freeing of interest rates, which have not had a significant influence on companies' investment decisions or commercial banks' behaviour. Officials have also tried to influence commercial bank lending by issuing specific rules.

The results of the study indicate that in China growth of the monetary base has behaved very much in line with McCallum's monetary policy rule. Toward the end of the 1990s monetary policy was somewhat tight compared to the rule, so that China experienced a brief spell of deflation. The study also employs deviations of actual money growth from the rule-determined growth rate (surplus money) to forecast China's inflation rate. Test results suggest that surplus money generally improves forecast accuracy compared to naive inflation forecasts, based solely on prior inflation rates. These results are however dependent on the particular forecast period, especially as regards consumer prices. On the other hand, surplus money generally improves the forecasts of wholesale (corporate goods) prices, regardless of the forecast period. The study finally takes up the possibility of using the McCallum rule to identify monetary policy shocks. Here, the tool of choice is a structural vector autoregressive model. Testing indicates that, for the Chinese economy, monetary expansion in excess of the McCallum rule prescription leads to growth of nominal GDP. In general, the study suggests that monetary policy rules based on the money stock may be useful in analysing China's monetary policy.

Literature
McCallum, Bennett T. (1988). Robustness Properties of a Rule for Monetary Policy, Carnegie-Rochester Conference Series on Public Policy 29 (Autumn), 173–203.

Taylor, John B. (1993). Discretion versus Policy Rules in Practice, Carnegie-Rochester Conference Series on Public Policy 39, 195–214.

Iikka Korhonen and Aaron Mehrotra

Conferences and seminars

The annual Bank of Finland Research and CEPR (Centre for Economic Policy Research) conference, this time arranged jointly with the Federal Reserve Bank of Philadelphia, will be held in October. The topic is 'Innovation and Intellectual Property in Financial Services'. The programme will be posted on the conference site http://www.bof.fi/en/tutkimus/konferenssit/tulevat_konferenssit/ in early autumn.

The following seminars are open to all interested parties.

Bank of Finland Research Seminars:
Thur, 4 Sep 2008,13.30–15.00. Ass. Prof. Ph.D. Antonella Trigari, Bocconi University.

Thur, 2 Oct 2008, 13.30–15.00. Ph.D. Gyöngyi Lóránth, University of Cambridge.

Please register in advance via Marjut Salovuori at seminars@bof.fi. For further information visit the seminar site http://www.bof.fi/en/tutkimus/konferenssit/tutkimusseminaarit/.

BOFIT seminars:
Tues, 5 August 2008, 10.30. Xie Ru. Goethe University Frankfurt and BOFIT. Foreign bank entry in China: Has corporate governance of banks improved?

Tues, 12 August 2008, 10.30. Laurent Weill. Universite Robert Schuman and BOFIT. How corruption affects bank lending in Russia.

Please register in advance via Liisa Mannila (firstname.lastname@bof.fi, + 358 10 8312268). For further information visit the seminar site http://www.bof.fi/bofit_en/ tutkimus/seminaarit/tiistai/seminaarit.htm.

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L Becchetti – A Castelli – Iftekhar Hasan: Investment-Cash Flow Sensitivities, Credit Rationing and Financing Constraints, BOF DP 15/2008.

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Juha Kilponen – Matti Viren: Why do growth rates differ? Evidence from cross-country data on pri-vate sector production, BOF DP 13/2008.

Jukka Topi: Bank runs, liquidity and credit risk, BOF DP 12/2008.

Kari Takala – Matti Viren: Efficiency and costs of payments: some new evidence from Finland, BOF DP 11/2008.

Bill B Francis – Iftekhar Hasan – James R Lothian – Xian Sun: The signalling hypothesis revisited: Evidence from foreign IPOs, BOF DP 10/2008.

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Alicia García-Herrero and Daniel Santabárbara: Does the Chinese banking system benefit from foreign investors?, BOFIT DP 11/2008.

Rajeev K. Goel: Regulatory bottlenecks, transaction costs and corruption: A cross-country investigation, BOFIT DP 10/2008.

K.C. Fung, Iikka Korhonen, Ke Li and Francis Ng: China and Central and Eastern European Countries: Regional networks, global supply chain or international competitors?, BOFIT DP 9/2008.

Kashif Saleem: International linkage of the Russian market and the Russian financial crisis: A multivariate GARCH analysis, BOFIT DP 8/2008.

Jarko Fidrmuc, Iikka Korhonen and Ivana Bátorová: China in the world economy: Dynamic correlation analysis of business cycles, BOFIT DP 7/2008.

Rajeev K. Goel and Michael A. Nelson: Causes of Corruption:History, Geography, and Government, BOFIT DP 6/2008.

Tomasz Kozluk and Aaron Mehrotra: The Impact of Chinese Monetary Policy Shocks on East Asia, BOFIT DP 5/2008.

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Mika Vaihekoski: History of Finance Research and Education in Finland: The First Thirty Years.

Efrem Castelnuovo – Luciano Greco – Davide Raggi: Estimating Regime-Switching Taylor Rules with Trend Inflation.

Tuomas Takalo – Tanja Tanayama: Adverse Selection and Financing of Innovation.

Helvi Kinnunen: Government Funds and Demographic Transition – Alleviating Ageing Costs in a Small Open Economy.

Iftekhar Hasan – Loretta J Mester: Central Bank Institutional Structure and Effective Central Banking: Cross-Country Empirical Evidence.

BOFIT Discussion Papers

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Tuuli Koivu – Aaron Mehrotra – Riikka Nuutilainen: McCallum rule and Chinese monetary policy.

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