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Welfare and growth impacts of innovation policies in a small, open economy; an applied general equilibrium analysis

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ABSTRACT

We explore how innovation incentives in a small, open economy should be designed in order to achieve the highest welfare and growth. The computable general equilibrium model we develop for the purpose allows for research and development (R&D)-driven endogenous technological change embodied in varieties of capital. We study policy alternatives targeted towards R&D, capital varieties formation, and domestic investments in capital varieties. Subsidising domestic investments, thereby excluding stimuli to world market deliveries, generates less R&D, capital formation, economic growth, and welfare than do the other alternatives, reflecting that the domestic market for capital varieties is limited. In spite of breeding stronger economic growth, a higher number of patents, and a higher share of R&D in total production, direct R&D support generates slightly less welfare than subsidising formation of capital varieties. The costs in terms of welfare relates to a lower production within each variety firm, which in presence of mark-up pricing results in efficiency losses.

1. Introduction

Promotion of productivity growth through research and development (R&D) has gained increased focus by national governments during the recent decade, as reflected in the Lisbon strategy of the EU. The main economic rationale is to increase the incentives of private firms to invest in technological improvements because of external knowledge spillovers to other firms (Romer, 1990). Some efficiency arguments counter R&D-promoting policies. There will be unnecessary social costs to the extent that R&D firms duplicate their findings or commercialise marginally better innovations that steal markets from already established R&D-based productions, as in the creative destruction model of Aghion and Howitt (1992). However, it is commonly accepted that the balance of evidence suggests too little private R&D and a case for policy intervention (Griliches, 1995; Jones and Williams, 1998; Klette et al., 2000).

The economy's size and openness are important for whether domestic R&D can be considered as the main engine for national growth, and are also decisive for the effects of different innovation incentives. In this paper we examine how innovation incentives in a small, open economy should be designed in order to enhance economic growth and welfare. In the small, open economy case a large part of the technological change relies on the external global common knowledge base (Coe and Helpman, 1995; Keller, 2004). Also, global conditions largely determine market prices and market access for domestic firms, including the financial market conditions. We explore how these features of small, open economies affect the impacts of national innovation policies, and how the policy implications deviate from the more commonly studied closed economy case; see Russo (2004), Alvarez-Pelaez and Groth (2005), and Steger (2005).[3]

The case of a small, internationally exposed economy is exemplified by Norway. The productivity growth during the last ten years has been slightly above the OECD average (Statistics Norway, 2008). Coe and Helpman (1995) present data that confirm the global knowledge base as a dominant source of productivity growth in the country. The share of own R&D activity in total GDP is small, only 1.5%, with only half of this taking place in the private sector (NIFU STEP, 2007). However, these low R&D intensities compared to OECD averages are explained by a highly resource-based industry structure (Statistics

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[3] In addition there is a substantial literature analysing the importance of an endogenous specification of technological change for climate-change analysis; see Goulder and Schneider (1999), Goulder and Mathai (2000), Popp (2004), and Otto et al. (2007). The latter formulates a CGE model based on the product-variety models of Romer (1990) and Jones (1995).

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Norway, 2008). As with several other European economies, Norway has a relatively ambitious goal regarding future R&D activity: a doubling of the R&D intensity (Norwegian Ministry of Science and Education, 2004) with two-thirds of this to be obtained in private industries. In 2002 a tax credit system for private R&D expenses was introduced as a means to obtain this goal (Cappelen et al., 2008). Other relevant features that are outside the focus of our study include the facts that Norway is a highly developed and prosperous economy, and has an education level well above the OECD average.

In order to conclude quantitatively on the implications of innovation policies in the small open economy case, we develop a Computable General Equilibrium (CGE) model for the Norwegian economy that can account for the complex economic settings within which innovation takes place. It captures interaction among markets, industrial differences in innovation rates, and market imperfections and policy wedges that potentially interact with innovation policies. Previous applied macroeconomic models have not addressed similar cases. The pioneering CGE study by Diao et al. (1999) describes Japan as an open economy, but in several, important respects less reliant on the outside world than what is reasonable to assume for the Norwegian and similar small and open economies (see the discussion below).[4]

As in the closed economy studies of Romer (1990), Jones and Williams (2000) and other descendants mentioned above, we treat technological change as result of profit-maximising R&D firms' output. However, compared to previous models where economies are closed and knowledge bases national commons, our model ascribes a relatively smaller role to domestic R&D and capital formation. It does, nevertheless, account for many of the central welfare arguments for subsidising national innovation activities, such as existence of *positive* external knowledge spillovers from previous R&D, love of capital variety in demand, and pro-competitive increases in output that counteract the inefficiencies due to imperfect competition in the capital variety markets (Markusen, 1981). As new patents will tend to crowd out output within each firm, the latter is an isolated argument for discouraging innovations.[5]

One main divergence from the open economy model of Diao et al. (1999) is our treatment of the cross-country knowledge spillovers. In Diao et al. (1999) the impacts of international technology are channelled through the domestic R&D production. All spillovers from abroad enhance the productivity of R&D production with non-decreasing returns to scale. Own R&D, thus, plays a decisive role for economic growth. According to evidence from Norwegian firms, absorption of international spillovers through domestic R&D is far less potent (Cappelen et al., 2007). In our model, knowledge spillovers from abroad, which in the benchmark are calibrated to cause about 95% of the Norwegian technological change, are absorbed through use of *all* resources, where investment goods that embody technological improvements caused by R&D are only one type of carrier. This feature of our model contributes to dampen the role of R&D-stimulating policies considerably.

The small, open economy focus also leads us to regard the interest rate as internationally given, in contrast to the closed capital market assumption in previous model analyses, including Diao et al. (1999). Export and import prices are, similarly, determined abroad. Capital varieties are both marketed abroad at given world market prices and sold in domestic markets characterised by monopolistic competition. Imports of other investment goods can substitute for the domestically produced capital varieties. Capital varieties are not exported in Diao et al. (1999), and the market power of each variety producer domestically is much larger than what is reasonable to assume in a small, exposed economy.

As productivity externalities are related to production and use of ideas and variety capital, we analyse three comparable policy alternatives stimulating these processes; the first is a subsidy of R&D production, the second is a subsidy towards formation of variety-capital, while the third is a subsidy towards domestic investments in variety-capital. The R&D subsidy approximates the kind of R&D support already implemented in Norway, and also introduced in several other countries (Warda, 2005). The support to investments in variety-capital illustrates policies like traditional investment tax credits (Goulder and Summers, 1989; Bovenberg and Goulder, 1993), or recent popular implementation subsidies particularly used to promote new energy and environmental technologies. The policy alternatives are all financed by higher lump sum taxes.

The small, open nature of the economy implies, as expected, far smaller welfare and growth effects of innovation policies than in previous studies. The main impacts of adding small, open economy features are less influence of own R&D and less market power. In addition, increased capital supply is not reinforced by a lower interest rate, a mechanism that augments growth effects within closed economy models. On the other hand, world market exposure is the major impetus behind the positive welfare and growth effects we find. The improved competitiveness obtained within variety-capital production when subsidising R&D and capital formation, can be exploited by increasing deliveries to the export markets. Consequently, merely subsidising domestic investments induces but insignificant growth and welfare effects, as domestic demand is relatively inelastic. The positive effects on R&D and production of variety-capital are, thus, strongly dampened.

As opposed to the findings of Diao et al. (1999), subsidising R&D proves slightly welfare-inferior to subsidising formation of capital varieties, in spite of generating higher growth. Again, this is a result of the open economy features. The possibility of exporting variety-capital is essential for reaping high R&D productivity gains in case of capital subsidies. This result also illustrates the more general point that promoting economic growth is not necessarily welfare improving. It will depend on to what extent the reallocations that take place compensate or reinforce the externalities and price wedges that riddle the economy. Because the number of varieties increases more in case of R&D support, more crowding-out occurs of production and profits within each variety firm. Due to monopolistic competition among the firms, these impacts dampen the productivity and welfare gains, in spite of somewhat higher knowledge spillovers and love-of-variety effects.

Section 2 presents the main structure of the CGE model by means of a stylised exposition, while Section 3 describes model details and the quantification and simulation procedures. The policy effects and sensitivity tests are presented and discussed in Section 4, while Section 5 concludes.

2. A simplified model

This section presents a stylised, dynamic growth model that illustrates the main structure of the CGE model and the most important channels for transferring effects of the policies we analyse in Section 4. As in Romer (1990) it embraces a patent producing R&D industry, a variety-capital industry, and a final goods industry. It differs from the Romer model in assuming a small, open economy, where variety-capital and final goods are traded in the world markets at exogenous prices. Domestic prices relative to world market prices determine the volumes of exports and imports. The interest rate is also exogenously given from the world market. Another feature of the small, open economy is that firm productivity is affected both by domestic growth mechanisms as in the Romer model and by technological spillovers from abroad.

We assume that all firms within each industry are small and identical. In the domestic factor and product markets prices are determined by equilibrium conditions and taken as given by firms.

[4] A more recent, open economy analysis in Ghosh (2007) shares these features with the model in Diao et al. (1999).

[5] This impact resemble, but is not identical to, the market-stealing effect in Aghion and Howitt (1992).