



Tax incentives and R&D activity: Firm-level evidence from Taiwan

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ABSTRACT

This paper investigates the effect of tax incentives on R&D activities in Taiwanese manufacturing firms. The propensity score matching (PSM) estimates show that recipients of R&D tax credits appear on average to have 53.80% higher R&D expenditures than that they do without receiving tax credits, while there is no significantly higher growth rate of R&D expenditure. This study further employs the panel instrumental variable (IV) and generalized method of moment (GMM) techniques to control for endogeneity of R&D tax credits and firm heterogeneity in determining R&D expenditure. The R&D tax credit is witnessed to exhibit a significantly positive influence on R&D expenditure and its growth, especially for electronics firms. The marginal effect is moderate, ranging from 0.094 to 0.120. Specifically, the R&D elasticity concerning tax credits tends to increase gradually along with the approaching expiration of R&D tax credits measure, lending a supportive view on its efficacy.

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1. Introduction

Most empirical studies and endogenous growth theories have highlighted the importance of innovation to economic growth.¹ Many countries have also attempted to create a favorable innovation environment and protective regularity, aiming to promote R&D in firms and consequently to contribute to sustainable economic growth. Essentially, R&D is uncertain and both time- and money-consuming. It is also recognized to possess public good characteristics, thereby preventing the market from providing sufficient quantities of R&D from the perspective of social return. To bridge the gap between private and social rate of return and foster industrial R&D activity, various policy measures have been launched. Specifically, the R&D tax credit has become increasingly popular in developed countries, such as the U.S., Canada, and some OECD countries since the early 1980s.²

Taiwan, one of the best performers among latecomers, has been very successful in narrowing the technological gap during the past two decades with its counterparts among leading countries, especially in the electronics industry. Her R&D/GDP ratio, a simple measure of a knowledge-intensive economy, rose from 1.62% in 1990 to 2.78% in 2008 gradually, which was a little higher than corresponding ratios of 2.77% and 2.64% in the U.S. and Germany in 2008.³ As for R&D output, Taiwan has recorded extremely fast growth both domestically and in the U.S. Taiwan not only placed 4th in the world in terms of the quantity of its U.S. patents since 2003, but also ranked high in terms of patents per capita, compared with G7 countries and the other “Asian Tigers” (Trajtenberg, 2001). This achievement is rare in the developing world and is almost nonexistent within or outside of Asia.

During the technological development process, the Statute for Upgrading Industries (SUI) that applies tax incentives, subsidies, and supporting measures to assist innovative activity is one of Taiwan's key industrial technology policies (Lien et al., 2007). However, economists have been generally skeptical regarding the efficacy of tax incentives. Expiration of the R&D tax credit of the

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¹ See Acemoglu et al. (2006) for a comprehensive survey on the theoretical and empirical literature of the innovation-economic growth nexus.

² For a survey on the tax treatment of R&D around the world, please refer to Table 1 in Hall and Van Reenen (2000).

³ The R&D expenditures attributable to the business enterprise sector accounted for 70.68% of the total in 2008. Moreover, Taiwan's R&D/GDP ratio increased to 2.94% in 2009.

SUI at the end of 2009 raises a legitimate concern: has the R&D-preferential policy induced greater R&D expenditures and a higher R&D growth in Taiwanese firms? From the perspective of public finance, the erosion of the tax base attributed to R&D incentives is possibly one cause of the fiscal shortage. Whether or not limited government resources should be used to encourage R&D depends on the efficacy of these measures to induce far greater R&D and contribute to sustainable growth. However, this important issue is not well examined in Taiwan.

High-tech industries are generally more R&D intensive and the primary recipients of R&D tax credits in the U.S. (Wu, 2008). This situation applies to Taiwan, while many so-called traditional industries (typically less R&D-intensive) voice criticism that R&D tax credits work more favorably for high-tech firms. Innovative behavior strongly relates to the technological environment surrounding the location of a firm. A relatively fertile technological environment induces firms to devote more R&D efforts, whereas the appearance of innovation is relatively rare in an infertile technological environment. This implies significant variations in innovative activity patterns between high-tech firms and their non-high-tech counterparts. To enforce a more effective policy of granting R&D tax credits, one possible improvement is to establish various tax credits across industries. This leads to another essential and prominent issue: does R&D-inducement effect differ between high-tech and other industries in Taiwan? Assessing the potential differences in R&D-inducement effects of R&D tax credits across industries can provide useful insights for legislation of new R&D policies.

At least two difficulties arise when using firm-level data to evaluate the effectiveness of an R&D tax credit within a country. Firstly, due to their different tax positions and expectations on future R&D spending, the variation between firms in credit effectiveness is highly endogenous (Bloom et al., 2002). Secondly, as indicated in Hall and Van Reenen (2000), there are many ways in which the R&D tax credit gives rise to heterogeneity, and often perverse incentives are a key feature in the debate on the desirability of R&D tax credits. Because the recipients of tax credits may differ in some firm characteristics from non-recipients (Czarnitzki et al., 2011), it is important to correct both selection bias and firm heterogeneity across recipients. This study thus adopts the non-parametric propensity score matching (PSM) method developed by Heckman et al. (1997, 1998) to correct possible selection bias. While the PSM approach deals with the selection bias problem to differentiate the treatment effect of R&D tax credit, it does not deal well with the second difficulty of unobservable firm heterogeneity. Fortunately, our dataset contains detailed information concerning the amount of R&D business tax deduction and firm characteristics, thus enabling us to adopt the panel instrumental variable (IV) and generalized method of moment (GMM) techniques to deal with both problems of endogeneity and firm heteroskedasticity.

This paper evaluates the effect of tax credits for R&D and its growth in Taiwanese manufacturing firms, to contribute to the empirical literature in the following ways. First, the question of how and to what extent tax credits stimulate industrial R&D has attracted widespread international attention among economists, with only limited empirical studies focused on developed countries such as the U.S., Canada, and France. However, tax incentive policies are worthwhile considerations in not only developed economies, but also for newly industrialized and developing countries (NIEs). Taiwan has successfully achieved substantial technological development over the past two decades, and its outstanding performance in terms of innovation makes it an excellent case for investigating the tax incentives issue. Our firm-level evidence from Taiwan can complement the existing literature that focuses only on advanced countries. Second, we further separate samples into electronics and non electronics firms to examine whether and to what degree potential differences exist in effectiveness of R&D tax credit.

This investigation can provide useful insights into ways to further revise R&D tax credits, because a uniform tax credit system for all industries is widely criticized as inappropriate. Third, this study employs the PSM method to correct the selection bias problem to differentiate the treatment effect of R&D tax credit. This enables us to compare the R&D activities of R&D tax credit recipients and non-recipients. This study further examines the marginal effect of R&D tax credits on R&D expenditures of firms. In this context, this research employs the panel IV and GMM techniques to deal with endogeneity and unobservable firm heterogeneity, appropriately assessing the effect of R&D tax credits on the R&D efforts of firms.

The remainder of this paper is organized as follows. The next section provides a brief review of the literature on R&D tax credits. Section 3 introduces Taiwanese R&D incentive measures and describes the data used in this study. Section 4 presents the empirical model and examines the R&D-inducement effect of an R&D tax credit using the propensity score matching method. Section 5 presents the findings from a further investigation into the marginal effect of R&D tax credits on R&D across industries. The final section concludes with the main results and their policy implications.

2. Literature review

Private R&D is widely thought to be under-invested in terms of the socially optimal level, due to the imperfect appropriability of new knowledge (David et al., 2000) and financing gaps induced by asymmetric information (Hall, 2002). Therefore, governments generally adopt various policy instruments to foster industrial R&D activity both directly or indirectly, such as tax incentives, subsidies, establishing government R&D labs, and investing in higher education.

The two primary policy tools applied by governments to stimulate R&D in firms are direct subsidies and tax incentives. While direct subsidies (either R&D contracts or R&D grants) can increase private R&D investment significantly, they may simply substitute for other R&D investments that performing firms would otherwise have prepared to undertake, that is, it crowds out firm-financed R&D expenditure and ultimately has no effect whatsoever on such activities (Wallsten, 2000).⁴ Wu (2005) argued that public R&D subsidies might negatively affect private R&D investment by reducing upward pressure on the prices of such R&D inputs as the wages of scientists and engineers. Alternatively, the tax credit instrument reduces the cost of private R&D and seems to be a market-oriented mechanism, because it leaves the choice of how to conduct and pursue R&D programs to enterprises. Although an R&D tax credit is only one of several policy instruments on R&D and is far from a panacea for failure in the R&D market, it has become a common strategy in many countries compared with direct government subsidies or directly conducting the R&D program (Klette et al., 2000).⁵

The increasing prevalence of R&D tax credits has caused wide concern among economists and policy-makers regarding whether or not and how tax incentives affect R&D. Since the early 1980s, a growing number of studies have utilized various methodologies to evaluate the effect of the tax system on R&D behavior (cost). Hall and Van Reenen (2000) provided a comprehensive summary of the literature and indicated that a dollar in the form of a tax credit for R&D stimulates approximately a dollar of additional R&D expenditure. Due to an increasingly lenient tax treatment of R&D, they also argued the likelihood that countries will increasingly turn toward the tax system and away from direct grants. Consequent studies

⁴ For studies on direct subsidies related to R&D activities, please see Özçelik and Taymaz (2008) for a comprehensive survey.

⁵ For the advantages and disadvantages of both tax incentives and direct subsidies for R&D, please see Klette et al. (2000) for a detailed discussion.

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