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Do business cycles affect patenting? Evidence from European Patent Office filings

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ABSTRACT

This paper studies the sensitivity of patent filings to the business cycle using patent filings at the European Patent Office (EPO). Using a dynamic model of patenting and the Hodrick-Prescott (HP) filter method to separate the cyclical component of real Gross Domestic Product (GDP) from its trend component, we find that patent filings are strongly pro-cyclical. This supports the view that short term resource constraints affect patenting decisions, even if there are longer term factors that determine innovation. The study also has significance for forecasting patenting behavior, which is important for policy decision-making, institutional operations, and strategic business planning. Forecasts that rely only on trends prove to be less accurate amidst economic booms and recessionary shocks, such as the recent global financial crisis.

1. Introduction

Two key issues motivate this paper: do business cycles affect patenting behavior and if so, is patenting pro-cyclical or counter-cyclical? Earlier, Griliches (1990) had observed the effects of oil shocks during the 1970s on patent applications. Likewise, the Great Recession of 2008 and 2009 has spurred interest in the impact of cyclical shocks on patenting.[1] The relationship matters to institutional organizations that operate the global patenting system, such as national and regional patent offices, and to industries that provide complementary services to the patenting community; for example, legal, translation, and consulting services. Cyclical shocks affect the ability of these organizations to forecast accurately for purposes of planning and budgeting. Such shocks can therefore affect the supply of services and resources for patent procurement. Cyclical shocks can also affect the demand side by influencing the investment and marketing decisions of firms and other potential patentees. The resulting imbalances in supply and demand could thus have repercussions for the nature and direction of innovation and commercialization.[2]

Much of the existing literature studying the determinants of patents and patenting propensity has not taken into account the role of cyclical shocks.[3] Patents and innovation are often studied under the branch of economic growth theory, as drivers of long run productivity and technological change, where the emphasis is more on structural determinants and trend factors than on cyclical influences. Furthermore, innovation is viewed by many as being driven by longer term considerations, given that the duration of innovation projects is often longer than that of market cycles (see Heger, 2004). On the other hand, short run resource constraints may be binding for some innovators as patenting is costly, and the costs of procurement

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[1] See, for example, Bertenrath et al. (2011), European Commission (2011), Guellec and Wunsch-Vincent (2009), OECD (2009), and World Intellectual Property Organization (2010).

[2] See, for example, Meade and Islam (2006).

[3] See Danguy et al. (2014), de Rassenfosse and van Pottelsberghe de la Potterie (2007), de Rassenfosse and van Pottelsberghe de la Potterie (2012), Hall (2005), Hu and Jefferson (2009), Kortum and Lerner (1999), Liu et al. (2014), Park (1999), Sanyal and Jaffe (2005), Scherer (1983), and Thumm (2001).

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are often incurred upfront before a patented invention is exploited commercially.

The literature on the relationship between innovation and business cycles is very limited, as will be surveyed in the next section. Few academic studies exist, focusing mostly on the input side of innovation – namely, research and development (R&D) expenditures. Research on the effects of business cycles on patenting is rarer. Furthermore, previous work has not formally derived and used a measure of business cycles, and instead has employed proxy variables, such as credit constraints or sales declines (although business cycles also include sales booms), or has compared conditions before and/or after an event, such as the Great Recession of 2008–2009. In this paper, we derive business shocks using standard filtering methods, and allow them to vary by country. A key novelty of our paper is that we apply our business cycle model to forecasting patent filings. This would especially be useful to the *supply side* we mentioned earlier. Failure to anticipate fluctuations leads these institutions and service providers to allocate resources poorly. Improved forecasting can lead to more accurate budgeting and greater cost effectiveness in services, and these increased efficiencies should potentially raise social welfare.

Using data on patent filings at the European Patent Office (EPO), this study provides evidence on the impacts of shocks to gross domestic product (GDP) on the patent filing behavior of 28 countries (including a rest-of-the-world group) over a span of more than three decades. The EPO is a regional patent institution representing a large market area. It provides a single patent granting procedure for its Member Contracting States. A patent granted through the EPO represents a bundle of national patents.

This paper is organized as follows. The next Section 2 briefly reviews the existing literature on business cycles and innovation. Section 3 presents the patenting model and discusses the methodology. Section 4 describes the data, and Section 5 presents the main results and robustness checks. Section 6 provides an application to forecasting EPO patent filings, and Section 7 concludes. Overall, EPO filings are found to be sensitive to business cycles, but the effects of cyclical shocks on filings eventually dissipate. Even so, the cyclical disturbances pose significant challenges for predicting patenting behavior.

2. Previous literature

The existing literature has identified two opposing effects of business cycles on innovation activity: the *resource effect* and the *opportunity cost effect*. The resource effect is that, in a booming economy, firms have more resources, or access to resources, for innovation. Firms typically rely mostly on internal resources, such as cash flow or retained earnings, to fund research projects, and secondarily on external sources, such as venture capital financing or subsidies and grants from the public sector. Both internal and external resources are more easily available when the economy is in an expansionary phase than in a contractionary one. Under the resource effect, innovation is pro-cyclical; that is, it increases when the economy is growing and decreases when it is declining. The opportunity cost effect states that innovation will increase when the economy is in a downturn. The reasons are two-fold. First, the cost of conducting research is lower during a recession. Research input costs, such as the price of materials and labor, will be lower. Second, the opportunity cost of conducting research is lower during a recession. Allocating resources to innovation will require diverting resources and effort away from production and marketing activities, but when the economy is in a downturn, the loss in sales is not too high. In contrast, when the economy is booming, firms face a higher opportunity cost of diverting time and resources away from production in order to engage in innovation. Under the opportunity cost effect, therefore, innovation is counter-cyclical – falls when the economy is growing and rises when the economy is contracting.

Few studies have tested the effects of business cycles on innovation. As a typology, they consist of both microeconomic studies using firm or industry level data and macroeconomic studies using country level data. Studies vary as to whether the dependent variable is R&D or patenting. Most of these focus on R&D as the measure of innovation. Rafferty and Funk (2008), for example, use firm level data for U.S. manufacturing industries from 1973–1990 and find that the opportunity cost effect is weak so that, overall, R&D is pro-cyclical. Their dependent variable is the growth rate of R&D, which they regress on measures of business cycles, such as sales rising (or falling), and cash flow rising (or falling). A limitation of these measures is that part of the movement in sales and cash flow can be due to shifts in the long term trend as well as to short term cycles. Another issue is whether it is appropriate to measure business cycle shocks using firm level variables, rather than say macroeconomic or industrial level variables. Fluctuations in firm sales, for example, need not be the outcome of business cycle shocks.

Lopez-Garcia et al. (2012), in contrast, find support for the opportunity cost effect. Using a large sample of Spanish firms from 1991–2009, the authors find R&D to be counter-cyclical, provided that credit constraints are absent. They argue that firms utilize economic downturns to invest in productivity-enhancing activities, such as R&D and on-the-job training. Their regression equation relates changes in R&D to changes in GDP, changes in cash flow, and other variables. Again, mere changes in GDP and cash flow are not good measures of the business cycle, as they consist of changes in both the trend and cyclical components of income.

A study that does focus on patenting and business cycles is Martinsson and Lf (2009). They study a sample of Swedish firms in the manufacturing industry from 1997–2005 in order to examine how a firm's patenting is affected by its cash flow. Fluctuations in cash flow are their proxy for business cycles (the limitation of which was discussed above). The authors find that cash flow shocks affect patenting only during economic downturns, but not during expansions. Hence, they find partial support for the resource effect, suggesting that patenting is pro-cyclical only when there is a recession. Giedeman et al. (2006) also study the effects of business cycles on patenting but for U.S. firms. They find that patenting by small firms in the semiconductor industry is pro-cyclical, while that in the automobile industry is countercyclical. The former industry tends to manufacture high-tech goods of relatively low durability whereas the latter industry produces durable consumer goods. In earlier work, Geroski and Walters (1995) examined counts of major U.K. innovations (namely, those that were commercial successes), as well as the patent filings of U.K. firms in the U.S., and found innovation activity to be pro-cyclical.

There are also a few macroeconomic studies on the effects of business cycles on innovation (see European Commission, 2011; Guellec and Wunsch-Vincent, 2009; OECD, 2009; World Intellectual Property Organization, 2010). Their analyses are based on what happened to innovation during the Great Recession. In a study on the impacts of public R&D and tax incentives on private research, Guellec and van Pottelsberghe de la Potterie (2003) use GDP growth as a control for business cycles. In this paper, we derive a more explicit measure of cyclical shocks and test their effects on innovation across a longer time horizon and across regions. Spatial differences in shocks can be used to determine whether variations in innovation are attributable to business cycles or to some other related global phenomena. To date, the literature has found little evidence for the opportunity cost hypothesis. Our multi-country panel data analysis further supports the view that patenting is pro-cyclical.