Economic Modelling 52 (2016) 851–858

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

Institutional path dependence and international research intensity☆

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ARTICLE INFO

Article history:
Accepted 17 October 2015
Available online 6 November 2015

JEL classification:
O33
O31
O57

Keywords:
Research intensity
Path dependence
Colonies
Patent rights
History
Democracy

ABSTRACT

Whereas there is informal and formal recognition and understanding of research inertia in driving the intensity of research, there is little formal evidence on the role of historical and political legacy or institutional path dependence in affecting research intensity. This paper uses data on about 100 nations to address this aspect, focusing on the long, medium and short-term research intensity. Across two measures of a nation's institutional history, we find that broader national stability positively affects research intensity both in the long and the medium terms, while the narrower path dependence measure supports these findings, albeit with weak statistical significance. The effects on short-term research intensity lack statistical support across both measures. Comparing institutional path dependence with research inertia, we find that both factors significantly affect research intensity. The main findings are robust to various modifications.

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1. Introduction

It has been widely recognized that innovation is key to economic growth and prosperity. Research spending not only results in innovation but also increases the spender's ability to benefit from the research of others. A nation's economic circumstances as well as socio-political institutions dictate its research intensity. For instance, greater economic prosperity makes research affordable and increases the potential payoffs from research, while institutions such as patent protection and democracy bear on the ability to appropriate rewards from research endeavors (see North, 1990; Scotchmer, 2004).

Given that research is cumulative, discontinuous, and lumpy, inertia from past research dictates present research intensity—i.e., there is inertia with research effort (see David, 2001; Nelson and Winter, 1982; Rosenberg, 1976; Ruttan, 1997 for a nice evaluation of alternate theories driving innovation). Some research projects are multi-year or unsuccessful outcomes from one research project might tie into fruitful byproducts for future projects. There is, however, inertia associated with institutions as well. Long-standing norms associated with democratic practices, patent protection policies, etc. have some state-dependence and are quite difficult and time consuming for nations to alter. Individuals and firms in politically stable nations and nations with a consistent set of institutions have greater confidence in engaging in research and in reaping potential rewards from such endeavors. Thus, historical institutional legacy bears upon incentives to engage in research activity.

Whereas there is informal and formal recognition and understanding of research inertia in driving the intensity of research (see David, 1985, 2001; Falk, 2006; Goel, 1999; Grabowski, 1968; Mansfield, 1964; Pakes and Schankerman (1984)), there is little formal evidence on the role of historical and political legacy in driving research intensity (see Arthur, 1994; David, 2001; Mokyr, 2010; North, 1990); also, Dosi et al. (2003), Fagerberg et al. (2008) and Whitley (2002)). The well-known work of Nelson and Winter (1982) on evolutionary economics can also be seen as emphasizing technological inertia. In an interesting piece of related evidence from the local level, Simmie et al. (2008) report survey results from the U.K. where respondents noted the importance of institutions (and their lack of flexibility) in driving innovation (also see Bresnahan et al. (2002) for some evidence from the United States and Colombo and Delmastro (2002) for a study based on data from Italian firms). In a broader sense, the institutional factors can be seen in the context of national innovation systems (Nelson, 1993). Yet, it is not a priori clear whether historical factors significantly affect research when other relevant influences have been formally accounted for.

This paper uses data on about 100 nations to address this aspect, focusing on long, medium and short-term research intensity. We use two different measures of historical inertia to test the robustness of

☆ Comments of two referees are appreciated. An earlier version of this article was presented at the 2015 meetings of the Technology Transfer Society.
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http://dx.doi.org/10.1016/j.econmod.2015.10.021
0264-9993/Published by Elsevier B.V.

our findings. Along another related and important dimension, we also compare the relative influences of institutional inertia and research inertia.

Results, using two measures of a nation's institutional path dependence, show that broader national stability positively affects research intensity both in the long and the medium terms, while the narrower path dependence measure supports these findings, albeit with weak statistical significance. The effects on short-term research intensity lack statistical support across both measures. Comparing institutional path dependence with research inertia, we find that both factors significantly affect research intensity. The main findings are robust to various alterations.

In the context of potential public policy importance of this work, the significance of historical factors in affecting research intensity might be viewed as largely exogenous. While various nations have been redoubling their efforts through various policy initiatives such as R&D subsidies, tax credits, and stronger patent protection laws, it may be the case that historical institutional inertia that is beyond their current control might have an equally important role. It might well be the case that differentials in research and productivity across nations are driven significantly by their history (Dosi and Nelson, 2010; also see Acemoglu and Zilibotti, 2001). The theoretical section to set up the formal analysis follows.

2. Theoretical background and model

The literature on path dependence in technological change has almost exclusively been theoretical and has also largely focused on technological inertia in driving future technical change (see North (1990), Rosenberg (1976) and Ruttan (1997) for broad overviews and Yap et al. (2014) and Luckraz (2013) for stylized theoretical models). The role of institutional and political legacy in regard to path dependence in research has largely been ignored (see Whitley (2002) for a notable exception and Simmie et al. (2008) for some anecdotal references; also see Dosi et al. (2003)). Some of the underlying methodological challenges have been noted by David (2001) and Vergne and Durand (2010). For instance, Vergne and Durand (2010, p. 736) mention that, "…path dependence is not yet a theory since it does not causally relate identified variables in a systematized manner." The present work focuses on institutional path dependence in terms of its influence on technical change and provides some unique cross-national evidence in this regard.

A nation's history can affect technological change via numerous channels (see Mokyr, 2010). For example, political upheavals in the past (wars, colonization, coups) can drastically change the political and institutional structure (e.g., transition from democracy to dictatorship or vice versa), besides altering the physical expanse of a nation (via foreign occupations or annexations) in some cases. This can increase uncertainty about potential payoffs from research and reduce research intensity (see Goel, 2007). On the other hand, a stable nation with a well-defined and consistent set of institutions, including institutions for patent protection, democracy and press freedom, would instill confidence in the ability to potentially recoup investments in research. National systems of innovation shape institutions that drive future technical change (Nelson, 1993), and Fagerberg et al. (2008) provide some interesting details of institutional legacy in the case of Norway.

Further, historical precedents, either due to serendipity or need driven by a nation's peculiar resource endowments, would trigger certain innovations and related research investments in some nations and not in others (see David, 1985, 2001; Nelson and Winter, 1982). Over time, future research investments then would be driven by this research/innovation inertia. Examples, besides the well-known cases of England surrounding the Industrial Revolution (see Mokyr, 2010), include the development of nautical navigation in Greece (due to its lack of adequate land borders and a vast archipelago) and the relative lagging behind in the development of paper in India (where dried leaves were often used for writing, but unlike paper, leaves disintegrated quickly over time). Thus, in the case of India, the lack of early development of paper can be seen as a reason for the historic focus not being toward the invention of the printing press. Furthermore, the inertia from the QWERTY keyboard in dictating future technical developments in keyboards is well known (see David, 1985). So, historical precedents shaped the direction and intensity of subsequent research in these (and many other) cases.

While the vast majority of the theoretical and empirical research on the drivers of research intensity has focused on micro-level firm behavior (see, for example, Falk, 2006; Grabowski, 1968; Mansfield, 1964; Pakes and Schankerman, 1984), this paper takes a broader, macro or country-level view. This approach seems justified in view of the fact that historical and political factors influence whole nations over time, whereas individual firms generally have much shorter horizons and longevity. Nevertheless, to the extent reasonable, we anchor our empirical approach in the extant empirical literature in choosing the determinants of research intensity.

One can use a basic discrete time framework to motivate and better understand the role of historical inertia on research intensity (for example see Goel, 1987). With t denoting a year and i a country, the historical legacy (Z) at the beginning of time $(t+1)$ would depend upon the legacy at time t (net of any institutional decay (μ) during the year t), plus any institutional additions (I) during the year t.[1] Formally,

$$Z_{i,t+1} = I_{it} + (1-\mu)Z_{it} \tag{1}$$

This Z in turn affects research intensity and forms the focal point of this work, leading to the following hypothesis that we will empirically test.

Hypothesis. *Greater historical and political stability in a nation positively affects its research intensity.*

The above hypothesis is tested with an equation of the following general form

$$\begin{aligned}\text{Research intensity } (R\&DExp_{it}) = f(&\text{Historical legacy}(Z)_{ijt},\ \text{Democracy}(DEM_{it}),\\ &\text{Population density}(PopDensity_{it}),\ \text{Patent protection}(PatentRights_{it^*},\ PropertyRights_{it}),\\ &\text{Openness}(OPEN_{it^*}),\ \text{Export structure}(HighTech_{it}),\ \text{Economic prosperity}(GDP_{it^*}),\\ &\text{Research inertia}(R\&DExp_{it-1}))\end{aligned} \tag{2}$$[2]

$i = 1,2,3, \ldots$

$j =$ *Antiquity*, *Colony*

$t =$ 1996–2012, 2000–2012, 2010–2012

(t^* denotes alternate periods noted in the tables)

To ascertain the effectiveness of historical inertia on research intensity, we use annual data on over 80 countries disaggregated into three separate periods: (1) long term; (2) medium term; and (3) short term. Each sample is based on unweighted averages over the period 1996–2012 for long term; 2000–2012 for medium term; and 2010–2012 for the short term. Although the choice of these different time frames is somewhat arbitrary and partly driven by data availability, the underlying logic is based on the fact that research spending in a nation is generally quite lumpy and prone to fluctuations from year to year, based on economic and non-economic influences. For instance, research spending dips in years of economic downturns, wars and natural calamities, while it might be especially pronounced in the event of unusual circumstances facing a nation—e.g., the space race or the perceived threat of war. The alternate time periods might also be capturing different innovation cycles (see Luckraz (2013) for a theoretical model

[1] One could also envision scenarios where the institutional decay rate μ might be variable over time and country.

[2] We also included inflation rate and ethnolinguistic fractionalization as regressors in Table 2. Both variables were insignificant and were dropped from the analysis.