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Output growth in German manufacturing, 1907–1936. A reinterpretation of time-series evidence

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Abstract

This study uses state space time series analysis to estimate output growth in German manufacturing between 1907 and 1936. In the absence of net-output data, previous research has estimated output change using proxy variables. Various proxy-based output series are available that imply either a 25% German labor-productivity lead over Britain or a parity of performance in 1907. The conventional strategy to deal with this conundrum involves a choice between the series. With the correlation between the different proxies and output unknown, such a choice is inappropriate because it results in the loss of information provided by the rejected proxies. Instead, this study makes full and efficient use of all information by estimating a common component in the various output series. The new estimate of output change implies a German lead over Britain in manufacturing labor productivity of 4.4% in 1907.

Keywords: Time series; state space models; comparative economic history; production; manufacturing; Germany
JEL classification: C320; L600; N140; N640; O140

1. Introduction

The data available to historical studies is frequently limited, especially for periods in the distant past. When a variable is unobserved, its behavior can be proxied by correlates. This strategy is widely applied in the field of economic history. One can think of the years of schooling as a proxy for human capital (e.g., Goldin, 2001) or installed horse power for technology levels (e.g., Crafts, 2004). Other, perhaps more daring examples are book production for literacy rates (e.g., van Zanden and Baten, 2008) or age heaping for numeracy rates (e.g., Baten et al., 2014). Notwithstanding the usefulness of proxy variables, these correlates are too often implicitly, and mistakenly, treated as the true value of the unobserved variable of interest. This creates, first, a false sense of accuracy and, second, confusion when two or more proxies are available that display different dynamics. As it is impossible to measure the strength of the correlation between the variable of interest and the proxy when the former is not observed, only circumstantial evidence remains to assess the latter's accuracy.

In this paper I use state space time series analysis as an alternative method for estimating unobserved variables. I

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show that this alternative approach provides a way around the disadvantages discussed above by applying it to the debate on German industrial output growth in the early twentieth century. At stake in this debate is the labor-productivity leadership in Europe shortly before WWI. In most German industries data on net output (hereafter "output" unless expressly stated otherwise) is unobtainable for years prior to the first census of production of 1936. Output proxies, such as production volumes, are often available, however. For some industries two or even three different proxies are on hand. This becomes problematic when they show dissimilar dynamics. As it turns out, choosing between proxies leads to very different estimates of labor productivity in German manufacturing; before WWI Germany either performed on par with Britain or enjoyed a clear lead of about 25%.

The historical implications of such a choice sparked off a debate on the reliability of available proxies (Broadberry and Burhop, 2007, 2008a,b; Ritschl, 2004, 2008). I argue, however, that it is not appropriate to prefer one series over another. The proxies used in the debate can all be linked to output change on the basis of economic theory, but the correlation with the true unobserved change of output is never perfect. This means that all proxies carry information, yet none can be rightfully considered equivalent to true output change. Therefore, choosing one series over the others leads to a loss of information. The debate on German output change focused on the use of two different proxies for output change in metal processing, a large manufacturing industry. Both the wage bill and the value of sales can be related to output change on theoretical grounds. If labor is paid its marginal product and income shares are fixed, changes in the wage bill capture changes in net output. On the other hand, the value of sales equals gross output if the economy is closed and without inventories. These conditions do not apply in reality so that none of the proxies can be expected to capture output perfectly. At the same time, all proxies will correlate with output change and must partly be driven by common dynamics.

A technique is required that determines the shared dynamics between the proxy series. One way of doing this is by taking a simple average of the different output series, a technique used mainly in the national-accounts literature. A famous example is Feinstein's (1972) 'compromise estimate' of U.K. national income between 1857 and 1948, calculated as the arithmetic average of three different national income estimates that are compiled with output, expenditure and income data (see also: Sefton and Weale, 1995). Burhop and Wolff (2005) pursue the same strategy in an attempt to reconcile different national-income estimates for Germany in the late nineteenth century. The central idea in both studies is that each of the national income estimates ought to be equivalent by accounting restriction, but they deviate by an error from the true data (Weale, 1985). Taking the least-square estimate of the observed series provides a possible solution. If all observed series are unbiased estimates of the true data and they are equally reliable, then the simple average presents the least-square solution (Solomou and Weale, 1991).

While this may be a "pragmatic solution", as Burhop and Wolff (2005, p. 635) call it, this strategy does not work in the case of the German debate on industrial output growth. None of the proxies used is an unbiased estimate of true output change and the accounting restriction that all estimates should be equivalent does not apply. What is needed is a method that relates the unobserved true output change to the observed proxy series by means other than assuming an accounting identity. For this I use state space analysis, the purpose of which is to infer the relevant properties of an unobserved variable from a knowledge of observed series (Durbin and Koopman, 2001). Because the state-space form provides a structural time series model, set up in terms of components which have a direct interpretation, it is very flexible and can handle a wide range of time series problems (Harvey, 1989). In the state-space form it is possible to model the observed German output series jointly, explicitly correlating the dynamics across the different series, which is appropriate given that they are subject to the same influence, namely output change in German industry.

My approach brings together two recent strands of research in the field of economic history. First, I build upon a literature that has used univariate state space time series models to estimate unobserved variables. Examples are studies on the interaction between economic and demographic variables, such as the work of Lee and Anderson (2002) and Crafts and Mills (2009) on Malthusian mechanisms in English history. Similar work for Germany is done by Pfister et al. (2012). Each of these studies uses the state-space form to estimate the dynamics of unobserved variables, such as technological change, the demand for labor or weather and disease prevalence. Second, my approach is closely linked to multivariate dynamic factor models that estimate co-movement across various observed series. This research avenue has been explored by Sarferaz and Uebele (2009) and Uebele (2011) in an attempt to track down business-cycle movements in pre-WWI Germany. To the best of my knowledge, this