

Financial development and sectoral output growth in nineteenth-century Germany¹

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In this article we re-evaluate the hypothesis that the development of the financial sector was an essential factor behind economic growth in nineteenth-century Germany. We apply a structural VAR framework to a new annual data set from 1870 to 1912 that was initially compiled by Walther Hoffmann (1965). With respect to the literature, the distinguishing characteristic of our analysis is the focus on different sectors in the economy and the interpretation of the findings in the context of a two-sector growth model. We find that all sectors were affected significantly by shocks from the banking system. Interestingly, this link is the strongest in sectors with small or non-tradable-goods-producing firms, such as construction, services, transportation and agriculture. In this regard, the growth patterns in nineteenth-century Germany are similar to those in today's emerging markets.

Keywords: economic growth, financial development, sectoral asymmetries

JEL classification: C22, N13, N23, O11

I

In this article we re-evaluate the hypothesis that bank lending was a key factor in the growth process in nineteenth-century Germany and that it was instrumental in financing the industrial revolution. This hypothesis has been developed, among others, by the influential economic historian Alexander Gerschenkron (1962). This conventional view has been adopted by most researchers and has triggered a literature that discusses the benefits of close relationships between banks and firms that were said to be typical of Germany at the time. A survey of papers arguing along these lines is given, for instance, in Guinnane (2002). A notable exception, however, is Edwards and Ogilvie (1996), who challenge this view and point out that large universal banks that serviced the big industrial firms contributed only a small fraction to total bank lending. They argue that universal banks were primarily engaged in organising the issuance of new shares, but hardly contributed to financing long-term investment by credit.

¹ We would like to thank Jeremy Edwards, Sheilagh Ogilvie, Aaron Tornell and the participants of the European Economic Association 2010 in Glasgow and Verein für Socialpolitik in Kiel as well as two anonymous referees for helpful comments and suggestions.

We employ a new data set to reinvestigate whether there has been a positive effect of bank lending on growth and whether indeed the industrial sector – or possibly other sectors in the economy – benefited most strongly from the development of domestic credit in Germany. This data set was initially compiled by Walther Hoffmann (1965) for the sample period of 1870–1912 and includes a detailed sectoral disaggregation of output.² It therefore allows us to trace the effect of the rapid increase in bank lending on net domestic product, as well as on the sectoral structure underneath it.³ In our article, we focus on the main subsectors, mining, industry, construction, agriculture, transportation, trade and services.

In the empirical analysis, we use a VAR framework to trace the effect of an unexpected shock in aggregate lending on domestic product and its subsectors. From the VAR coefficients, we generate impulse response functions in two different ways. On the one hand, we use generalised impulse response functions. These can be computed without prior knowledge of the contemporaneous causal relationships among the variables. On the other hand, we use a Cholesky decomposition that was proposed by Tornell and Westermann (2005) and that, using an appropriate ordering, can be interpreted as structurally identified in the context of a theoretical two-sector growth model with credit market imperfections. As output, in the model, depends on investment and credit in period $t-1$, it is assumed not to be affected by bank lending in the same period.⁴

Considering first the aggregate variables, we find that net domestic product (NDP) displays a significant and positive reaction to a standard shock in the bank lending variable, using both identification approaches. We find a direct effect on NDP and an additional indirect channel via its effect on investment. This finding is consistent with most papers on economic history (see, for instance, Burhop (2006) for Germany, Levine (1997), King and Levine (1993), Rousseau and Wachtel (1998, 2000) and Schularick and Steger (2010) for other countries), as well as a large body of literature on finance and growth in the post-World War II period, in particular in today's emerging markets (see Beck *et al.* (2000) for an overview).

In the sectoral analysis, we find that all subsectors also react significantly to an unexpected shock in aggregate lending. It is interesting, however, that the importance of these shocks varies substantially across sectors. In a variance decomposition of the forecast errors, we find that for the mining sector, the industrial sector and the trade sector, shocks from the banking system only play a minor role. The agricultural sector, the construction sector, the transportation sector and the service sector, on

² We also used the updated and corrected series by Burhop (2005) and Burhop and Wolff (2005).

³ In addition to the historical interest in the German industrial sector, the importance of sectoral information, when analysing the effects of financial deepening on growth, has been emphasised, among others, by Rajan and Zingales (1998) and Tornell and Schneider (2004), as aggregate measures on output often mask deep asymmetries in sectoral output dynamics.

⁴ In our empirical exercise a 'period' would be a year, as higher frequencies were unavailable for this time period.

the other hand, are substantially more affected. Although our findings confirm previous empirical studies on the aggregate impact of bank lending on growth, they therefore challenge the conventional view of the role the banking system has actually played in promoting growth. Our results indicate that rather than speeding up the structural change within the industrial sectors, the importance of bank lending was that it allowed other sectors to keep pace. In a period of rapid technological change, it seems to have allowed for a more *balanced* growth path than could otherwise have taken place. This result appears to be at odds with the hypothesis that the industrial sector benefited most from the development of lending in the banking sector, but is consistent with Edwards and Ogilvie's view that the German banking system was primarily engaged in small-firm financing.

The importance of sectoral information, when analysing the effects of financial deepening on growth, has also been emphasised in Tornell and Schneider (2004), who point out that aggregate measures on output often mask deep sectoral asymmetries in credit-constrained economies.⁵ It is interesting that the sectoral patterns observed in today's emerging markets are indeed reminiscent of the sectoral growth patterns in nineteenth-century Germany. Tornell, Westermann and Martinez (2003) have documented in a broad cross-section of middle-income countries from 1980 to 2000 that there exists a pronounced shift towards small firms and those producing non-tradable goods in periods of rapid credit expansion.⁶ Tornell and Schneider (2004) motivate theoretically that small firms in non-tradable-goods-producing sectors are likely to benefit most from bank lending, while the tradable sectors typically consist of large firms that have other forms of financial instruments available. In their model, the latter sectors can borrow directly from the (international) capital market and are largely unaffected by the domestic banking system. Taking into account these characteristics of credit markets, Rancière and Tornell (2010) developed a two-sector growth model, in which the non-tradable sector creates a 'bottleneck' to economic growth as it is used as an input in the tradable sectors' production. Relaxing the credit constraints in the non-tradable sector therefore leads to overall higher growth.

The empirical results in our article seem to confirm this view. The industrial, mining and trade sectors are classical tradable-goods-producing sectors. In particular, the industrial sector displayed the highest export share during the late nineteenth and early twentieth century in Germany. Also the latter two sectors consist of mostly large firms. Construction, transportation and services, on the other hand, are clearly non-tradable. Although agriculture ranks among the more tradable sectors today, it is plausible that due to the lack of modern refrigeration technologies as well as high tariffs, its output was substantially less tradable more than a century ago. Also, this sector is characterised by a large number of relatively small firms.⁷

⁵ See also Rajan and Zingales (1998).

⁶ See also Krueger and Tornell (1999) for a case study on Mexico.

⁷ The changing role of the agriculture sector in the late nineteenth century towards more global interpretation has been documented by O'Rourke and Williamson (1999).

The rapid increase in productivity of small agricultural firms is documented in van Zanden (1991).⁸ Its importance for the industrial revolution has been discussed for instance in Perkins (1981) and Webb (1982).⁹ In the context of the Ranci re and Tornell model, it can be seen as an input into the production process, and the financial sector development helps to remove this bottleneck that prevents an overall higher growth path. Finally, the assumptions on credit market imperfection in the Tornell and Schneider (2004) model are likely to be valid for our sample period. Guinnane (2001) has argued that rural credit was a significant problem in nineteenth-century Germany and pointed out that ‘credit conditions in Germany sound similar to those found in many developing countries today’ (p. 368).

We test for the robustness of our results in several ways. First, we employ three alternative indicators of bank lending, the net contribution of banks to financing investment and total assets in the banking system, reported by Hoffmann (1965), as well as the total assets of joint-stock credit banks, reported by Burhop (2002) and Deutsche Bundesbank (1976). Furthermore, we use data on equity capital to show that the non-tradable sectors did not benefit disproportionately from the alternative forms of financing that are typically used by large industrial firms. When using equity capital in our VARs instead of bank lending, the industrial sector is the one that reacts to an unexpected increase in financial resources most strongly.

Section II provides a description of the data¹⁰ and a preliminary analysis of the unit root and cointegration properties. The VAR analysis of aggregate output is given in Section III. Section IV contains the sectoral analysis and robustness tests. Section V concludes.

II

The data in our analysis are drawn from a book written by the German economic historian Walther Hoffmann (1965). This data set is particularly useful for our analysis because it includes a detailed decomposition of sectoral output.

Our main variables are the net domestic product (NDP),¹¹ investment (I)¹² and bank lending (B).¹³ Both domestic product and investment are expressed in net

⁸ Van Zanden shows that the use of mechanical threshers, reapers or sowing machines was particularly high in post-1870 Germany. The development of agriculture finance in the nineteenth-century Germany has been documented in Bl mer (1990).

⁹ This has also been documented for other countries. There is a consensus among economic historians that an agricultural revolution has preceded the industrial revolution in several countries (see, for instance, Crafts (1995) who documents growth in the agricultural sector in England prior to 1820).

¹⁰ Additional information about the sources and composition of our variables is provided in the appendix.

¹¹ See Hoffmann (1965), table 5a, pp. 26f., converted in level data.

¹² See Hoffmann (1965), table 248, pp. 825f.

¹³ See Hoffmann (1965), table 239, pp. 812f. Because the data for *bank lending* are only available in nominal terms, we adjusted the values with the price index for the net national product, table 148, pp. 598ff.

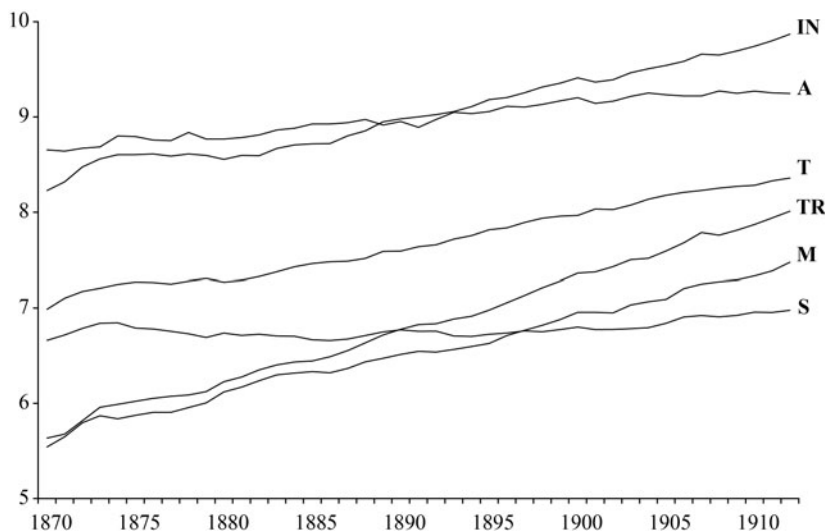


Figure 1. *Sectoral output growth (in logs)*

Note: The graphs for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR), and services (S) are displayed.

terms and in constant 1913 prices. Our bank variable captures the contribution of banks in the financing of net investment.

On a disaggregated level we consider the following sectors: mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S).¹⁴ The mining sector contains value added of mining and salines, the industry sector consists of industry and skilled crafts, and the agriculture sector covers the value added of farming, forest and fisheries. The trade sector contains the value added of trade, banks, insurances and public houses. Figure 1 shows the time paths of the sectors in logged terms. While mining and industrial production were growing very fast over our sample period there was also substantial growth in agriculture. Transportation was the fastest growing among all sectors.

We also take an alternative measure of the banks' contribution to financing investment. Our indicator *total assets 1 (TA1)* includes the total assets of savings banks, cooperative credit associations, mortgage banks, banks of issue, land mortgage banks and commercial banks.¹⁵ *Total assets 2 (TA2)* represents the total assets of joint-stock credit banks reported in Burhop (2002). The variable *equity capital (EC)* represents the paid-up capital of stock corporations.¹⁶ All data are recorded on an annual basis. The sample period covers the years 1870–1912.¹⁷

¹⁴ See Hoffmann (1965), table 103, pp. 454f.

¹⁵ See Hoffmann (1965), tables 202, 203, 205, 206, 207, 208, pp. 733ff.

¹⁶ See Hoffmann (1965), table 220, pp. 772ff.

¹⁷ Note that some of the data go back to 1850. In our benchmark regressions, we did not take the full time period, however, in order to limit our analysis to a period in which the federal territory of

Table 1. *Results of the ADF tests*

Variable	Levels			Squares		
	ADF	k	Prob.	ADF	k	Prob.
Net domestic product	0.252	0	0.973	-5.493***	0	0.000
Investment	-0.988	1	0.749	-12.507***	0	0.000
Bank lending	-2.455	0	0.134	-6.950***	1	0.000
Total assets 1	-2.840	0	0.061	-4.596***	0	0.000
Total assets 2	-1.691	2	0.428	-4.648***	0	0.001
Equity capital	0.123	4	0.963	-4.938***	3	0.000
Mining	-0.205	0	0.930	-5.679***	1	0.000
Industry	0.119	0	0.964	-4.875***	0	0.000
Agriculture	-0.953	0	0.761	-8.067***	0	0.000
Trade	0.347	0	0.978	-7.984***	0	0.000
Transportation	-0.584	0	0.864	-5.465***	0	0.000
Services	-1.364	1	0.591	-4.804***	0	0.000

Note: The ADF test is calculated for levels and first differences for the variables net domestic product (NDP), investment (I), bank lending (B), total assets 1 (TA1), total assets 2 (TA2), equity capital (EC), mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) for the years 1870–1912. The lag length is selected by the Schwarz information criterion. *** indicates significance at the 1% level.

We start our empirical analysis by testing the unit root properties of our time series. We first apply the conventional Augmented Dickey Fuller test. In Table 1, which reports the results for our main variables, we can see that all of our time series are non-stationary in levels, but stationary in first differences. The optimal lag length in the test specifications was chosen by the Schwarz information criterion.

In the following sections of the article we will estimate the causal linkages among our main variables by using a vector autoregression. In this VAR our variables enter in logged levels and we therefore need to check the cointegration properties of our data set as a second preliminary exercise (see Table 2).

Overall, there is substantial evidence on cointegration among our time series, although in some cases the evidence is mixed, when using different techniques of estimation. Using the Engle and Granger (1987) approach, we find evidence of cointegration among all pairs of time series that later enter the VAR analysis, except services and bank lending. We cannot generally confirm cointegration using the Johansen (1991) test, however. In particular, the three-variable system of net domestic

Germany was uniform and to avoid structural breaks. We also avoid the necessary interpolation of some data points in the 1850s. The main results of the analysis are unaffected by the choice of the time window.

Table 2. Results of cointegration tests

Variable	Johansen		Engle/ Granger		
		Trace	Max-Eigenvalue		
Net domestic product, investment and bank lending	r = 0	61.634**°	r = 0	25.360*°	-4.016*
	r ≤ 1	36.275**°	r = 1	18.934*°	
	r ≤ 2	17.340**°	r = 2	17.340**°	
Net domestic product and bank lending	r = 0	38.974**°	r = 0	23.660**°	-3.417*
	r ≤ 1	15.314**°	r = 1	15.314**°	
Investment and bank lending	r = 0	30.903**°	r = 0	21.465**°	-4.243**
	r ≤ 1	9.438*	r = 1	9.438*	
Mining and bank lending	r = 0	36.425**°	r = 0	27.208**°	-3.176*
	r ≤ 1	9.217	r = 1	9.271	
Industry and bank lending	r = 0	31.528**°	r = 0	20.425**°	-3.467*
	r ≤ 1	11.103*°	r = 1	11.103*°	
Agriculture and bank lending	r = 0	26.850**°	r = 0	15.858*	-3.614**
	r ≤ 1	10.992*°	r = 1	10.992*°	
Trade and bank lending	r = 0	48.807**°	r = 0	33.476**°	-3.564*
	r ≤ 1	15.331**°	r = 1	15.331**°	
Transportation and bank lending	r = 0	30.750**°	r = 0	18.707*°	-3.245*
	r ≤ 1	12.043*°	r = 1	12.043*°	
Services and bank lending	r = 0	11.252	r = 0	8.631	-1.567
	r ≤ 1	2.521	r = 1	2.621	

Note: * and ** indicate significance at 5% and 1% level by employing critical values from Osterwald-Lenum. ° and °° indicate significance at 5% and 1% level for critical values from Cheung and Lai (1993). For Engle and Granger (1987) cointegration, * and ** indicate significance at 5% and 1% level using critical values from MacKinnon (1991).

product, investment and bank lending as well as some bivariate combinations do not appear cointegrated in this second approach.

Although there is only mixed evidence on cointegration, we continue with the VAR specification in levels, as the alternative – an estimation in first differences – seems to have even more severe shortcomings. The time series in the first differences have a much higher variance at the beginning of the sample than towards the end. The intuition of this phenomenon is that at this very early stage of development, the time series start to grow from very low levels. Thus, positive as well as negative growth rates will have a much larger amplitude than in the later part of the sample, where they have reached a higher level.

Proceeding with the VAR in levels, we need to keep in mind, however, a potential bias in our results if the time series are not clearly cointegrated. Except for the bivariate

combination of services and bank lending, we can reject the null of no cointegration in at least one of the three approaches (Engle/Granger, Johansen, Trace/Max-Eigenvalue Statistic).

III

In the subsequent analysis, we take two different approaches to modelling the link between financial development and growth. One of the key issues in a VAR framework is the identification of structural shocks. In our first approach, we apply the concept of generalised impulse responses. This approach has the benefit that the impulse response functions are independent of the ordering of the variables in the VAR. Its drawback, however, is that the structural shocks are ultimately not identified. We simulate a *system shock*, where the contemporaneous reactions of the other variables are already included.

In the second approach we follow the structural identification proposed in Tornell and Westermann (2005). In this article, the identification is based on a theoretical two-sector growth model that also guides the analysis in the later sections of the article. We employ a Cholesky decomposition, where output cannot contemporaneously react to domestic lending in the same period. The intuition is that output results from investment that is financed by domestic credit in the period $t-1$. This also applies to sectoral output. As lending, on the other hand, can react to changes in output in the same period, we have a recursive system that can be used to identify shocks from each variable, following the standard Cholesky procedure. The advantage of this approach is that a structural interpretation can be given to the impulse response functions in the context of this model. A drawback is that we need to limit the analysis to bivariate systems. In our view, neither of the two approaches may clearly be better, but jointly, they give a more complete picture of the link between financial development and growth.

Generalised impulse response functions

Figure 2 reports the generalised impulse responses from our first VAR, which includes the variables net domestic product, investment and bank lending. Our main interest is in the effect that banks have on the net domestic product, which is displayed in panel A. There, a statistically significant effect for about four years exists. Panel B shows that there is in addition another indirect effect. For a period of three to four years, an unexpected increase in bank lending increases investment. It is well known that investment, in turn, has a positive impact on NDP.¹⁸

Although the impulse response functions have revealed a clear link between aggregate bank credit and net domestic product, they do not allow us to assess the

¹⁸ Indeed, the impulse response for NDP and investment reveals a positive but short-lived impact on NDP when investment is shocked unexpectedly. Because this effect is often reported in the literature, we do not show this graph in this article.

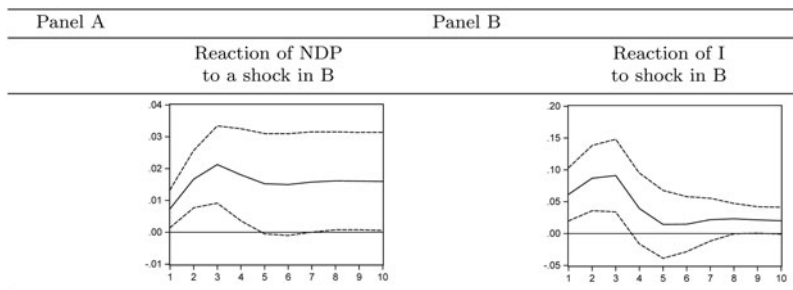


Figure 2. *Generalized impulse responses for net domestic product, investment and bank lending*
 Note: The solid lines trace the impulse responses of net domestic product (NDP) and investment (I) to shocks in bank lending (B) for the years 1870–1912.

Table 3. *Variance decomposition for net domestic product, investment and bank lending*

Variance decomposition (%)	Years	
	5	10
NDP variance due to B	24.009 [12.374]	23.129 [12.294]
I variance due to B	30.006 [12.470]	29.281 [12.541]

Note: The variance decomposition of the forecast error is shown for the three-variable VAR, including net domestic product (NDP), investment (I) and bank lending (B) for the years 1870–1912. The values in parentheses indicate the standard deviation.

importance of these shocks in the total forecast error variance. For this purpose, we conduct a variance decomposition as a next step. Table 3 shows the variance decomposition for a forecast horizon of five and ten years. We find that bank lending explains up to 24 per cent of the forecast error variance of net domestic product and up to 30 per cent of the forecast error variance of investment. Although this implies that others shocks seem to be more important, this is a relatively high number in a VAR analysis.¹⁹

¹⁹ The estimation of generalised impulse response functions is a useful approach, as it allows for a representation that needs very few assumptions about the underlying causal structure of the variables. This can be seen in the graphs, for instance, from the fact that none of the impulse response functions starts from zero (due to the assumptions on the recursiveness of the variables). As discussed above, a shortcoming of this approach is the lack of precise identification when the contemporaneous correlation is fairly high.

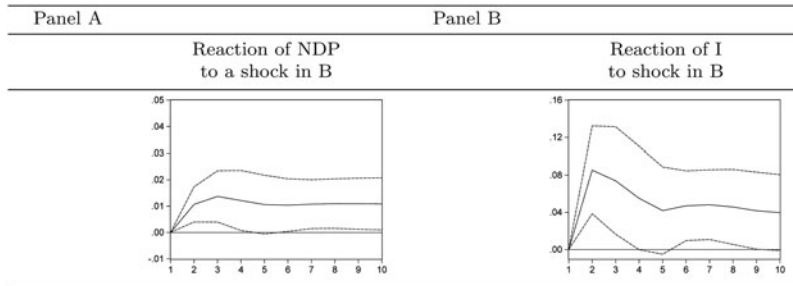


Figure 3. *Impulse responses for net domestic product and bank lending, and investment and bank lending*
 Note: The solid lines trace the impulse responses of net domestic product (NDP) and investment (I) to shocks in bank lending (B) for the years 1870–1912.

Cholesky decompositions

In this section, we estimate the alternative approach of a Cholesky decomposition (see Tornell and Westermann (2005)). Panel A and panel B of Figure 3 show the results of the impulse response functions, generated from two different VARs. In this first VAR, we only include net domestic product (NDP) and bank lending (B); in the second one, we include NDP and investment (I). Panel A shows that there is a positive and significant reaction of net domestic product to an unexpected shock in bank lending. Furthermore, in panel B, we see that there is also a significant reaction of investment to bank lending.²⁰ The variance decomposition, reported in Table 4, shows that the shock in bank lending explains 21 per cent and 25 per cent of the forecast error variance. Thus, the results seem to confirm the finding from the previous section that used generalised impulse response functions.

IV

The findings in the previous sections largely confirmed earlier research on historical data in Germany and other countries. A key question that we would like to address in the present article is to understand which sectors of the economy benefited most from the positive link between bank lending and growth. In the literature on today's emerging markets, pronounced sectoral asymmetries are often found, and we find it very interesting to compare how the growth process in nineteenth-century Germany relates to the experiences of the emerging markets of the last 20 to 30 years.

²⁰ The results remain qualitatively similar, regardless of whether we use Cholesky decomposition or generalised impulse responses. Using the latter approach, the reactions of the impulse responses are even stronger. Solely in the case of agriculture does the impulse response become only weakly significant. For trade, the generalised impulse response is significant at the 5% level.

Table 4. *Variance decomposition for net domestic product and bank lending, and investment and bank lending*

Variance decomposition (%)	Years	
	5	10
NDP variance due to B	20.777 [10.648]	21.045 [11.186]
I variance due to B	25.256 [12.860]	25.69 [13.955]

Note: The variance decomposition of the forecast error is shown for the two-variable VARs, including net domestic product (NDP) and bank lending (B), and investment (I) and bank lending (B) for the years 1870–1912. The values in parentheses indicate the standard deviation.

We therefore also investigate the sectoral differences in the responses of output to aggregate lending in this section.

In the literature on financial development in emerging markets, sectors are typically classified as small (and non-tradable) or large (and tradable). The motivation for this classification is that the former set of firms finances investment mainly via the domestic banking system, while the latter has other financial instruments available, such as issuing equity or commercial paper, or borrowing on the international capital market. It is often found that the strength of the link between financial development and output growth differs substantially between these two groups. This difference across sectors is quite pronounced in middle-income countries and emerging markets but less prevalent in industrial economies.

The data set of Hoffmann (1965) includes detailed information on the sectoral aggregate accounts of Germany and allows us to perform such a decomposition. We focus on six main subsectors of NDP, the industrial sector, mining, agriculture, trade, transportation and services.

Figure 4 shows the impulse response functions that were generated from bivariate VARs, including the respective measure of output and our bank lending variable. As in the previous section, we generate the impulse response functions from a Cholesky decomposition, where the bank lending variable is ordered at the second position in the VAR.

We find that in all sectors there is a positive reaction of output to an unexpected shock in bank lending. In all sectors, except for the trade sector, this reaction is also statistically significant at the 5 per cent level.²¹ However, the variance decomposition in Table 5 shows that the shocks coming from the banking system are of quite different importance for the various sectors of the economy. The insignificant trade sector

²¹ See note 20.

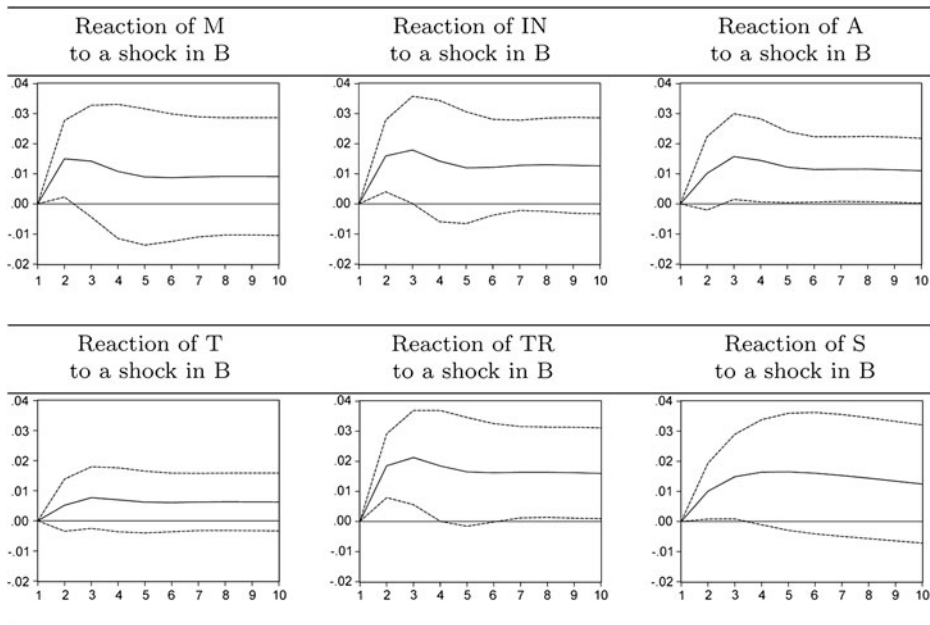


Figure 4. *Impulse responses for sectoral output and bank lending*

Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in bank lending (B) for the years 1870–1912.

Table 5. *Variance decomposition for sectoral output and bank lending*

Period	M due to B	IN due to B	A due to B	T due to B	TR due to B	S due to B
5	6.773 [8.496]	9.691 [8.481]	16.049 [13.064]	4.556 [6.939]	24.643 [12.972]	16.559 [14.152]
10	5.730 [9.577]	9.343 [9.213]	17.969 [14.958]	4.916 [8.264]	25.386 [15.532]	25.095 [20.331]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The figures show the share of the forecast error variance that is due to a shock in bank lending (B).

is least affected by banks. Shocks from the banking system explain only up to 4.9 per cent of the forecast uncertainty of the trade sector. Interestingly, shocks from the banking system also show little impact on the industry and mining sectors, with values of 9.3 per cent and 5.7 per cent. This finding is interesting as it challenges the conventional wisdom that the industrial revolution was substantially accelerated

by the parallel development of the banking system. On the other hand, we find that the sectors most affected by shocks in the banking system were agriculture (up to 17.9 per cent), transportation (up to 25.5 per cent) and services (up to 25 per cent).²²

The structure of German exports – that was also recorded, although not on an annual basis, by Hoffmann (1965) – suggests that the industrial sector was indeed the most tradable in Germany. In 1910–13, final goods had the largest share in total German exports – textiles (12.3 per cent), metal and machinery (21 per cent) as well as chemicals (9.9 per cent) – followed by raw materials such as coal (5.3 per cent) and half-manufactured goods such as iron (6.6 per cent). Food products, such as grain (3.4 per cent) and sugar (2.3 per cent), had substantially smaller shares.²³ Exports as a share of production were also quite high within some sectors. The highest shares were recorded for leather products (110 per cent), metal products (93 per cent) and textiles (99 per cent) in 1910–13. Overall the export share of production increased from 70 per cent in 1875–9 to 95 per cent in 1910–13.²⁴

Although this evidence does not support the view that bank development was very important for the technological progress that occurred in manufacturing during the industrial revolution, it is remarkable that the patterns in nineteenth-century Germany are very similar to modern emerging markets. In emerging markets it is typically found that the non-tradable sectors are impacted the most by the domestic banking system (see Tornell and Westermann (2005) and IMF (2003)). Table 5 shows that this was also the case in nineteenth-century Germany, as both services and transportation are clearly non-tradable. Due to the lack of modern refrigeration, the output of the agricultural sector is likely to have been relatively non-tradable as well. Webb (1977) documents that tariff protection was substantially higher in agriculture than in other industrial sectors.

Bank lending measured by total assets

In this subsection we perform some robustness tests on our main findings that (a) banks contributed substantially to investment and growth in nineteenth-century Germany and (b) this has been particularly important for non-tradable sectors. We start by taking an alternative measure of bank lending.

As all of our variables – net domestic product and investment – are in net terms, we initially started the analysis with the net contribution of the banking system to financing investment as our main indicator of bank lending. In the present section we first take the more conventional measure of total assets in the banking system that is also reported in the Hoffmann data set as an alternative (denoted as *TAI* in the following tables).

²² Note that the significance level of the variance decomposition is very low in general. Our robustness tests in the following section will show, however, that the contributions of banks to the forecast error variance are also significant at conventional levels when using the alternative banking indicator.

²³ See Hoffmann (1965), table 60, p. 154.

²⁴ See Hoffmann (1965), table 70, p. 158.

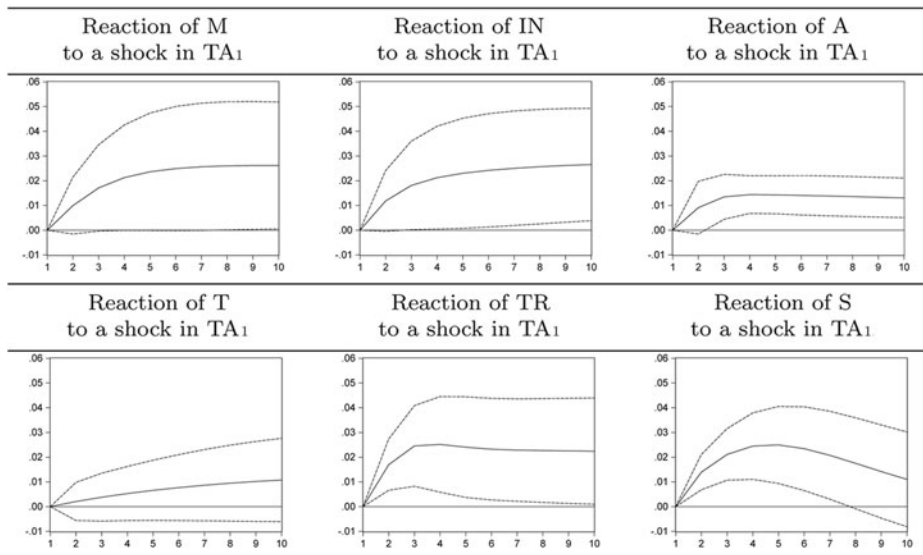


Figure 5. *Impulse responses for sectoral output and total assets 1*

Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in total assets 1 (TA1) for the years 1870–1912.

The impulse response functions of the six sectors of the economy are displayed in Figure 5. We see that all sectors (except trade) respond positively to a standard shock in our alternative measure of bank lending.²⁵ Table 6 shows, furthermore, that we find roughly similar results also for the variance decomposition. Overall the share of the forecast error variance is somewhat higher than in the previous tables. The least affected sector is still the trade sector (up to 7.3 per cent), followed by the industrial sector (24.8 per cent), mining (32.1 per cent) and transportation (33.9 per cent). Substantially higher values are found in the agricultural sector (53.3 per cent) and in services (59.9 per cent). Again, the non-tradable sectors appear to have been more strongly affected by bank lending than the industrial or mining sector.

Furthermore, we compare our findings to a second measure of total assets, reported by Burhop (2006) and Deutsche Bundesbank (1976) (denoted as TA2). This second measure of total assets is restricted to the assets of joint-stock credit banks, but has been used in earlier studies, including Burhop (2002) who updated the data set until 1913.²⁶

²⁵ The results remain similar when using generalised impulse response functions.

²⁶ The data of this new total assets variable are extracted from Burhop (2002) for the years 1870–82 and from Deutsche Bundesbank (1976) for 1883–1912. We adjusted the values with the price index for the net national product from Hoffmann (1965).

Table 6. *Variance decomposition for sectoral output and total assets 1*

Period	M due to TA ₁	IN due to TA ₁	A due to TA ₁	T due to TA ₁	TR due to TA ₁	S due to TA ₁
5	17.946 [16.247]	13.897 [13.224]	33.133 [11.584]	2.468 [6.010]	31.212 [16.796]	46.562 [14.979]
10	32.093 [22.455]	24.847 [19.798]	53.348 [14.181]	7.274 [11.766]	33.908 [23.282]	59.882 [16.409]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The figures show the share of the forecast error variance that is due to a shock in total assets 1 (TA₁).

An alternative measure of total assets

In this second measure of total assets (TA₂), we again find a positive and significant response of output in all sectors to an unexpected change in lending, as documented in Figure 6.²⁷ In Table 7, we see that there are substantial differences in the variance decomposition. The largest responses are in the agricultural and service sectors, where the responses are statistically significant at the 5 per cent level. Among the remaining sectors, lending seems to be least important for the trade sector, followed by industry, mining and transportation. In all these sectors, the share of the variance that can be explained by shocks from the banking system is statistically insignificant after ten years. Overall these patterns are quite similar to the previous bank lending measures.

Equity capital

Finally, we perform a plausibility test for our main hypothesis that small, non-tradable-goods-producing sectors were dependent on the banking system, while other sectors, in particular the industrial sector, had other sources of finance available. In the Hoffmann data set, we extracted the time series on total equity capital (denoted as equity capital (EC)) that was raised in the economy by listed stock market companies. When we use this indicator in our regressions – instead of bank lending – we find that the industrial sector does indeed show the strongest reaction to an unexpected change in equity capital that is statistically significant at the 5 per cent level (see Figure 7). Most other sectors (except mining) also show a significant but quantitatively smaller reaction than the industrial sector.²⁸ When looking at the variance decomposition Table 8, this finding is also confirmed. After five years, the

²⁷ Using generalised impulse responses the results remain the same.

²⁸ Again, the main conclusions are unchanged when generalised impulse responses are used. Furthermore, all impulse responses are statistically significant at the 5% level.

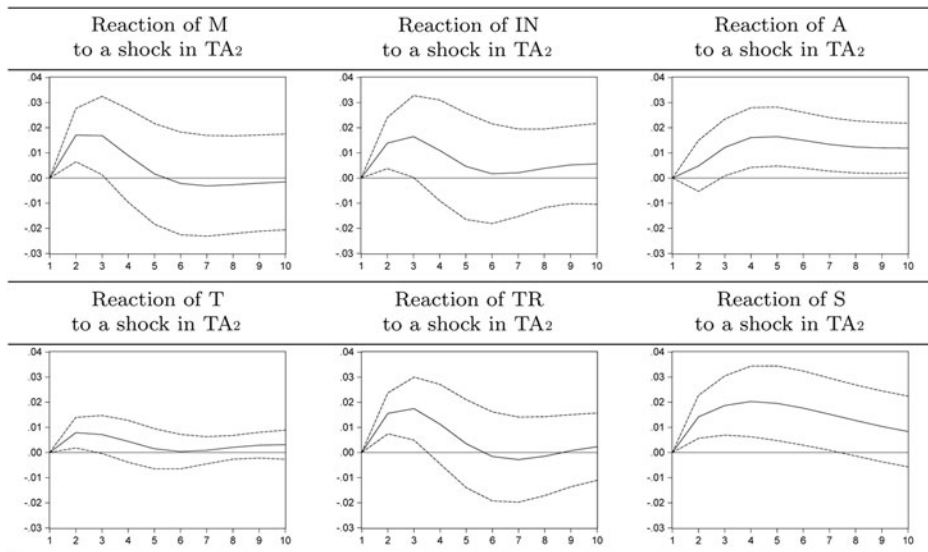


Figure 6. Impulse responses for sectoral output and total assets 2

Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in total assets 2 (TA2) for the years 1870–1912.

Table 7. Variance decomposition for sectoral output and total assets 2

Period	M due to TA2	IN due to TA2	A due to TA2	T due to TA2	TR due to TA2	S due to TA2
5	9.746 [8.573]	6.042 [7.554]	18.185 [12.117]	4.204 [4.604]	10.386 [8.667]	26.621 [14.055]
10	5.081 [7.001]	3.391 [6.595]	22.476 [14.280]	2.611 [3.823]	5.119 [5.833]	34.821 [16.824]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The figures show the share of the forecast error variance that is due to a shock in total assets 2 (TA2).

industrial sector and the trade sector show the highest share of forecast error variance that is explained by the equity shocks with 20.5 per cent and 23.4 per cent, respectively. After a period of ten years, it is again the agricultural sector that is most affected, followed by the industrial sector and the trade sector, although with a much smaller lead compared to the previous section. For services the equity financing plays a much smaller role, explaining only 5.2 per cent of the variance after five years and 11.1 per cent after ten years.

Sectoral output data by Burhop/Wolff and further robustness tests

In a further robustness test, we investigate an alternative sectoral data set that was used by Burhop and Wolff (2005) and Burhop (2005). In this alternative data set, we are able to confirm that the industrial sector reacts more strongly to equity capital than to bank lending. Figure 8 shows that the industrial sector’s reaction to bank lending is statistically insignificant while the reaction to equity capital is significant for three to ten years. The construction sector, on the other hand, reacts more strongly to changes in bank lending. The reaction is statistically significant and Table 9 shows that shocks coming from the banks explain a substantial share of the total forecast error variance. In the variance decomposition of the industrial sector, we see that the share explained by equity capital is substantially larger than the share explained by banks.

We have implemented several further robustness tests to our main specification. The results are available upon request. In particular, we have extended the VAR to include further control variables, such as interest rates, money and prices. Of course there are some differences in the details but overall the findings reported in this article remain quite robust. An advantage of a larger specification is that in a full system, the long-term effects become insignificant reflecting the long-term neutrality of money and credit. However, the VAR specification also suffers from an increasingly

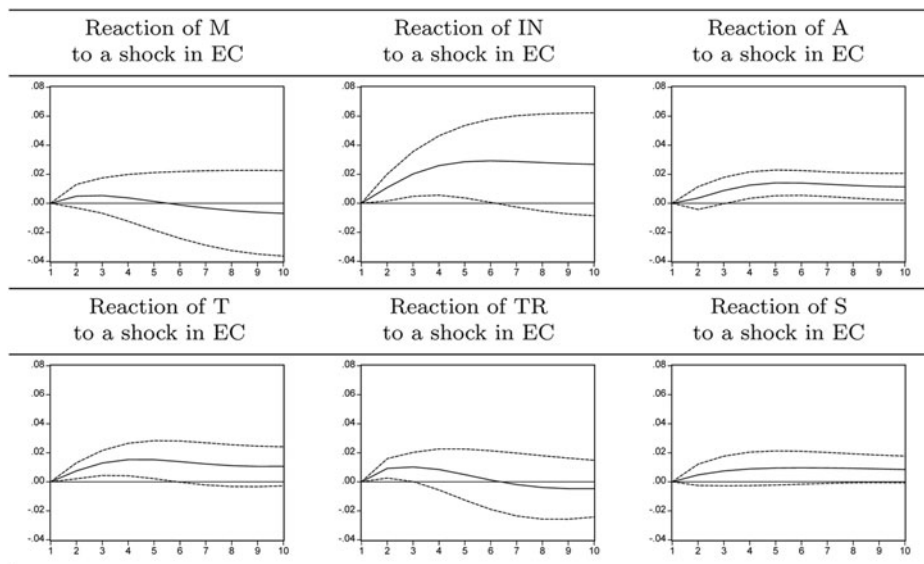


Figure 7. *Impulse responses for sectoral output and equity capital*

Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in equity capital (EC) for the years 1870–1912.

Table 8. *Variance decomposition for sectoral output and equity capital*

Period	M due to EC	IN due to EC	A due to EC	T due to EC	TR due to EC	S due to EC
5	0.670 [3.026]	20.532 [13.086]	16.207 [9.637]	23.426 [15.464]	3.594 [5.668]	5.202 [7.061]
10	0.852 [6.767]	24.775 [20.563]	26.664 [13.019]	20.462 [17.772]	2.272 [5.561]	11.091 [10.762]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The figures show the share of the forecast error variance that is due to a shock in equity capital (EC).

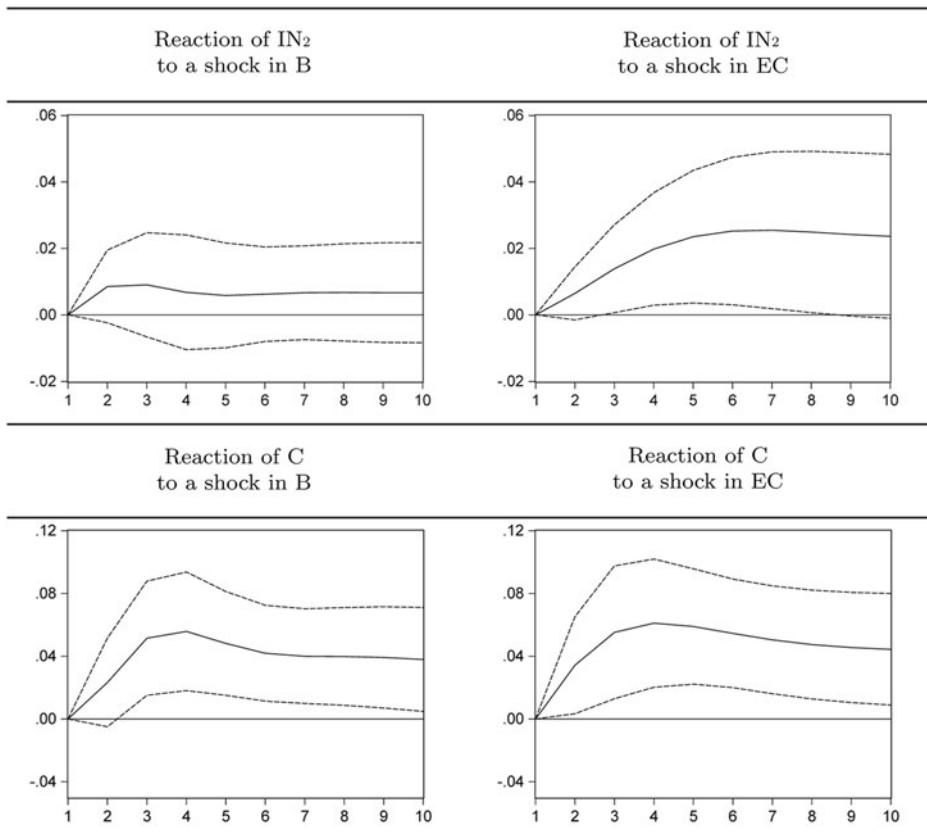


Figure 8. *Impulse responses for industry 2 and construction to shocks in bank lending and equity capital*
 Note: The solid lines trace the impulse responses for industry 2 (IN2) and construction (C) to shocks in bank lending (B) and equity capital (EC) for the years 1870–1912.

Table 9. *Variance decomposition for industry 2 and construction to shocks in bank lending and equity capital*

Period	IN2 due to B	IN2 due to EC	C due to B	C due to EC
5	3.244 [7.003]	20.061 [12.780]	26.706 [16.374]	37.071 [12.767]
10	2.998 [7.362]	30.393 [20.499]	31.968 [18.873]	47.965 [13.077]

Note: The variance decomposition (in percent) is shown for industry 2 (IN2) and construction (C). The figures show the share of the forecast error variance that is due to a shock in bank lending (B) and equity capital (EC).

severe identification problems and larger standard errors due to the relatively small sample period.

V

In this article we attempted to evaluate the role that the banking system played in nineteenth-century Germany by taking a sectoral perspective. We found evidence that the sectors of the economy were affected *asymmetrically* by shocks from bank lending. This evidence is robust to reasonable alternative estimation procedures and alternative indicators of bank lending. Our central finding is that it was not the industrial sector, but transportation, agriculture, services and construction that benefited most from the development of the banking sector.

We explain this new stylised fact, referring to a two-sector growth model of Tornell and Schneider (2004), who show that small, non-tradable-goods-producing firms benefit most from lending booms in economies with contract-enforceability problems. We point out that our findings are indeed similar to stylised facts that have been documented on today's emerging markets. During boom–bust cycle episodes in the 1980s and 1990s, the non-tradable sector has often grown more strongly during the boom phase and fallen into a more deep and sustained recession in the aftermath of banking crisis.

Several questions remain unanswered, however, that further research might be able to address. First, we found that – similar to today's emerging markets – the tradable sector was hardly affected by domestic banks. But was this due to a well enough developed *international* capital market, or due to the size of the firms in the industrial sector, which had equity finance and other *domestic* financial instruments available? The Hoffmann data set gives some indication that capital markets were indeed quite open. German gross foreign assets increased, for instance, from 7,172 million Mark in 1882 to 19,396 million Mark in 1912. The foreign emissions of equity and

commercial paper increased from 300 million Mark in 1883 to 604 million Mark in 1913 (with a peak of 1,108 million Mark in 1905).²⁹ Also the trade account appears to have been quite open, as between 1880 and 1913 the share of exports to NDP fluctuated between 12.8 per cent and 17.7 per cent.³⁰ The openness of financial markets in the nineteenth century has also been documented by Bordo (2002). In addition, it is worth noting that changes in the tariffs on different sectors might have affected the asymmetries in sectoral growth patterns.

Furthermore, there may have been other influences on the agricultural sector in particular. Institutional barriers in the agricultural sector were dissolved just prior to our sample period. These include the strength of village community institutions, which prevented new crops and rotation systems from being introduced and blocked the privatisation of common land. Also an agricultural price ceiling, prior to 1850, contributed to investment being relatively unprofitable at the beginning of the century. Starting from a low base, agriculture might therefore have been able to benefit more from bank lending than other sectors in the economy.

Firm-level data, if available, and individual case studies would help to strengthen the case that today's industrialised countries experienced a start-up phase in their development process similar to that of today's emerging markets. Several such case studies and a large body of literature on the institutional development of the German banking system already exist and are surveyed, for instance, in Guinnane (2002). Particularly interesting from our perspective are the origins of German credit cooperatives in the 1840s and 1850s, which, besides financing small businesses and corporations, also engaged directly in purchasing agricultural inputs and the marketing of agricultural products.³¹ Also, Edwards and Fischer (1994) and Edwards and Nibler (2000) have documented the development of the banking system in Germany. Continuing to put together these pieces of information is a challenging but worthwhile exercise for researchers in both economic history and development finance.

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²⁹ See Hoffmann (1965), table 43, p. 262. These numbers are quite high. In the peak year 1905, total domestic equity capital was 8,043 million Mark and the total block of commercial paper was 2,345 million Mark.

³⁰ See Hoffmann (1965), table 65, p. 151.

³¹ See also Guinnane (2001).

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Table A1-1. *Description and composition of the variables; data source: Hoffmann (1965)*

Variable	Table		Column	Page
Net domestic product (NDP)	5a:	<i>Die jährliche Wachstumsrate des Nettoinlandsprodukts und des Kapitalstocks, jeweils in Preisen von 1913, der Beschäftigten und der gesamten Faktorproduktivität (%)</i> The annual growth rates of net domestic product and capital stock, both in prices of 1913, of employment and total factor productivity	1: <i>Nettoinlandsprodukt in Preisen von 1913</i> Net domestic product in prices of 1913	26–7
Investment (I)	249:	<i>Die Verwendung des Nettosozialprodukts zu Marktpreisen in Preisen von 1913</i> The financing of the net domestic product in market prices of 1913	2: <i>Nettoinvestitionen</i> Net investment	827–8
Bank lending (B)	239:	<i>Die Finanzierung der einheimischen Nettoinvestitionen</i> The financing of domestic net investment	1: <i>Banken und Bausparkassen</i> Banks and building societies	812–3
Total assets 1 (TA1)	Sum of:			
Savings banks	202:	<i>Die Finanzierung durch die Sparkassen</i> The financing through saving banks	3: <i>Bilanzsumme</i> Total assets	733–4
Cooperative credit associations	203:	<i>Die Finanzierung durch die Kreditgenossenschaften</i> The financing through cooperative credit banks	4: <i>Bilanzsumme</i> Total assets	736–7
Mortgage banks	205:	<i>Die Finanzierung durch die Hypothekenbanken</i> The financing through mortgage banks	4: <i>Bilanzsumme</i> Total assets	739–40
Central banks	208:	<i>Die Finanzierung durch die Notenbanken</i> The financing through central banks	1: <i>Korrigierte Bilanzsumme</i> Adjusted total assets	751–2
Credit banks	207:	<i>Die Finanzierung durch die Kreditbanken ohne Notenausgabe</i> The financing through credit banks without bank note issuance	1: <i>Aktienkapital</i> + 2: <i>Reserven</i> + 3: <i>Kreditoren, Depositen</i> + 4: <i>Akzente</i> Capital stock + reserves + payables, debtors + acceptances	748–9

Continued

Table A1-1. *Continued*

Variable	Table	Column	Page
Land mortgage banks	206: <i>Die Finanzierung durch die öffentlich-rechtlichen Bodenkreditinstitute</i> The financing through land mortgage banks	1/3/6/9: <i>Pfandbriefe – 2: Amortisationsfond</i> + 4/7/11: <i>Reserven und Kapital</i> +10: <i>Kreditoren</i> Issue of <i>Pfandbriefe</i> – funds of amortisation + reserves and capital + payables	742–3

Note: All variables which are extracted from Hoffmann (1965) are listed with their corresponding abbreviations. In addition to the table and column numbers, table and column names are given in the original German and in translation. The sample contains the years 1870–1912.

Table A1-2. *Description and composition of the variables; data source: Hoffmann (1965)*

Variable	Table	Column	Page
Mining (M)	103: <i>Die Wertschöpfung nach Wirtschaftsbereichen in Preisen von 1913</i> The value added according to economic sectors in 1913 prices	2: <i>Bergbau und Salinen</i> Mining and salines	454–5
Industry (IN)	103: <i>Die Wertschöpfung nach Wirtschaftsbereichen in Preisen von 1913</i> The value added according to economic sectors in 1913 prices	3: <i>Industrie und Handwerk</i> Industry and skilled crafts	454–5
Agriculture (A)	103: <i>Die Wertschöpfung nach Wirtschaftsbereichen in Preisen von 1913</i> The value added according to economic sectors in 1913 prices	1: <i>Landwirtschaft, Forsten, Fischerei</i> Farming, forestry and fisheries	454–5
Trade (T)	103: <i>Die Wertschöpfung nach Wirtschaftsbereichen in Preisen von 1913</i> The value added according to economic sectors in 1913 prices	5: <i>Handel, Banken, Versicherungen, Gaststätten</i> Trade, banks, insurance and public houses	454–5
Transportation (TR)	103: <i>Die Wertschöpfung nach Wirtschaftsbereichen in Preisen von 1913</i> The value added according to economic sectors in 1913 prices	4: <i>Verkehr</i> Transportation	454–5
Services (S)	103: <i>Die Wertschöpfung nach Wirtschaftsbereichen in Preisen von 1913</i> The value added according to economic sectors in 1913 prices	6: <i>Häusliche Dienste</i> Services	454–5
Equity capital (EC)	220: <i>Das eingezahlte Kapital der Aktiengesellschaften</i> Paid-up capital of stock corporations	18: <i>Insgesamt</i> Total ^a	772–5

Note: All variables which are extracted from Hoffmann (1965) are listed with their corresponding abbreviations. In addition to the table and column numbers, table and column names are given in the original German and in translation. The sample contains the years 1870–1912.

^aLinear interpolation for the years 1872/4/5.

Table A2. *Description and composition of the variables; data source: Deutsche Bundesbank (1976), Burhop (2002, 2005), Burhop and Wolff (2005)*

Variable	Table		Column	Page
Total assets 2 (TA2)	Data from:			
1870–1883	Burhop (2002)	<i>Statistik der Aktienkreditbanken 1848–1883 (in 1.000 Mark), laufende Preise</i>	<i>Bilanzsumme</i>	128
		Statistics of the joint-stock credit banks 1848–1883 (in 1.000 Mark), current prices	Total assets	
1884–1912	Deutsche Bundesbank (1976)	<i>Aktien-Kreditbanken</i>	<i>Bilanzsumme</i>	56
		Joint stock credit banks	Total assets	
Industry 2 (IN2)	Burhop and Wolff (2005)	Subseries for calculation of German Compromise NNP	Industrial production	
Construction (C)	Burhop (2005)	Production index	Construction	

Note: The variables which are extracted from Deutsche Bundesbank (1976), Burhop (2002), Burhop and Wolff (2005) and Burhop (2002) are listed with its corresponding abbreviations in original terms and in translation.