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Financial Development and Sectoral Output Growth in 19th Century Germany

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CESIFO WORKING PAPER NO. 3283
CATEGORY 7: MONETARY POLICY AND INTERNATIONAL FINANCE
DECEMBER 2010

CESifo *Working Paper No. 3283*

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Abstract

In this paper we re-evaluate the hypothesis that the development of the financial sector was an essential factor behind economic growth in 19th century Germany. We apply a structural VAR framework to a new annual data set from 1870 to 1912 that was initially recorded 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, non-tradable goods producing firms, such as services, transportation and agriculture. In this regard, the growth patterns in 19th century Germany are reminiscent to those in today's emerging markets.

JEL-Code: C22, N13, N23, O11.

Keywords: economic growth, financial development, sectoral asymmetries.

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December 2010
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 2010 in Kiel, for helpful comments and suggestions.

1 Motivation

In this paper we re-evaluate the hypothesis that bank lending was a key factor in the growth process in 19^{th} century Germany and that it has been 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 bank-firm relationships that were said to be typical of Germany at the time. A survey on papers arguing along these lines is given for instance in Guinnane (2002). In a notable exception, however, Edwards and Ogilvie (1996) 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 organizing the issuance of new shares, but hardly contributed to financing long-term investment by credit.

In this paper, 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 recorded by Walter Hoffmann (1965) for the sample period of 1870-1912 and includes a detailed sectoral disaggregation of output. 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.[1] In our paper, we focus on the main subsectors manufacturing, mining, 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 generalized 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

[1] 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 emphasized, 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.

model, depends on investment and credit in period *t-1*, it is assumed not to be affected by bank lending in the same period.[2]

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 GDP 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 two 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 transportation sector and the service sector, on 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 on the role the banking system has actually played in promoting growth. Our results indicate that rather than speeding up the structural change towards the industrial sectors, the importance of the bank lending was to to allow other sectors to keep up with its pace. In a period of rapid technological change, it seems to have allowed for a more *balanced* growth path than it otherwise could have been. This result appears to be at odds with the hypothesis that the industrial sector benefited most strongly from the development of lending in the banking sector, but is consistent with Edwards and Ogilvie's view that 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 emphasized in Tornell and Schneider (2004), who point out that aggregate measures on output often mask deep sectoral asymmetries in credit constrained economies.[3] It is interesting that the sectoral patterns in 19^{th} century Germany are indeed

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

[3] See also Rajan and Zingales (1998).

reminiscent of the sectoral growth patterns observed in today's emerging markets. Tornell, Westermann and Martinez (2003) have documented in a broad cross section of middle income countries from 1980-2000 that there exists a pronounced shift toward small firms and non-tradable goods producing firms in periods of rapid credit expansion. Tornell and Schneider (2004) motivate theoretically that small firms in non-tradables goods producing sectors are likely to benefit most from bank lending, while the tradables sectors typically consist of large firms that have other forms of financial instruments available. In their model, the later sectors can directly borrow 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 is 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 paper seem to confirm this view. The industry, mining and trade sector are classical tradable goods producing sectors. In particular, the industrial sector displayed the highest export share during the late 19^{th} and early 20^{th} century in Germany. Also the latter two sectors consist of mostly large firms. Transportation and services, on the other hand, are clearly non-tradable. Although agriculture ranks among the more tradables sectors today, it is plausible that due to the lack of modern refrigerating technologies as well as high tariffs, its output was relatively non-tradable more than a century ago. The rapid increase in productivity of small agricultural firms is documented in van Zanden (1991)[4]. Its importance for the industrial revolution has been discussed for instance in Perkins (1981) and Webb (1982).[5] In the context of the Rancière 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 19^{th} century Germany and pointed out that "*credit conditions in Germany sound similar to*

[4]Van Zanden shows that the use of mechanical threshers, reapers or sowing machines was particularly high in post-1870 Germany. The development of agricultural finance in the 19^{th} century Germany has also been documented in Blömer (1990).

[5]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 (1985) who documents growth in the agricultural sector in England, prior to 1820).

those found in many developing countries today" (p.368).

We test for the robustness of our results in several ways. First, we employ two alternative indicators of bank lending, the net contribution of banks to financing investment and total assets in the banking system. Furthermore, we use data on equity capital to show that the non-tradables sectors did not disproportionately benefit from alternative forms of financing that are typically used by large industrial firms. When using equity capital in our VAR's, instead of bank lending, the industrial sector is the one that reacts to an unexpected increase in financial resources most strongly.

Section 2 provides a description of the data and a preliminary analysis of the unit root and cointegration properties. The VAR analysis of aggregate output is given in section 3. Section 4 contains the sectoral analysis and robustness tests. Section 5 concludes.

2 Description of the data and preliminary analysis

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

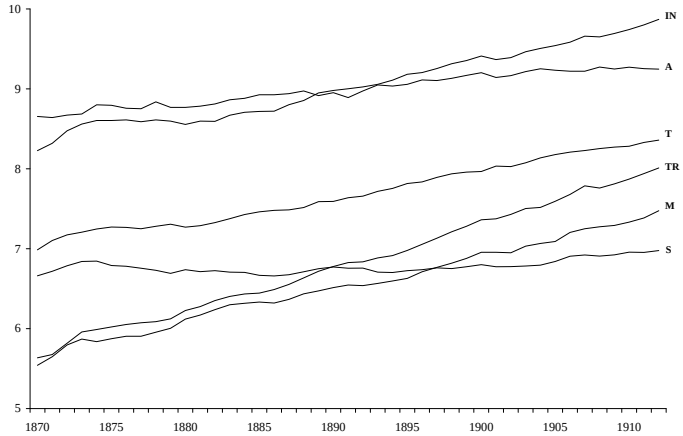
Our main variables are the *Net Domestic Product (NDP)*[6], *Investment (I)*[7] and *Bank Lending (B)*[8]. Both, domestic product and investment are expressed in net terms and in constant 1913 prices. Our bank variable captures the contribution of banks in the financing of net investment.

On a disaggregated level we consider the following sectors: *Mining (M)*, *Industry (IN)*, *Agriculture (A)*, *Trade (T)*, *Transportation (TR)* and *Services (S)*.[9] The mining sector contains value added of mining and salines, the industry sectors consists of industry and handcraft and the agriculture sector covers the value added of farming, forest and fishing. 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.

[6]See Hoffmann (1965), table 5a, p.26f., converted in level data.
[7]See Hoffmann (1965), table 248, p.825f.
[8]See Hoffmann (1965), table 239, p.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, p.598ff.
[9]See Hoffmann (1965), table 103, p.454f.

Transportation was the fastest growing among all sectors.

Figure 1: Sectoral Output Growth



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

Table 1: Results of the ADF tests

Variable	Levels			1st Differences		
	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	-1.921	1	0.320	-3.941***	0	0.004
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, investment, bank lending, total assets, equity capital, mining, industry, agriculture, trade, transportation and services for the years 1870 to 1912. The lag length is selected by the Schwarz information criterion. *** (**,*) indicates significance at the 99% (95%, 90%) level.

We also take an alternative measure of the banks' contribution to financing investment. Our indicator *Total Assets (TA)* includes the total assets of savings banks, cooperate credit associations, mortgage banks, banks of issue and commercial banks.[10] All data are recorded on an annual basis. The sample period covers the years 1870 to 1912.[11]

[10] See Hoffmann(1965), tables 202, 203, 205, 206, 207, p.733ff.

[11] Note that some of the data go back to 1850. In our benchmark regressions, we did not take the full time period, however, to limit our analysis to a period with a uniform federal territory of Germany 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

	Johansen				Engle/Granger
Variable		Trace		Max-Eigenvalue	
Net Domestic Product, Investment	r=0	61.634**°°	r=0	25.360* °	-4.016*
Bank Lending	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	2.621	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), ** and * indicate significance at 5% and 1% level using critical values from MacKinnon (1991).

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 that reports the results for our main variables, we can see that all of our time series are nonstationary in levels, but stationary in first differences. The optimal lag length in the test specifications were chosen by the Schwarz information criterion.

In the following sections of the paper 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 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 with using the Johansen (1991) test, however. In particular the three variable system of net domestic 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 speci-

fication 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 in the beginning of the sample than towards the end of the sample. 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 the 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 at least in one of the three approaches (Engle/Granger, Johansen, Trace/Max-Eigenvalue Statistic).

3 Investment, credit and output growth - a VAR analysis

In the subsequent analysis, we take two different approaches of modeling 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 generalized 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.

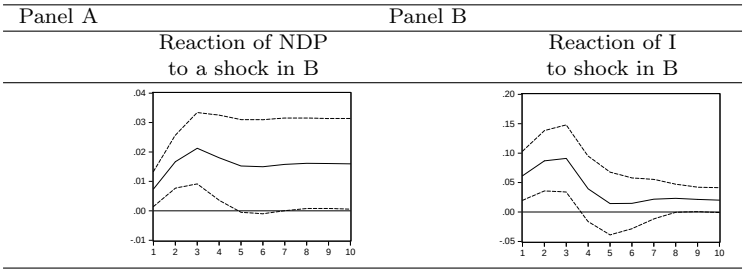
In the second approach we follow the structural identification proposed in Tornell and Westermann (2005). In this paper, the identification is based on a theoretical two-sector growth model that also guides the analysis in the later sections of this paper. We employ a Cholesky decomposition, where output 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 a bivariate system. 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.

Generalized impulse response functions

Figure 2 reports the generalized impulse responses from our first VAR that 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.[12]

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) to shocks in investment (I) and bank lending (B) for the years 1870 to 1912.

Table 3: Variance Decomposition for Net Domestic Product, Investment and Bank Lending

	Years	
Variance Decomposition	5	10
NDP variance due to B (in percent)	24.009	23.129
	[12.374]	[12.294]
I variance due to B (in percent)	30.006	29.281
	[12.470]	[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 to 1912. The values in parentheses indicate the standard deviation.

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

[12]Indeed, the impulse response for NDP and investment reveal 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 paper.

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 5 and 10 years. We find that bank lending explains up to 24% of the forecast error variance of net domestic product and up to 30% of the forecast error variance of investment. Although this implies that other shocks seem to be more important, this is a relatively high number in a VAR analysis.[13]

Cholesky Decompositions

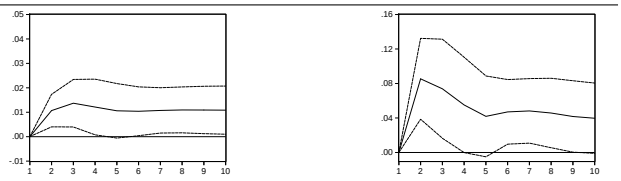
In this section, we estimate the alternative approach of a Cholesky decomposition see Tornell and Westermann (2005). Panel A and Panel B of figure 3 show the results of the impulse response functions, generated from two different VAR's. In this first VAR, we only include net domestic product (NDP) and bank lending, in the second one, we include NDP and investment. 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.[14] The variance decompositions, reported in table 4, show that the shock in bank lending explain 21% and 25% of the forecast error variance. Thus, the results seem to confirm the finding from the previous section that used generalized impulse response functions.

[13]The estimation of generalized 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 by the fact, that none of the impulse response functions start from zero (due to the assumptions on the recursiveness of the variables). As discussed above, a short-coming of this approach is the lack of precise identification, when the contemporaneous correlation is fairly high.

[14]Note that these impulse response functions come from separate regressions. In a Cholesky decomposition it is not feasible to include the three variables at the same time, as it does not exists a plausible ordering for net domestic product and investment.

Figure 3: Impulse Responses for Net Domestic Product and Bank Lending, and Investment and Bank Lending

Panel A	Panel B
Reaction of NDP to a shock in B	Reaction of I to shock in B



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 to 1912.

Table 4: Variance Decomposition for Net Domestic Product and Bank Lending, and Investment and Bank Lending

	Years	
Variance Decomposition	5	10
NDP variance due to B (in percent)	20.777	21.045
	[10.648]	[11.186]
I variance due to B (in percent)	25.256	25.690
	[12.860]	[13.955]

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 to 1912. The values in parentheses indicate the standard deviation.

4 A sectoral analysis

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 paper, is to understand which sectors of the economy benefited most strongly 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 19^{th} century Germany relates to the experiences of the emerging markets of the last 20 to 30 years. 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 are financing investment mainly via the domestic banking system, while the later 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 do 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% level. 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 is least affected by banks. Shocks from the banking system explain only up to 4.9% 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% and 5.7%. 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 agriculture (up to 17.9%), transportation (up to 25.5%) and services (up to 25%) were most affected by shocks in the banking system.[15]

The structure of German exports - that was also recorded, although not on an annual basis, by Hoffmann (1965) - suggests that the industry sector was indeed the most tradable in Germany. In 1910-13, final goods had the largest share in total German exports - textiles (12.3%), metal and machinery (21%) as well as chemicals (9.9%) - followed by raw materials

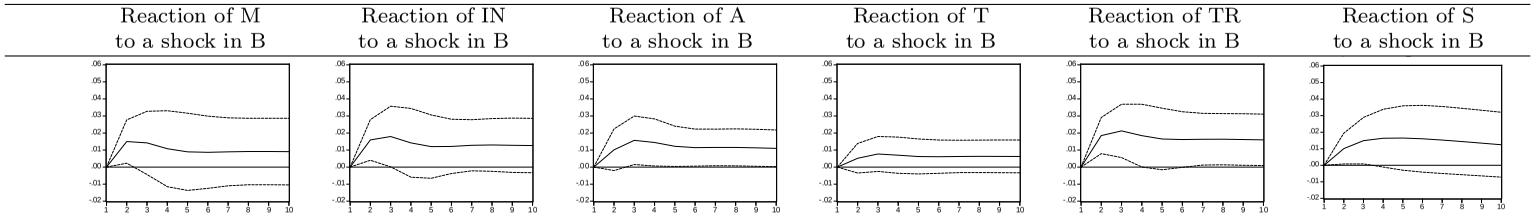
[15]Note that the significance level of the variance decomposition is very low in general. Our robustness tests in the following section will show, however, that the contributions of banks to the forecast error variance are also significant at conventional levels, when using the alternative banking indicator.

such as coal (5.3%) and half-manufactured goods such as iron (6.6%). Food products, such as grain (3.4%) and sugar (2.3%) had a substantially smaller shares.[16] Exports as a share of production were also quite high within some sectors. The highest shares were recorded for leather products (110%), metal products (93%) and textiles (99%) in 1910-13. Overall the export share of production increases from 70% in 1875-79 to 95% in 1910-13.[17]

Although this evidence does not support the view that bank development was very important for technological progress that occurred in manufacturing during the industrial revolution, it is remarkable that the patterns in 19^{th} century Germany are very similar to modern emerging markets. In emerging markets it is typically found that the non-tradables sectors are impacted the most by domestic banking system (see Tornell and Westermann (2005) and IMF (2003)). Table 5 shows that this is also the case in 19^{th} century Germany, as both services and transportation are clearly non-tradable. Due to the lack of modern refrigeration, the output of the agriculture 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.

[16] See Hoffmann (1965), table 60, p.154.
[17] See Hoffmann (1965), table 70, p.158.

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 to 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	9.691	16.049	4.556	24.643	16.559
	[8.496]	[8.481]	[13.064]	[6.939]	[12.972]	[14.152]
10	5.730	9.343	17.969	4.916	25.386	25.095
	[9.577]	[9.213]	[14.958]	[8.264]	[15.532]	[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.

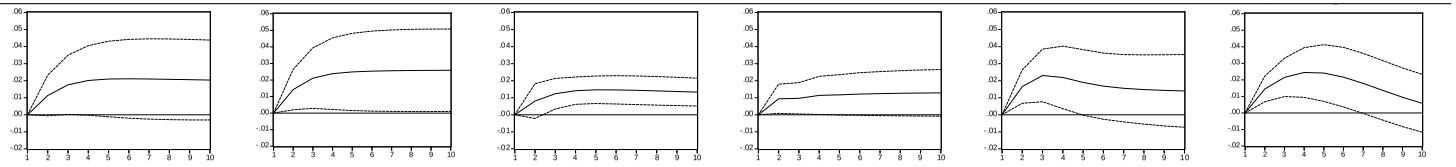
An alternative measure of bank lending

In this subsection we perform some robustness tests to our main findings that (a) banks contributed substantially to investment and growth in 19^{th} century Germany and (b) this has been particularly important for non-tradables 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 take the more conventional measure of total assets in the banking system as an alternative (denoted as TA in the following tables).

The impulse response functions of the six sectors of the economy are displayed in figure 5. We see that all sectors still respond positively to a standard shock in our alternative measure of bank lending. Table 6 shows furthermore, that we find roughly similar results also for the variance decomposition. Overall the share of the forecast error variances is somewhat higher than in the previous tables. The least affected sector is still the trade sector (up to 14.3%), followed now by the transportation sector (17.5%), mining (20.7%) and the industry (23.7%). Substantially higher values are found in the agriculture sector (47.9%) and services (48.6%). Again, the non-tradables sectors appear to have been more strongly affected by bank lending than the industry or mining sector.

Figure 5: Impulse Responses for Sectoral Output and Total Assets



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 (TA) for the years 1870 to 1912.

Table 6: Variance Decomposition for Sectoral Output and Total Assets

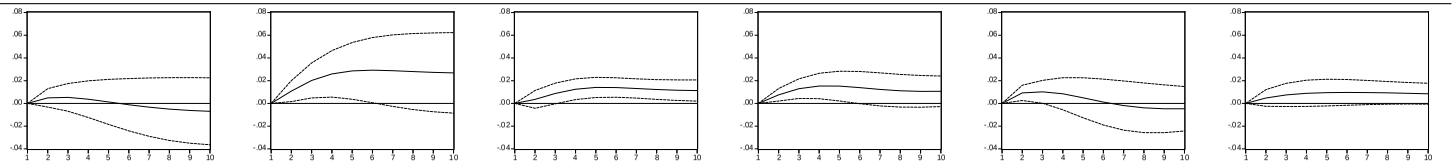
Period	M due to TA	IN due to TA	A due to TA	T due to TA	TR due to TA	S due to TA
5	15.477	16.891	29.144	10.645	23.686	39.361
	[13.614]	[13.154]	[12.461]	[8.503]	[14.269]	[13.268]
10	20.735	23.690	47.979	14.297	17.487	48.659
	[18.654]	[19.408]	[14.049]	[11.824]	[15.230]	[14.824]

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.

Equity Capital

Finally, we perform a plausibility test for our main hypothesis that small, non-tradables 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 indeed the industrial sector shows the strongest reaction to an unexpected change in equity capital, that is statistically significant at the 5% level. Most other sectors (except mining) also show a significant reaction but quantitatively smaller than the industrial sector. When looking at the variance decomposition, this finding is also confirmed. After 5 years, the industrial and the trade sectors show the highest share of forecast error variance that is explained by the equity shocks with 20.5% and 23.4%, respectively. After a period of 10 years, it is again the agricultural sector that is most affected, followed by the industrial sector and the trade sectors, 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% of the variance after 5 years and 11.1% after 10 years.

Figure 6: Impulse Responses for Sectoral Output and Equity Capital with Cholesky Decomposition



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 to 1912.

Table 7: 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	20.532	16.207	23.426	3.594	5.202
	[3.026]	[13.086]	[9.637]	[15.464]	[5.668]	[7.061]
10	0.852	24.775	26.664	20.462	2.272	11.091
	[6.767]	[20.563]	[13.019]	[17.772]	[5.561]	[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.

5 Conclusions

In this paper we attempted to evaluate the role that the banking system played in 19^{th} 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 not the industrial sector, but transportation, agriculture and services benefited the most from the development of the banking sector.

We explain this new stylized fact, referring to a two sector growth model of Tornell and Schneider (2004), who show that small, non-tradables firms benefit most from lending booms in economies with contract enforceability problems. We point out that our findings are indeed reminiscent to stylized facts that have been documented on today's emerging markets. During Boom- Bust cycle episodes in the 1980's and 1990's, 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 is hardly affected by the domestic banks. But is this due to a well enough developed *international* capital market, or due to the size of the firms in the industrial sector, who 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 7172 (mill.) Mark in 1882 to 19396 (mill.) Mark in 1912. The foreign emissions of equity and commercial paper increased from 300 (mill.) Mark in 1883 to 604 (mill.) Mark in 1913 (with a peak of 1108 (mill.) Mark in 1905).[18] 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% and 17.7%.[19] The openness of financial markets in the 19^{th} century have also been documented by Bordo (2002).

Furthermore, there are maybe 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, who prevented new crops and

[18] See Hoffmann (1965), table 43, p.262. These numbers are quite high. In the peak year 1905, total domestic equity capital was 8043 (mill.) Mark and the total block of commercial paper was 2345 (mill.) Mark.
[19] See Hoffmann (1965), table 65, p.151.

rotation-systems from being introduced and blocked the privatization of common land. Also agricultural price ceiling, prior to 1850, contributed to investment being relatively unprofitable in the beginning of the century. Starting from a low base, agriculture might therefore been able to benefit more strongly from the bank lending than other sectors in the economy.

Firm level data, if available, and individual case studies would help a lot to strengthen the case that today's industrialized countries experienced a similar start up phase in their development process as 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 1840's and 1850's, who, next to financing small businesses and corporations, also engaged directly in purchasing agricultural inputs and the marketing of agricultural products.[20] Also, Edwards and Fischer (1994) and Edwards and Nibler (2000) documented the development of the banking system in Germany. Continuing to set together these pieces of information is a challenging, but worthwhile exercise for both, researchers in economic history and in development finance.

[20]See also Guinnane (2001).

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Appendix

Table A.1-1: Sources and Composition of the Variables

Variable	Table	Column	Page
Net Domestic Product (NDP)	5a: *Die jährlichen Wachstumsraten des Nettoinlandsprodukts und des Kapitalstocks, jeweils in Preisen von 1913, der Beschäftigten und der gesamten Faktorproduktivität (%)* The annual growth rates of net domestic product and capital stock, both in prices of 1913, of employment and total factor productivity	1: *Nettoinlandsprodukt in Preisen von 1913* Net domestic product in prices of 1913	26-7
Investment (I)	249: *Die Verwendung des Nettosozialprodukts zu Marktpreisen in Preisen von 1913* The financing of the net domestic product in market prices of 1913	2: *Nettoinvestitionen* Net investment	827-8
Bank Lending (B)	239: *Die Finanzierung der einheimischen Nettoinvestitionen* The financing of domestic net investment	1: *Banken und Bausparkassen* Banks and building societies	812-3
Total Assets (TA)	Sum of:		
Saving Banks	202: *Die Finanzierung durch die Sparkassen* The financing through saving banks	3: *Bilanzsumme* Total assets	733-4
Cooperative Credit Associations	203: *Die Finanzierung durch die Kreditgenossenschaften* The financing through cooperative credit banks	4: *Bilanzsumme* Total assets	736-7
Mortgage Banks	205: *Die Finanzierung durch die Hypothekenbanken* The financing through mortgage banks	4: *Bilanzsumme* Total assets	739-40
Central Banks	208: *Die Finanzierungen durch die Notenbanken* The financing through central banks	1: *Korrigierte Bilanzsumme* Adjusted total assets	751-2
Credit Banks	207: *Die Finanzierung durch die Kreditbanken ohne Notenausgabe* The financing through credit banks without bank note issuance	1: *Aktienkapital* + 2: *Reserven* + 3: *Kreditoren, Depositen* + 4: *Akzepte* Capital stock + reserves + payables, debtors + acceptances	748-749 454-5

Note: All variables used in this paper are listed with its corresponding abbreviations. Data are taken from Hoffmann (1965). In addition to the table and column numbers, table and column names are shown in original terms and in translation. The sample contains the years from 1870 to 1912.

Table A.1-2: Sources and Composition of the Variables

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

Note: All variables used in this paper are listed with its corresponding abbreviations. Data are taken from Hoffmann (1965). In addition to the table and column numbers, table and column names are shown in original terms and in translation. The sample contains the years from 1870 to 1912.

[a]Linear interpolated for the years 1972/4/5.