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**Conference Paper**

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Beiträge zur Jahrestagung des Vereins für Socialpolitik 2013: Wettbewerbspolitik und Regulierung in einer globalen Wirtschaftsordnung - Session: Economic Development and Technological Change, No. D10-V3

**Provided in Cooperation with:**

Verein für Socialpolitik / German Economic Association

*Suggested Citation:* Hattendorff, Christian (2013) : The Natural Resource Curse Revisited: Is There a Financial Channel?, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2013: Wettbewerbspolitik und Regulierung in einer globalen Wirtschaftsordnung - Session: Economic Development and Technological Change, No. D10-V3, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft, Kiel und Hamburg

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# The Natural Resource Curse Revisited: Is There a Financial Channel?

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August 2013 (Draft)

**Abstract:** The paper contributes to the ongoing debate on the natural resource curse, which postulates a negative link between natural resource abundance and economic growth. It shows empirically that resource-rich countries appear to have a less developed financial system and investigates a potential mechanism behind this connection by applying insights from the finance and trade literature. It tests whether the resource sectors' lower demand for short-term external credit negatively affects financial development in a resource-based economy. This is done with cross-sectional and panel analysis, using an instrument for credit demand based on exogenous geographic determinants. The results, however, suggest that poor economic diversity rather than firms' credit demand drives the detrimental effect of resources on finance.

JEL classifications: F10, G20, O13, O16

Keywords: Financial development, external dependence, natural resource curse, international trade, gravity model

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# 1 Introduction

The observation that resource-based economies experienced rather low growth rates in the last 60 years compared to other nations gives rise to the idea that resources might be a curse rather than a blessing. Researchers presented a number of explanations for the phenomenon, e.g. harmful exchange rates effects, exposure to conflicts or a weak institutional framework. This paper investigates whether growth in resource-abundant economies might be mitigated due to lower financial development caused by lower external credit demand.

The work builds on the literature's finding that finance is an important determinant of growth. In order to evaluate the effect of natural resources on growth, it is crucial to explore a potential financial channel. I find a significant negative link between resource abundance and financial development, which confirms previous empirical studies. This result continues to hold when endogenous measures of resource abundance such as the share of resources in total exports are replaced by more exogenous measures of pure subsoil wealth.

The present paper further contributes to the literature by investigating a potential reasoning for this negative relationship in detail. The approach emphasizes the demand-side effect in the determination of financial markets. It exploits the finding that industrial sectors systematically differ in their dependence on the financial sector. This is assumed to be due to technological differences between industries. Financially independent firms need less external finance because they can use internal cash flow for investment, instead. In an economy with many financially independent sectors, credit demand may be low, and there is less need to develop a large financial sector providing external credit. This consideration is based on the believe that financial development is at least in part influenced by the demand for external credit. In case resource sectors rely less on the financial system - as has been suggested by many researchers - resource-dominated countries would have a less developed financial system.

In order to address the problem formally, the paper applies a model developed in the trade and finance literature by Do and Levchenko (2007) that relates financial development and sectoral external dependence in the presence of international trade.

I basically follow their empirical strategy and adjust it for the purposes of the natural resources analysis. Aggregate credit demand of a nation's industry is proxied by the external finance need of exports ( $EFNX$ ), where sectors' financial dependence is multiplied with their share in total exports. This measure is used as the main right-hand side variable of the regression equation, while the dependent variable is a measure of financial development. Estimation is done with ordinary least squares (OLS) in a cross section of 93 (110) countries with averages from 1970 to 2007 (1992 to 2007). Control variables include other determinants of financial development such as income per capita, trade openness and legal origin. In addition, I estimate a panel specification with both time and country fixed effects in order to capture omitted variables.

As the literature suggests, financial development (as an endowment) might, in turn, influence the export structure, which is embodied in the proxy  $EFNX$ . In order to handle this important endogeneity problem, I construct an instrument for the country's aggregate credit demand. The actual trade flows are predicted with the help of sector-level gravity estimations with exogenous geographic determinants of trade such as distance and land area. Estimation for each sector allows predicting the export pattern rather than just the trade volume. The obtained instrument is used in a two-stage least squares (2SLS) regression.

At first sight, the results are ambiguous. In the cross section with both OLS and 2SLS, there is evidence for a resource curse to operate via a demand-side effect in the financial system. In contrast, the panel analysis does not support this hypothesis, which could be due to omitted variables in the cross section.

Following the literature on resources, the quality of a country's institutions may play a role in this context. Robustness checks show, however, that measures of institutional quality are unlikely to be the omitted variable. Further analysis suggests that most resource-based countries show high export concentration. A poorly diversified economy rather than low credit demand may explain the negative link between resources and finance.

The paper is structured as follows: Section 2 gives an overview of the resource curse literature. Section 3 sheds light on a possible financial channel and explains the theory applied in detail. The empirical strategy and data are described in Section 4. The results are presented in Section 5. Section 6 concludes.

## 2 The Natural Resource Curse

In the last decades, economists observed that on average resource-rich countries, including especially many African, Latin American and Arab nations such as Nigeria, Sierra Leone, Venezuela and Saudi Arabia, tend to grow at slower rates than countries with few natural resources. While resource abundance has been considered unambiguously positive until World War II, economic literature later started to analyze this "paradox of plenty" (Karl 1997) in more detail. The phenomenon is usually referred to as the "resource curse" (Auty 1994), where the resources of interest are point resources with a high concentration in certain regions of the world such as oil, natural gas and mining products.

Since then, a number of empirical studies has tried to validate the resource curse hypothesis, among them Sachs and Warner (1995 and 2001), who apply resource exports relative to GDP as a measure of a country's resource abundance. However, these studies have been challenged by recent publications. The measure of abundance in particular is criticized because output- and trade-related variables suffer from endogeneity problems. These variables might just represent low economic diversification, which is a common characteristic of poor countries, and not the actual resource abundance. Brunnschweiler (2008), for example, proposes alternative measures such as subsoil wealth per capita, which are more appropriate to capture the actual natural resource endowment of an economy. Alexeev and Conrad (2009) point out that most empirical papers do not consider economic booms in the early years of extraction prior to the 1970s, thereby underestimating the role of resource depletion over time. These authors are more skeptical towards the presence of a resource curse. Nevertheless, there is still an ongoing and lively debate on the detrimental effect of resource abundance on a country's development, where no consensus has been reached so far.

In order to explain through which mechanisms the resource curse may operate, economists present a variety of theories. A standard argument highlights that a national economy dominated by resource extraction is heavily exposed to the usually relatively high commodity price volatility and, thus, to macroeconomic volatility (van der Ploeg 2010).<sup>2</sup> Another explanation that has been popular among researchers is the so-called "Dutch disease", based on the supposed experience of the Netherlands after a resource

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<sup>2</sup>Hausmann and Rigobon (2002) show that volatility is even more severe with financial market imperfections.

boom in the 1960s. It states that the rents obtained from resource exports can render a country's manufacturing sector less competitive by raising the real exchange rate (see Corden and Neary 1982, van Wijnbergen 1984 and Stijns 2003). Another theory suggests that resource abundance might foster armed conflicts and civil war through "looting" of resources by rebel groups and "grievances" in local communities due to mineral extraction (e.g. Ross 2004). Gylfason (2001) finds that natural capital deteriorates public and private incentives to accumulate human capital.

Yet a further explanation that has gained prominence in recent years is that the resource curse operates through the institutional channel (Mehlum, Moene and Torvik 2006). On the one hand, differences in the quality of institutions such as bureaucratic quality, legal and political system, rule of law as well as property rights determine whether resources are advantageous or disadvantageous for an economy. On the other hand, resource extraction may, in turn, affect a country's institutions. Researchers show that both private agents and politicians tend to engage in rent-seeking in order to benefit from the available resource income, thereby crowding out profit-oriented entrepreneurship and fostering corruption among bureaucrats (see e.g. Tornell and Lane 1999 and Sala-i-Martin and Subramanian 2003). Resource dominance has been associated with a lack of democracy and a tendency towards autocratic political systems (see e.g. Ross 2001). The institutional hypothesis is important because institutions are considered to play a crucial role for the development of an economy (Acemoglu, Johnson and Robinson 2001). Furthermore, the theory can explain why some resource-rich countries such as Australia, Canada, Norway and Botswana were economically very successful in the last decades. These countries were able to avoid or overcome the resource curse due to their strong institutional environment, and they show that resource abundance does not necessarily lead to lower economic growth.

Given the importance of the institutional setting, it is surprising that there has been relatively few research on finance as a possible channel of the resource curse. Indeed, growth economists have identified financial development as a major determinant of growth (see e.g. Levine 2005 as well as Rajan and Zingales 1998).<sup>3</sup> Thus, resource dominance could have an indirect effect on economic growth through a country's financial system.

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<sup>3</sup>In the course of the financial crisis of 2008 and 2009, more recent studies claim that too large financial sectors may be bad for growth (Arcand, Berkes and Panizza 2011). However, in a broad cross section of countries with many developing and emerging economies, higher financial development can generally be considered as something advantageous.

### 3 The Financial Channel

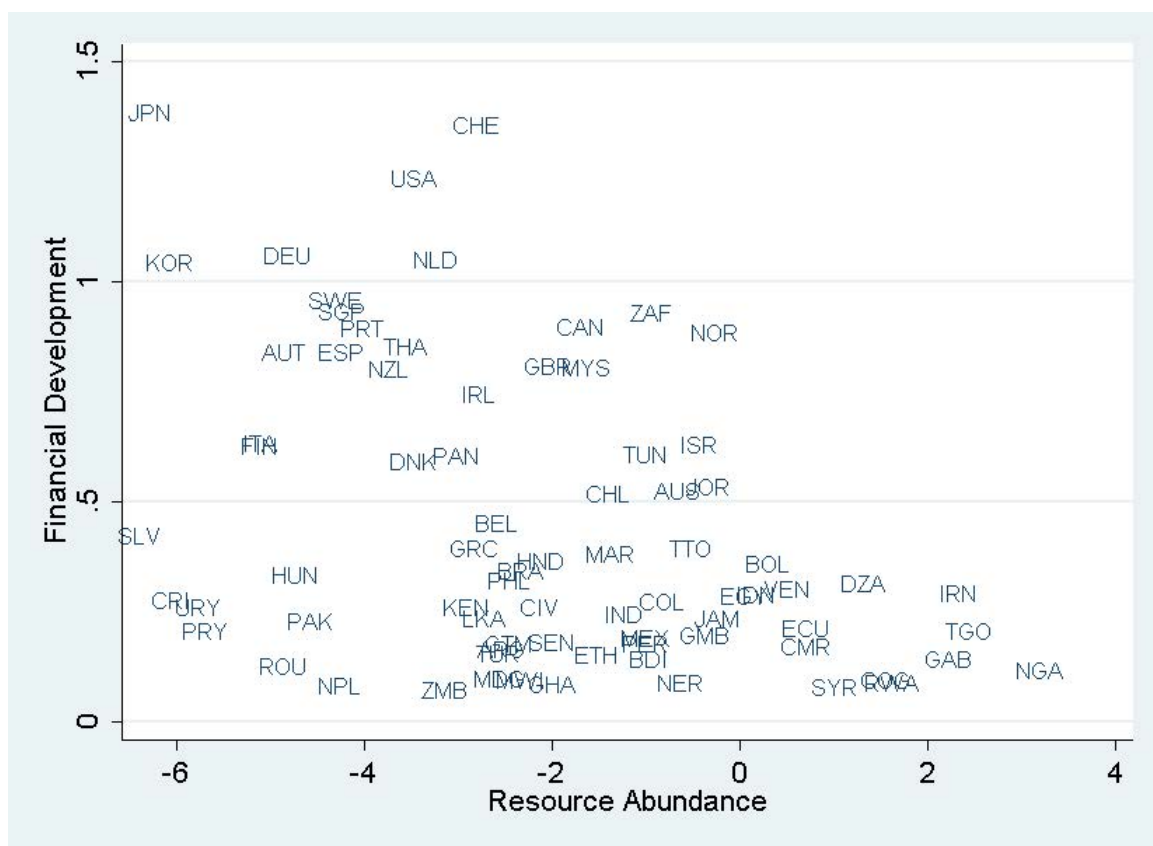


Figure 1: Financial Development (Private Credit to GDP) and Resource Abundance (Export Share of Resources).

Do resource-based economies have a less developed financial system? Figure 1 suggests that this, indeed, seems to be the case.<sup>4</sup> Countries with a high share of resources in total exports tend to have a smaller financial sector measured by private credit to GDP. Chapter 5.1 will show in more detail that this holds true when I control for other determinants of financial development such as GDP per capita and trade openness. The negative relationship is even more pronounced when the x-axis depicts the share of oil and natural gas in total exports excluding mining products. Furthermore, substituting the export shares by a more pure measure of resource abundance, e.g. subsoil in total wealth, does not change the general negative association between financial development and natural resources. This is in line with recent paper's findings (Nili and Rastad 2007, Beck 2011 and Kurronen 2012).

<sup>4</sup>Here, the export share of resources is depicted as  $\log[\text{share}/(1 - \text{share})]$ . "Log" refers to the natural logarithm in this paper. Data averages from 1970 to 2007.

### 3.1 Literature

There are several explanations for this negative relationship. Nili and Rastad (2007) identify a dominant role of the government in investment and a weak private sector as the main drivers of relatively low financial development. Berglöf and Lehmann (2009, p.199) think that "bulkiness of investment and a lack of demand for broader financial services" might play a role, but remain silent on the details or empirical underpinning. Yuxiang and Chen (2011) name four possible mechanisms: first, a resource boom often weakens the traded sector of an economy. Accordingly, there is less support for liberal trade policies, which are generally positively related to financial development. Second, rent-seeking and corruption in resource-based economies undermine a government's credibility and, thus, its ability to promote reliable financial sector reforms. Opportunities for rent-seeking may also reduce the activity and credit demand of entrepreneurs. Third, the detrimental effect of resource abundance on human capital (see Chapter 2) may weaken the social capital of an economy, that is its level of trust. Since trust plays an important role for financial contracts, financial development may shrink as well (Guiso, Sapienza and Zingales 2004b). Fourth, the finding of Gylfason and Zoega (2006) that resource abundance negatively affects productive investment may have implications for the financial sector, too.

Another argument is that the macroeconomic volatility caused by cyclical and highly uncertain commodity prices generally weakens financial development, as has been suggested by Kurronen (2012). The author further points out that local incumbents, especially in the resource sectors, tend to prevent financial reforms in order to deter competitors from market entry which typically rely more on external finance at the beginning (see also Rajan and Zingales 2003).

However, the afore mentioned works are confined to rather broad suggestions, without explicitly investigating the theories.



## 3.2 Demand for External Finance and Financial Development

This paper proposes and empirically investigates another pathway by which the resource curse may operate. The approach exploits the assumption that firms' financial dependence and, thus, demand for external finance *ceteris paribus* determines the size of the financial sector. In case resource firms rely less on external finance, there would be less credit demand in the economy and, therefore, a smaller and less developed financial system.<sup>5</sup>

### 3.2.1 Theory

Rajan and Zingales (henceforth: RZ, 1998) find that industries systematically differ in their need for external financing provided by the financial sector. It means that some industries rely more on the financial system than others. The communication-equipment sector, for example, is rather dependent on external finance since it has a limited ability to finance its investment need through own cash flow. Sectors' different external dependence is assumed to be due to persistent technological characteristics such as the gestation and cash harvest period, properties of the production function and characteristics of input use (von Furstenberg and von Kalckreuth 2006). Therefore, the ranking of sectors according to their level of financial dependence appears to be relatively stable over time and across countries (e.g. Rajan and Zingales 1998, Hattendorff 2012). Rajan and Zingales (1998) measure external dependence by capital expenditures minus operative cash flow divided by capital expenditures. An alternative measure of a firm's liquidity need is proposed by Raddatz (2006): the ratio of inventories to sales. Since a high level of inventories ties up cash, this figure is considered to be suitable for capturing a firm's external dependence. In contrast to the RZ-measure, it accounts for more short-term external finance need.

The finding of Rajan and Zingales (1998) has become a building block in studies conducted on both growth and trade. In particular, Do and Levchenko (2007) apply the concept in order to explain that demand in external finance may shape an economy's financial development.

They present a model with one factor, labor, and two goods (p.800). One is finan-

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<sup>5</sup>Kurronen (2012) hints at a similar explanation, without exploring the idea further.

cially dependent ( $F$ ), the other one not ( $A$ ). Entrepreneurs in the economy can choose between the production of either of these goods. The simple good  $A$  uses a linear technology with one unit of labor for one unit of  $A$ , while the production of  $F$  is more complicated due to additional financial constraints. In each period, the investment project of an entrepreneur producing  $F$  experiences a liquidity shock that may be either positive or negative. In order to fulfill possible liquidity need, agents can borrow on a spot credit market, where capital is provided by entrepreneurs with excess liquidity (p.801). The model finds that the probability of a firm's liquidation shrinks with an increase of the number of agents engaged in the  $F$ -sector, indicating positive spillovers and a "positive relation between the financial system's size and its quality" (p.802). Furthermore, this leads to less volatility of total output in the constrained sector. The authors show that in an autarky equilibrium, the credit market is linear in the size of this sector.

In a trade equilibrium, however, the outcome is different. Trade between two countries, say "North" and "South", emerges due to comparative advantage other than financial development. By assumption, there is a Ricardian productivity difference with North having an advantage in the financially dependent sector. In consequence, North produces only good  $F$  and South, in contrast, only the simple good  $A$ . According to the logic of the model, credit demand and lending in South declines to zero, thereby also affecting the financial system's quality since a marginal entrepreneur cannot insure anymore against liquidity shocks through borrowing (p.804). On the contrary, the Northern financial system's size and quality increase. Thus, the model is able to explain how the trade pattern may influence a country's financial development. Do and Levchenko (2007) test this hypothesis empirically and, indeed, find a significant positive association.<sup>6</sup> Their analysis, however, is limited to manufacturing sectors.

The close relationship between the financial sector's size and financial depth is in line with empirical finance literature (e.g. Levine and Schmukler 2006). Suitable and commonly used measures such as private credit to GDP or stock market capitalization are discussed in the following chapters. In addition, one may question whether national financial markets still matter with increasing internationalization since companies may just borrow on foreign capital markets. However, evidence from the finance literature suggests the opposite. Pagano, Randl, Röell and Zechner (2001) analyze firms'

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<sup>6</sup>They apply the RZ-type measure of external dependence.

cross-listing decisions at international stock exchanges, and find that local financial development remains to be an important determinant of a region's economic well-being. This view is supported by Guiso, Sapienza and Zingales (2004a), who show that in the financially well-integrated Italian regions, a higher regional level of financial development enhances the economic activity of local individuals.

The present paper does not claim that financial markets are shaped by the industry's credit demand only. An economy's general level of wealth (income per capita), legal origin, financial regulation and trade openness play an important role, too (La Porta, Lopez-de-Silanes, Shleifer and Vishny 1998, Mayer and Sussman 2001, Rajan and Zingales 2003).

### **3.2.2 Applying the Theory to the Resource Curse**

How does the theory of Do and Levchenko (2007) apply to the natural resource curse? The answer relates to the external dependence of resource firms. A resource-dominated economy with a high concentration of economic activity in few resource sectors may be similar to country South (see 3.2.1) in case resource sectors are financially independent. Indeed, researchers have often supposed that resource companies such as oil and gas producers rely less on external financing than others (Guriev, Plekhanov and Sonin 2009, Beck 2011). Hattendorff (2012) takes a closer look at the resource sectors' finance need in different countries by comparing various measuring approaches. The study shows that the resource sectors' financial dependence relative to manufacturing differs with the measure being applied. Table 1 shows that the resource sectors "coal mining", "crude petroleum and natural gas production", "metal ore mining" and "other mining" (ISIC Rev.2) are rather financially dependent when external dependence is measured by capital expenditures minus operative cash flow divided by capital expenditures (RZ-type measure). In contrast, they rely less on external finance when the ratio of inventories to sales is used. This is true for oil and gas, in particular. Accordingly, the correlation coefficient is low and insignificant. A meaningful financial channel of the resource curse is, therefore, linked to a scenario where a country's aggregate finance need measured by *inventories to sales* has a significant influence on financial development. It makes sense to argue that short-term credit in particular is provided by local banks. Long-term finance is assumed to rather come from equity markets. In the following empirical analysis, I will concentrate on short-term credit

demand and bank-based measures of financial development, such as private credit to GDP. Stock market measures will be used for robustness checks. This approach takes into consideration that my samples include developing and emerging countries, which are less suitable for investigating more sophisticated equity-based financing relations. A list of resource and manufacturing sectors ranked by their financial dependence is depicted in Appendix Table 8.

Since sectors' external dependence is relatively stable over time and across countries, I can use figures based on U.S. data for the calculation of each country's finance need. High financial development in the United States ensures that data is reliable and comprehensive. Applying these figures to other countries' industries also avoids the problem that firms' financial dependence is endogenous to the country's specific financial development (Kroszner, Laeven and Klingebiel 2007).

## 4 Empirical Strategy and Data

There are two hypotheses to be tested: first, a general negative relationship between financial development and resource abundance, as has been supposed in Figure 1. Second, in order to find an explanation for this phenomenon, a positive association between financial development and a country's aggregate short-term credit demand.

### 4.1 Financial Development and Resource Abundance

As mentioned in Section 3, resource-rich countries seem to have a less developed financial sector. The paper investigates this relationship more formally in a cross section of countries with averages over time. The estimating equation is:

$$FD_c = \alpha + \beta RESOURCES_c + \gamma X_c + \epsilon_c, \quad (1)$$

where  $FD_c$  is a measure of country  $c$ 's financial development,  $RESOURCES_c$  is a measure of resource abundance and  $\gamma X_c$  is a vector of control variables. These controls include the country's level of income per capita, its trade openness and dummies for legal origin. More information on data will be given in Section 4.4. Estimation is done with ordinary least squares (OLS). It is expected to find a negative coefficient

Financial Dependence across Sectors

ISIC	Sector	RZ-type Measure 1990-2009 (1)	Inventories to Sales 1990-2009 (2)
210	Coal mining	-0.24	0.05
220	Crude petroleum and natural gas production	0.58	0.00
230	Metal ore mining	4.79	0.16
290	Other mining	-0.30	0.14
311	Food products	-0.68	0.11
313	Beverages	0.02	0.08
314	Tobacco	-5.11	0.17
321	Textile	-1.04	0.16
322	Apparel	-1.25	0.17
324	Footwear	-2.34	0.20
331	Wood products	-1.33	0.10
332	Furniture	-2.24	0.11
341	Paper and products	-1.00	0.11
342	Printing and publishing	-2.06	0.05
351	Industrial chemicals	-0.38	0.10
352	Other chemicals	-0.92	0.13
3522	Drugs	38.16	0.08
353	Petroleum refineries	-0.45	0.06
354	Petroleum and coal products	7.75	0.17
355	Rubber products	-0.01	0.15
356	Plastic products	-0.37	0.12
369	Nonmetal products	-0.11	0.13
371	Iron and steel	-0.44	0.16
372	Nonferrous metal	-0.19	0.14
381	Metal products	-1.45	0.14
382	Machinery	-0.84	0.18
3825	Office and computing	1.11	0.13
383	Electric machinery	-0.37	0.18
3832	Communication equipment	-0.41	0.16
384	Transportation equipment	-0.16	0.17
3843	Motor vehicles	-0.21	0.12
385	Professional goods	0.54	0.19
390	Other industries	0.07	0.17
Correlation		1	-0.16 <sup>a</sup>

(1) The *RZ-type measure* is calculated as  $(CAPX_t - OANCF_t)/CAPX_t$ , where *CAPX* denotes capital expenditures and *OANCF* net cash flow from operative activities (in Compustat mnemonics). (2) The ratio of *inventories to sales* is calculated as  $INVT/SALE$ . Sector classification is ISIC Rev.2. See Hattendorff (2012). <sup>a</sup> Insignificant value.

Table 1

$\beta$ . Robustness checks include alternative measures of financial development and of resource abundance. In particular, potentially endogenous measures such as resource exports to total exports are replaced by measures that are more exogenous to other

economic variables and refer to the pure natural endowment. Furthermore, I control for the quality of institutions.

## 4.2 Financial Development and External Finance Need of Exports

The theoretical model presented above suggests that countries whose industries show less credit demand tend to have a less developed financial sector. This may include resource-abundant countries when financial dependence is measured by inventories to sales. To show this empirically, I follow the strategy proposed by Do and Levchenko (2007) and adjust it to the purposes of the resource curse analysis.

An economy's aggregate credit demand is proxied by its external finance need of exports. This measure is constructed according to Almeida and Wolfenzon (2005):

$$EFNX_{ct} = \sum_{i=1}^I \omega_{ict}^{EXP} ED_i. \quad (2)$$

Subscript  $c$  indexes countries,  $i$  industries and  $t$  time periods.  $\omega_{ict}^{EXP}$  denotes the share of sector  $i$ 's exports in total exports from country  $c$  in  $t$ , including both manufacturing and natural resources.  $ED_i$  is the measure of sector  $i$ 's financial dependence. Due to data availability and the instrumentation strategy applied, I use export data instead of output data for calculating a country's aggregate credit demand. An analysis of aggregate external finance need in manufacturing calculated with trade data (Do and Levchenko 2007) and output data (Almeida and Wolfenzon 2005) shows that both measures are, indeed, highly positively correlated (correlation coefficient of 0.72).

I estimate the following equation with OLS in a cross section of countries:

$$FD_c = \alpha + \beta EFNX_c + \gamma X_c + \epsilon_c, \quad (3)$$

where the left-hand side variable is again the measure of financial development. Control variables are the same as in regression equation (1), that is income per capita, trade openness and legal system. The variables are averaged over several time periods. In this regression, predictions from Section 3 are supported if the coefficient  $\beta$  is significantly larger than zero. Sensitivity analysis includes alternative measures of financial development, a variation of country samples as well as measures of institutional quality

and export concentration as additional control variables.

In order to control for omitted variables, I use a panel specification with country and time fixed effects. This is possible since most variables change over time. More precisely, I run the following estimation with OLS:

$$FD_{ct} = \alpha + \beta EFNX_{ct} + \gamma X_{ct} + \delta_c + \delta_t + \epsilon_{ct}, \quad (4)$$

with  $\delta_c$  for country fixed effects and  $\delta_t$  for time fixed effects. The panel specification is estimated on a sample of non-overlapping five-year and ten-year averages.

### 4.3 Causality

The estimations presented in the two previous subsections are prone to endogeneity problems since financial development may affect the right-hand side variables as well. It is, thus, important to carefully identify the direction of causality.

Concerning the relationship between financial development and natural resource abundance, the problem can be solved by using pure geographical measures of resource endowment. As mentioned above, financial markets are rather unlikely to affect measures that refer to the actual subsoil wealth.

However, in case of estimating equations nos. (3) and (4), which relate financial development to the external finance need of exports, it is more complicated to control for endogeneity. Indeed, a country's level of financial development will certainly influence its trade structure. This view has been supported by a number of studies in the finance and trade literature. They show that in the presence of credit constraints, quality and size of financial markets may be a source of comparative advantage, thereby offering an additional explanation for international trade patterns. Among others, Beck (2002) as well as Svaleryd and Vlachos (2005) find empirical evidence that a high level of financial development fosters exports in financially dependent industries. In order to identify a causal link between a country's external finance need of exports and financial markets, it is, therefore, necessary to accurately address the endogeneity problem. This is done with an instrumentation strategy that follows Do and Levchenko (2007, p.806). To overcome endogeneity, we need a variable that is highly correlated with the original one, i.e. the external finance need of exports, but uncorrelated with the error term. More precisely, this means finding an instrument for the trade structure, which is done

with the gravity approach that has been proposed by Frankel and Romer (1999). Trade as a share of GDP is predicted on the basis of a gravity regression of bilateral trade volumes on merely geographical explanatory variables like distance and land area. The obtained coefficients are used to predict bilateral trade between country pairs. These figures are, then, summed up over all trading partners of a country in order to get the predicted total trade relative to GDP.

While the analysis by Frankel and Romer (1999) is limited to the national level, Do and Levchenko (2007, p.806) modify the approach by also considering the sectoral level. Thus, they are able to predict a country's trade structure rather than just its general ratio of trade to GDP. Relying on Frankel and Romer (1999), the following regression equation is estimated for each sector  $i$ :

$$\begin{aligned}
LogEXP_{icd} = & \alpha + \eta_i^1 ldist_{cd} + \eta_i^2 lpop_c + \eta_i^3 larea_c + \eta_i^4 lpop_d + \eta_i^5 larea_d \\
& + \eta_i^6 landlocked_{cd} + \eta_i^7 border_{cd} + \eta_i^8 border_{cd} * ldist_{cd} \\
& + \eta_i^9 border_{cd} * pop_c + \eta_i^{10} border_{cd} * area_c + \eta_i^{11} border_{cd} * pop_d \quad (5) \\
& + \eta_i^{12} border_{cd} * area_d + \eta_i^{13} border_{cd} * landlocked_{cd} \\
& + \eta_i^{14} subsoilintotalwealth_c + \eta_i^{15} subsoilintotalwealth_d + \epsilon_{cd},
\end{aligned}$$

where  $EXP_{icd} = \frac{Exports_{icd}}{GDP_{ic}}$ .

The left-hand side variable  $LogEXP_{icd}$  denotes the log of exports from country  $c$  to  $d$  relative to GDP in industry  $i$ . Relating trade to sectoral GDP ensures that we control for a country's size. This is important since large countries tend to trade less with their neighbors, in relative terms, than small ones. For example, Germans surely engage much in trade with Germans, while Belgians trade comparatively less with their own countrymen (Frankel and Romer 1999, p.380). They have less fellow citizens to trade with. The geographical explanatory variables at the right-hand side include the log of bilateral distance between the two countries major cities  $ldist_{cd}$ , the log of country  $c$ 's population  $lpop_c$ , the log of its land area  $larea_c$  and both variables for trade partner  $d$ , respectively. The dummy variable  $landlocked_{cd}$  indicates whether none, one or both of the countries are landlocked by taking the value of zero, one or two.  $border_{cd}$  is a common-border dummy. Since the presence of a common border will most likely alter the effect of all previous variables, the right-hand side also consists of interaction terms with  $border_{cd}$ . In addition to Do and Levchenko (2007), this



paper adds *subsoilintotalwealth*, which denotes the subsoil in total wealth for both the exporter  $c$  and importer  $d$  (see Data Description 4.4).

The coefficients I obtain from these regressions by sector are then used to predict the log of exports to GDP in sector  $i$  from country  $c$  to  $d$ ,  $\widehat{\text{LogEXP}}_{icd}$ . Since the construction of the finance need of exports requires the sectoral export share in total exports, not sectoral bilateral exports, I take the exponential of  $\widehat{\text{LogEXP}}_{icd}$ , and sum over all trade partners ( $d = 1, \dots, C$ ):

$$\widehat{\text{EXP}}_{ic} = \sum_{d=1}^C e^{\widehat{\text{LogEXP}}_{icd}}, \quad \text{where } d \neq c. \quad (6)$$

The next step is to eliminate  $\text{GDP}_i$ , that is still embodied in  $\widehat{\text{EXP}}_{ic}$ . This is done in the following manner:

$$\widehat{\omega}_{ic}^{\text{EXP}} = \frac{\widehat{\text{EXP}}_{ic}}{\sum_{i=1}^I \widehat{\text{EXP}}_{ic}}. \quad (7)$$

With predicted rather than actual trade shares of sectors, it is now possible to construct the instrument for the main right-hand side variable, external finance need of exports (Do and Levchenko 2007, p.807). In analogy to equation (2), the instrument is:

$$\widehat{\text{EFNX}}_c = \sum_{i=1}^I \widehat{\omega}_{ic}^{\text{EXP}} \text{ED}_i. \quad (8)$$

While trade literature shows that gravity approaches deliver astonishingly good predictions of actual trade volumes at the national level, one might be more reluctant towards a strategy predicting countries' trade structures with the corresponding sectoral disaggregation. In particular, one might argue that the geographical determinants used as explanatory variables refer to the national level and do not vary across industries. However, since the gravity regression is estimated for each sector  $i$ , the estimated gravity coefficients  $\eta_i$  also differ across sectors and, thus, the predicted exports to GDP  $\widehat{\text{EXP}}_{ic}$  within a country. The intuition is that goods with, for example, a highly negative coefficient on distance will be traded less with trading partners that are far away from the home country than other products. Other export goods might react sensitively to whether there is a common border between country  $c$  and  $d$ . That is, the sectors' export behavior is differently affected by the geographical determinants in the gravity

equation (5). Obviously, significant variation of the gravity coefficients across industries is important for the instrumentation strategy to work. Whether this is, indeed, the case, is tested in Section 5.

Do and Levchenko (2007) list both theoretical and empirical studies which support the view that these coefficients differ across sectors. Anderson and van Wincoop (2003, 2004) show, for example, that coefficients on distance and border depend on trade costs and the elasticity of substitution between product varieties within an industry. Both factors may well differ across sectors according to empirical literature.

Another potential objection to the approach might be the presence of zero trade observations when two countries do not trade in a particular sector. There is a high probability that two small countries which are far away from each other do not trade in every sector. Do and Levchenko (2007) find that this phenomenon is less of a problem. One reason is that trade patterns rather than volumes are estimated, and country pairs with no bilateral trade at all can be easily ignored. Nevertheless, the instrument may still be biased since the procedure predicts zero trade when it observes zero trade. The authors conduct a number of robustness checks to avoid this problem and find convincing evidence that zero trade observations are not a major concern for the instrumentation strategy.<sup>7</sup>

The instrument is used in regression equation (3) with two-stage least squares (2SLS).

## 4.4 Data Description

In the following section, data and data sources are described in more detail. The present paper exploits the cross-country heterogeneity in finance. It is, therefore, crucial to use an appropriate measure of an economy's level of financial development. The most commonly used measure in the finance literature is the ratio of private (domestic) credit to GDP, that is the amount of credit by banks and other private financial institutions to the private sector as a share of GDP (Rajan and Zingales 1998, p.569). As mentioned above, there is reason to assume that the quality of a financial system is a function of its size (Do and Levchenko 2007, p.799). A similar measure is the ratio of liquid liabilities to GDP (M2/GDP). Alternatively, one can use a country's stock market trade value or stock market capitalization relative to GDP. While both stock

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<sup>7</sup>Among others, they estimate the gravity equation in levels applying a Poisson pseudo-maximum likelihood estimator with zero trade observations.

market measures do not reflect the actual amount of funding obtained by borrowers, these composites are considered to be suitable proxies for financial development. In contrast, the stock market turnover ratio, defined as the value of total shares traded divided by the average real market capitalization, is a proxy for the stock market *activity* and not for its size. The net interest margin, which is the accounting value of bank's net interest revenue as a share of interest-bearing assets, is another possibility to avoid using the financial sector's size (Do and Levchenko 2007, p.821). Generally, the measures presented here are positively correlated, with the exception of the net interest margin, where a low value suggests a well developed financial system. All measures are taken from Beck and Demirgüç-Kunt (2009).

Measures of resource abundance include the share of natural resources - that is coal, oil and gas, metal ores and other mining products - in total (manufacturing and natural resources) exports. Alternatively, I use the share of oil and natural gas exports in total exports. Both measures are based on own calculations. In order to control for endogeneity, more pure measures of a country's resource endowment are used. These are subsoil wealth per capita and subsoil wealth in total national wealth provided by the World Bank (2006). Subsoil wealth includes oil, natural gas, coal and mineral resources, while total wealth includes all natural assets (e.g. forests) as well as produced capital and intangible capital.<sup>8</sup>

Data for sectors' financial dependence, that is inventories to sales and the RZ-type measure, comes from Hattendorff (2012).

International trade data is taken from both the World Trade Database (Feenstra, Lipsey, Deng, Ma and Mo 2005) for the time period 1970 to 2000 and UN Comtrade for 2001 to 2007. These databases capture a large majority of bilateral trade flows and provide data classified by four-digit SITC Revision 2. Since financial dependence data is classified by ISIC Revision 2, trade data is converted to (three-digit) ISIC Rev. 2, as well. This is partly done with a correspondence table developed by Muendler (2009). The convergence allows constructing the measure of external finance need of exports *EFNX*. In addition, this data is used to calculate the export concentration variables for robustness checks.

The same sources of trade data are used for the left-hand side variable of the grav-

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<sup>8</sup>Van der Ploeg and Poelhekke (2010) argue that also measures of subsoil wealth could be endogenous in growth regressions due to specific assumptions made for their calculation. I believe that this is less of a problem here, even more so as this potential endogeneity would rather mitigate the negative effect of resources on finance: wealthy countries tend to have higher values of subsoil wealth per capita, as for the World Bank figures.

ity equation, where the additionally required GDP data at the sectoral level comes from the United Nations Industrial Development Organization's database INDSTAT4 and the UNIDO publication "World Statistics on Mining and Utilities" (2010). Data is again converted to three-digit ISIC Rev. 2. Due to small inconsistencies in the matching of the sector classifications ISIC Rev. 2 and 3, the plastic products sector (356) has to be dropped, here. A database from Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) provides geographical data for the right-hand side variables, that is bilateral distances between two countries' major cities, land area as well as information on whether a country is landlocked and whether two countries share a border (Head, Mayer and Ries 2010). Data on population comes from the World Bank's "World Development Indicators".

The control variables GDP per capita (PPP-adjusted) and trade openness (sum of imports and exports as a share of GDP) come from the Penn World Tables (Heston, Summers and Aten 2002). Data on the legal system is based on La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998).

Further robustness checks require measures of institutional quality. In detail, this is the Polity IV index (Marshall, Jaggers and Gurr 2011), which captures the strength of democracy on a scale from -10 to 10. Second, the size of government, which is proxied by government consumption spending to GDP (from Penn World Tables), and where a high value indicates low quality of institutions. Third, the property rights index by the Heritage Foundation capturing the protection of private property on a scale from 0.1 to 1. And fourth, the Economic Freedom of the World Index (Gwartney, Lawson and Hall 2012), which is a composite including 42 components of the five categories government size, legal system, property rights, sound money (inter alia inflation), freedom to trade internationally as well as flexible regulations (credit market, labor market, doing business).

Different samples are used in the analysis. The first sample for the regression of financial development on natural resource abundance consists of 78 countries for the time period 1970 to 2007, while the second one covers 84 countries. The latter captures a shorter time period, from 1992 to 2007, which permits to include a number of former socialist economies. The corresponding samples for the regression of financial development on the external finance need of exports are somewhat larger: 93 and 110 countries. The sample used for the 2SLS estimation consists of only 34 countries

from 1992 to 2007 due to limited sectoral GDP data, especially for figures on mining production. A list of countries is depicted in Appendix Table 14.

## 5 Results

This section presents the empirical results. The first part deals with the relation between a country's level of financial development and its natural resource endowment. The second part relates financial development and the aggregated credit demand of a country in a cross-section and in a panel specification, and it reports the results of the instrumentation strategy. As indicated in Section 3, I focus on a scenario where firms' financial dependence is measured by inventories to sales. Further robustness checks test whether institutional quality or export concentration are important for the analysis.

### 5.1 Financial Development and Resource Abundance

As outlined in Section 3, it is reasonable to empirically validate whether there is a negative relationship between resource abundance and a country's financial system before investigating a possible mechanism of the financial channel in more detail.

I run a cross-sectional OLS regression with a sample of 78 countries, estimating equation (1) with various measures of financial development and resource abundance. In order to mitigate the problem of an unbalanced panel, averages of all variables from 1970 to 2007 are taken. The results are reported in Table 2, with robust standard errors in parentheses, where the columns represent different specifications. The first specification is a simple bivariate regression of financial development on resource abundance measured by private credit to GDP and the export share of resources, respectively. The coefficient on resource abundance is  $-0.463$  and significant at the 1% level. The following specifications add other variables suitable to explain a country's level of financial development, such as income per capita and trade openness (Column 2). It does not come as a surprise that wealth is positively correlated with a large private credit market. Trade openness appears to be insignificant. The coefficient on resource abundance remains significantly negative. This is also true in Column 3, including legal origin dummies, where the  $R^2$  is 0.71.

In the context of the resource curse, it is often argued that institutions play an im-

	(1)	(2)	(3)	(4)
Dep. Var. (FD)	Pr.Credit/GDP	Pr.Credit/GDP	Pr.Credit/GDP	Pr.Credit/GDP
Resource Abundance Measure	Export Share of Resources	Export Share of Resources	Export Share of Resources	Export Share of Resources
Resource Abundance	-0.463*** (0.092)	-0.245** (0.075)	-0.173** (0.072)	-0.239*** (0.081)
Log(Income)		0.183*** (0.019)	0.156*** (0.021)	0.175*** (0.024)
Log(Trade Openness)		0.039 (0.056)	0.040 (0.047)	0.030 (0.047)
British Legal Origin			0.013 (0.107)	0.426*** (0.080)
French Legal Origin			-0.112 (0.102)	0.282*** (0.069)
Socialist Legal Origin			-0.354*** (0.096)	
German Legal Origin			0.378* (0.135)	0.785*** (0.139)
Scandinavian Legal Origin				0.414*** (0.111)
Polity IV				-0.008 (0.005)
Constant	0.555*** (0.053)	-1.224*** (0.230)	-0.971*** (0.258)	-1.446*** (0.217)
Observations	78	78	78	77
$R^2$	0.14	0.57	0.71	0.70

Robust standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at the 1%, 5% and 10% level. Variables are averaged over the period 1970-2007. In all specifications, financial development ( $FD$ ) is measured by private credit to GDP, while resource abundance is captured by the export share of resources. Log(Income) is the log of real GDP per capita, and Log(Trade Openness) is the log of total trade to GDP (both from Penn World Tables). The legal origin dummies come from La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998). The index Polity IV measures the strength of democratic institutions (Marshall, Jaggers and Gurr 2011).

Table 2

portant role (see Section 2). For this reason, I control for institutional quality using the Polity IV index, which is frequently applied in the literature. As can be seen in Column 4, however, this variable does not have a significant effect on the left-hand side variable.<sup>9</sup> It seems that the negative relationship between financial system and resources cannot simply be explained by institutional shortcomings. The coefficient on resource abundance remains to be significant when government size as a measure of institutional quality is used. With a measure of economic freedom or of property rights, the results are ambiguous, but do not generally contradict the negative link between finance and resources (not depicted in the tables).

<sup>9</sup>It remains insignificant when the legal origin dummies are dropped.

Furthermore, I check the robustness of these results using alternative measures of resource abundance. The results of a specification with control variables income per capita, trade openness and legal origin are depicted in Table 3. When resource abundance is measured by the export share of just oil and natural gas without mining products, the negative relationship found above is even stronger (Column 1). As indicated in the description of methods, it is even more important to vary the resource variable using a pure, exogenous measure such as subsoil wealth per capita or the share of subsoil in total wealth in order to overcome the simultaneity problem of the export shares of resources used so far. Although the coefficients on the main right-hand side variable (Column 2 and 3) are smaller than in the previous regressions, the results support the finding from above.

In addition, the measures of financial development are varied. In detail, these are the ratios of liquid liabilities, stock market trade value and stock market capitalization to GDP, the stock market turnover ratio and the net interest margin. Selected results using two of them, the stock market trade value to GDP and the stock market turnover ratio, are depicted in Table 3, with wealth, trade openness and legal origin dummies as control variables. Still, coefficients on resource abundance are negative and significantly different from zero with values of  $-0.196$  and  $-0.315$ . Even though not all combinations of financial development and resource abundance measures deliver highly significant results and  $R^2$  tends to shrink, the previously obtained findings are supported (not depicted in the tables).

The same analysis is conducted for a sample covering the period 1992 to 2007, which includes a number of former Soviet countries. Appendix Table 9 shows the specifications as in Column 3 of Table 2, with income per capita, openness and legal origin as controls. Again, measures of resource abundance and financial development are varied. Overall, the results are in line with the findings from above. Most of the coefficients on resource abundance are even higher and have higher t-statistics.

Thus, we can state that countries which are abundantly endowed with natural resources, indeed, tend to have a less developed financial system. Furthermore, the size of the effect appears not to be negligible. These results are in line with Yuxiang and Chen (2011), Beck (2011) and Kurronen (2012).

Financial Development and Resource Abundance  
Robustness, OLS Cross Section, Averages, 1970-2007

	(1)	(2)	(3)	(4)	(5)
Dep. Var. (FD)	Pr.Credit/GDP	Pr.Credit/GDP	Pr.Credit/GDP	Stock Market Trade Value/GDP	Stock Market Turnover/GDP
Resource Abundance Measure	Export Share of Oil and Gas	Subsoil Wealth p.c. <sup>a</sup>	Subsoil in Total Wealth	Export Share of Resources	Export Share of Resources
Resource Abundance	-0.217*** (0.062)	-1 * 10 <sup>-5</sup> *** (3.2*10 <sup>-6</sup> )	-0.172** (0.073)	-0.196** (0.092)	-0.315** (0.132)
Other Controls	Log(Income), Log(Trade Openness), Legal Origin Dummies				
Constant	-0.998*** (0.257)	-1.534*** (0.237)	-1.074*** (0.256)	-0.825* (0.433)	0.578 (0.594)
Observations	78	77	78	65	65
R <sup>2</sup>	0.72	0.71	0.71	0.46	0.44

Robust standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at the 1%, 5% and 10% level. Variables are averaged over the period 1970-2007. The resource abundance measure is varied using the export share of resources (4 and 5), the export share of oil and gas (1), subsoil wealth per capita (2) and subsoil in total wealth (3). Selected measures of financial development (*FD*) are private credit to GDP (1-3), the stock market trade value (4) and the stock market turnover to GDP (5). Log(Income) is the log of real GDP per capita, and Log(Trade Openness) is the log of total trade to GDP (both from Penn World Tables). The legal origin dummies come from La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998). <sup>a</sup> Without Norway, which is a strong outlier.

Table 3

## 5.2 Financial Development and External Finance Need of Exports

Armed with this finding, we can now turn to an empirical investigation of a mechanism that is able to explain why resource-rich countries tend to have a less developed financial system. As described in Section 3, the external dependence of resource sectors may play a role. The hypothesis to be tested is whether credit demand by sectors, proxied by the (short-term) external finance need of exports, affects a country's financial development.

### 5.2.1 Cross-Sectional Analysis

#### a. Ordinary Least Squares (OLS) Regression

The first cross-sectional OLS regressions are conducted with a sample of 93 coun-



Financial Development and External Finance Need of Exports  
 OLS Cross Section, Averages, 1970-2007

	(1)	(2)	(3)	(4)
Dep. Var. (FD)	Pr.Credit/GDP	Pr.Credit/GDP	Pr.Credit/GDP	Stock Market Capitalization/GDP
EFNX	1.900*** (0.686)	2.500*** (0.526)	1.976*** (0.501)	2.693** (1.164)
Log(Income)		0.188*** (0.018)	0.171*** (0.019)	0.219*** (0.036)
Log(Trade Openness)		0.079 (0.056)	0.075 (0.050)	0.220** (0.090)
British Legal Origin			0.049 (0.106)	0.328** (0.161)
French Legal Origin			-0.041 (0.098)	-0.052 (0.121)
Socialist Legal Origin			-0.249*** (0.093)	-0.057 (0.184)
German Legal Origin			0.372*** (0.139)	0.071 (0.294)
Constant	0.198*** (0.066)	-1.787*** (0.266)	-1.568*** (0.321)	-2.774*** (0.723)
Observations	93	93	93	76
$R^2$	0.05	0.61	0.70	0.52

Robust standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at the 1%, 5% and 10% level. Variables are averaged over the period 1970-2007. In specifications 1 to 3, financial development ( $FD$ ) is measured by private credit to GDP, while 4 uses.  $EFNX$  is the external finance need of exports, which is calculated using inventories to sales.  $\text{Log}(\text{Income})$  is the log of real GDP per capita, and  $\text{Log}(\text{Trade Openness})$  is the log of total trade to GDP (both from Penn World Tables). The legal origin dummies come from La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998).

Table 4

tries and data averages over 38 years, that is from 1970 to 2007. The results are shown in Table 4, with robust standard errors in parentheses. In Column 1, financial development (private credit to GDP) is regressed on the external finance need of exports, i.e. on the economy's aggregate credit demand of firms. Firms' financial dependence  $ED_i$  from equation (2) is measured by inventories to sales. The coefficient on the right-hand side variable  $EFNX$  is 1.900 and significant at the 1% level. The  $R^2$ , however, is rather low. Column 2 and 3 present the results from specifications including the control variables income per capita, trade openness and legal origin dummies. As expected, wealth is positively related to the size of the credit market. Trade openness, however, is insignificant in all specifications. Column 3 shows that especially a socialist legal origin negatively affects the financial system. Here, the  $EFNX$  variable is still significant at the 1% level ( $\beta = 1.976$ ), and  $R^2$  is much higher than in the first specification.

In order to check these estimates for robustness, alternative measures of financial de-

velopment are applied instead of private credit to GDP. As in Section 5.1, this includes the ratios of liquid liabilities, stock market trade value and stock market capitalization to GDP, the stock market turnover ratio and the net interest margin. The regression result with stock market capitalization is demonstrated in Table 4 in Column 4. Overall, the results are mixed. With liquid liabilities and stock market capitalization to GDP, the coefficients on  $EFNX$  are positive and significant as above, even though the  $R^2$  is only at around 0.50. The coefficients are insignificant, however, when the financial system's quality is proxied by the other three measures (not depicted in the table).

Nevertheless, in the cross section, there is some evidence that the external finance need of exports measured by short-term financial dependence might affect countries' financial development. This result would, indeed, suggest a credit demand channel of the resource curse.<sup>10</sup>

Furthermore, I run all regressions and robustness checks from above with a sample including more countries (110) at the expense of a shorter time period covered (1992-2007). The results obtained from these estimations are strongly in line with those from the 1970-2007 sample. Again, the external finance need of exports with inventories to sales is significantly related to financial development.

#### b. Instrumentation Strategy

As outlined in Section 4.3, the external finance need of exports, the main right-hand side variable, may be endogenous, that is the trade structure could be influenced by financial development itself. The results of the instrumentation strategy are presented below.

The approach allows only cross-sectional analysis, and limited availability of data leads to a smaller sample covering less countries over a shorter time period. More precisely, I use a sample with 34 countries from 1992 to 2007.

First, I estimate the gravity equation (5) at the sectoral level, i.e. for each of the 32

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<sup>10</sup> $EFNX$  is clearly insignificant in all specifications when it is calculated with the Rajan-Zingales-type measure instead of inventories to sales. This result continues to hold when the exact calculation of cash flow is varied, as proposed by Hattendorff (2012).

sectors. The data is averaged over the whole period. The estimation results with all relevant variables are depicted in the Appendix Tables 10 to 13, where each column represents an industry. The number of observations differs across the sector-level gravity regressions, ranging from 350 (coal mining) to 2,542 (machinery). The  $R^2$ 's are between 0.19 and 0.56.

How can we interpret the sectors' coefficients on the geographical determinants? As expected, distance is clearly mitigating the ratio of bilateral exports to GDP. The farther away countries are, the less they trade with each other. According to Frankel and Romer (1999, p.384), the coefficients on the exporter's population and area are supposed to be negative, too, since agents in large countries, such as the United States, have more opportunities to trade with their fellow citizens and are farther away from customers beyond the border. This distance argument is also applied to explain why the importer's land area negatively affects bilateral trade to GDP. These predictions are only partly supported by the data from my gravity estimation. On the other hand, a large population of the importer provides good market opportunities and increases bilateral exports significantly. Not surprisingly, landlocked countries trade considerably less. A common border tends to increase bilateral trade, whereas this is less obvious when border interaction terms are included in the regression. Overall, the coefficients' size and signs correspond rather well to those obtained by Frankel and Romer (1999) at the aggregate national level.

Do and Levchenko (2007) point out that the gravity coefficients have to differ across industries. Since all geographical right-hand side variables are the same in the set of industry-level estimations, predicted trade values would just be the same, too, if  $\eta^{1-15}$  were equal across sectors. However, comparing the coefficients in Appendix Tables 10 to 13 shows that they differ significantly in magnitude. For example,  $\eta^1$  on  $ldist_{cd}$  (log of bilateral distance) ranges from  $-1.998$  to  $-0.436$ . Thus, expanding the Frankel-Romer approach to a sector-level analysis is, indeed, possible.

Armed with the fifteen estimates on the geographical variables, I predict bilateral exports as a share of GDP for each industry and country, and calculate the predicted external finance need of exports as described in Section 4.

The 2SLS regression results are presented in Table 5, where  $\widehat{EFNX}_c$  is the instrument for  $EFNX_c$  calculated with inventories to sales. Column 1 reports a simple bivariate regression, while the Columns 2 and 3 add the set of control variables that

are known from above. The bottom panel refers to the first stage of the estimation. The coefficient on  $\widehat{EFNX}_c$  ranges from 1.754 to 2.585 and is significant at the 10% level or at the 5% level. The partial  $R^2$ 's are between 0.14 and 0.32. The partial F-statistics range from rather low 2.89 to 4.82.

The second-stage outcomes are presented in the top panel of Table 5. The coefficient on  $EFNX$  is clearly insignificant in the bivariate regression (t-statistics of 0.39). With the additional control variables income per capita and trade openness, it is significant at the 1% level and very high in magnitude (5.467). Including legal origin dummies increases the coefficient even further, but lowers significance. The variation of financial development measures does not alter this finding much (the specifications with stock market capitalization and the stock market trade value are depicted in the table).<sup>11</sup> So, in sum, the external finance need of exports calculated with inventories to sales seems to increase a country's financial development. This corresponds to the outcome of the cross-sectional OLS analysis above.

### 5.2.2 Panel Analysis

In the following, the results of the panel analysis are presented. The procedure allows to add a time-series dimension of the data and to control for omitted variables that have not been considered in the cross-sectional estimation. As outlined in Section 4, both country and time fixed effects are being applied. Hence, it is possible to control for unobserved time-invariant characteristics that are specific to a country, and for changes over time in the global environment (Do and Levchenko 2007, p.824). A robust version of the Hausman specification test shows a high Chi-squared statistic with a p-value close to zero. This means a fixed effects approach is preferred to random effects. Obviously, the assumption that random effects are orthogonal to the regressors does not hold, here. Due to limited data, regression equation (4) is estimated with OLS, only.

Table 6 reports the regression results with a sample from 1970 to 2007 with nonoverlapping five-year averages, that is 1970-1974, 1975-1979 etcetera, where the last average covers only 3 years, 2005-2007. Taking five-year averages mitigates the problem of an

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<sup>11</sup>In case  $EFNX$  is calculated with the RZ-type measure, the instrumentation strategy fails, as indicated by the weak instrument diagnostics.

Financial Development and External Finance Need of Exports  
2SLS Cross Section, Averages, 1992-2007

	(1)	(2)	(3)	(4)	(5)
Panel A: 2nd Stage					
Dep. Var. (FD)	Pr.Credit /GDP	Pr.Credit /GDP	Pr.Credit /GDP	Stock Market Capitalization /GDP	Stock Market Trade Value/GDP
EFNX	1.482 (3.763)	5.467*** (1.968)	7.138** (2.970)	6.431** (3.370)	6.231** (3.005)
Log(Income)		0.351*** (0.067)	0.233** (0.095)	0.123 (0.117)	0.139** (0.069)
Log(Trade Openness)		-0.035 (0.100)	0.087 (0.116)	-0.039 (0.126)	-0.102 (0.121)
British Legal Origin			-0.011 (0.188)	0.742*** (0.237)	0.275 (0.307)
French Legal Origin			-0.270* (0.156)	0.197 (0.134)	0.052 (0.269)
Socialist Legal Origin			-0.545** (0.212)	0.020 (0.228)	-0.085 (0.299)
Scandinavian Legal Origin			-0.170 (0.210)	0.446** (0.163)	0.313 (0.272)
Constant	0.491 (0.445)	-3.231*** (0.732)	-2.579** (0.973)	-1.588 (1.083)	-1.401 (1.080)
Panel B: 1st Stage					
Dep.Var.	EFNX	EFNX	EFNX	EFNX	EFNX
$\widehat{EFNX}$	1.754* (1.033)	1.857* (0.915)	2.540** (1.157)	2.585** (1.181)	2.585** (1.181)
Partial F-Test	2.89	4.12	4.82	4.79	4.79
Partial $R^2$	0.14	0.20	0.32	0.32	0.32
Observations	33	33	33	34	34

Robust standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at the 1%, 5% and 10% level. Variables are averaged over the period 1992-2007. In specifications 1 to 3, financial development ( $FD$ ) is measured by private credit to GDP, while 4 uses stock market capitalization, and 5 the stock market trade value.  $EFNX$  is the external finance need of exports, which is calculated using inventories to sales.  $\text{Log(Income)}$  is the log of real GDP per capita, and  $\text{Log(Trade Openness)}$  is the log of total trade to GDP (both from Penn World Tables). The legal origin dummies come from La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998).  $\widehat{EFNX}$  is the predicted  $EFNX$  based on a gravity approach with geographical data.

Table 5

unbalanced panel and filters out short-run business cycle fluctuations. In order to control for both heteroskedasticity and autocorrelation, standard errors clustered at the country level are being applied. In contrast to the previous estimations, only controls that vary over time can be used. This excludes the variables capturing legal origin. Columns 1 and 2 show the estimations with private credit to GDP. As expected, the log of income per capita is again significant with a coefficient of 0.351. Trade openness is significant now, too, although it clearly has a weaker effect on the left-hand side

variable. It does not come as a surprise that the  $R^2$ 's are relatively high in all fixed effects regressions. Remarkably, the coefficient on the external finance need of exports with inventories to sales is insignificant, here.<sup>12</sup>

Varying the measures of financial development, using the ratios of M2, stock market trade value and stock market capitalization to GDP, the stock market turnover ratio and the net interest margin, rather confirms this finding (selected measures in Table 6 in Column 3 and 4).<sup>13</sup>

The above panel analysis is repeated with ten-year averages instead of five-year averages. It turns out that these outcomes generally support the ones previously obtained. The same is true for specifications with five-year averages and lagged regressors using first and second lags (not depicted in the tables).

As in the cross section, I also use a sample covering the period from 1992 to 2007 that includes many of the former socialist countries. This allows only five-year averages to be taken. The results, that are not reported in the tables, basically correspond to those before.<sup>14</sup>

In summary, we can say that controlling for omitted variables brings with it a considerable change of results. When a country's external finance need is calculated with inventories to sales, it does not have a significant influence on financial development. This contradicts the finding from 5.2.1.

### 5.2.3 Interpretation of Results

As indicated above, the estimations deliver different results with regard to the link between financial development and external credit demand. In the cross-sectional analysis, the external finance need of exports ( $EFNX$ ) calculated with inventories to sales enters significantly in basically all specifications. This is true for both ordinary least squares and two-stage least squares, and seems to confirm the hypothesis

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<sup>12</sup>The coefficient on the RZ-type  $EFNX$  is significant at the 1% level, which corresponds with the one obtained by Do and Levchenko (2007).

<sup>13</sup>In particular, there is no evidence that  $EFNX$  calculated with the short-term measure is more correlated with credit market indices, or RZ-type  $EFNX$  with stock market indices, or vice versa.

<sup>14</sup>Some financial development variations provide too few observations to conduct meaningful estimations.

Financial Development and External Finance Need of Exports  
 OLS Panel Estimation, 5 Year Averages, 1970-2007

	(1)	(2)	(3)	(4)
Dep. Var. (FD)	Pr.Credit/GDP	Pr.Credit/GDP	M2 /GDP	Stock Market Capitalization /GDP
EFNX	0.546 (0.687)	0.268 (0.650)	0.566 (0.446)	1.059 (1.788)
Log(Income)		0.351*** (0.055)	0.189*** (0.044)	0.235* (0.133)
Log(Trade Openness)		0.122** (0.050)	0.062* (0.034)	0.128 (0.129)
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Observations	679	673	671	369
No. of Countries	93	93	93	76
$R^2$	0.80	0.84	0.90	0.84

Standard errors clustered at the country level are in parentheses. \*\*\*, \*\* and \* indicate significance at the 1%, 5% and 10% level. Nonoverlapping five-year averages from 1970 to 2007. In specifications 1 and 2, financial development (*FD*) is measured by private credit to GDP, while 3 uses liquid liabilities to GDP, and 4 stock market capitalization to GDP. *EFNX* is the external finance need of exports, which is calculated using inventories to sales. Log(Income) is the log of real GDP per capita, and Log(Trade Openness) is the log of total trade to GDP (both from Penn World Tables).

Table 6

that resource-based economies have lower financial development due to lower credit demand. On the contrary, the panel estimations in 5.2.2 show that *EFNX* calculated with the short-term measure is clearly insignificant. This points to omitted variables in the cross section, which are controlled for in the fixed-effects estimation. Several variables could come into question.

As in the regression of financial development on natural resource abundance in 5.1, one may argue that institutions matter (see also Section 2). In order to control for institutional quality, several measures are applied: the Polity IV index for the strength of democracy, the size of government, the property rights index by the Heritage Foundation and the Economic Freedom of the World Index, which is a composite of the categories government size, legal system, property rights, sound money, freedom to trade internationally and flexible regulations.

Table 7 reports the estimation results in the cross section with private credit to GDP on the left-hand side. The right-hand side variables are *EFNX*, the measures of institutional quality and the standard set of controls, that is national wealth, trade openness

and legal origin. Variables are averaged over the period 1970 to 2007. Sample size and  $R^2$  are similar to those above. Except from the Polity IV index, all institutional variables are significant and have the expected signs (Columns 1-4). Private property and the index of economic freedom enter positively, government size negatively. In particular, I am interested in the change of the coefficient on  $EFNX$  in comparison to the estimations without the quality of institutions. Using Polity IV, government size or the property rights index, the external finance need of exports variable is still positive and significant. This result does not hold with the composite Economic Freedom Index (Column 4). However, if the index is substituted by its sub composites of the five categories,  $EFNX$  is again significant (not depicted in the tables). All estimation results are generally robust to the variation of the financial development measure. Using the larger sample with averages from 1992 to 2007 as well as including institutional quality in the instrumentation strategy delivers similar outcomes. Thus, institutions are unlikely to be the omitted variable.

Countries with low external finance need of exports often have only few export sectors. This gives rise to the idea that export concentration - rather than short-term external credit demand - may negatively affect financial development. To control for this possible effect, two measures of export concentration are being used: the concentration ratio, which sums up the export shares of the four largest export sectors, as well as the Herfindahl-Hirschman Index, which sums up the square of export shares of all export sectors.

The effect of export concentration on financial development is estimated in a regression with the standard set of controls and  $EFNX$  (with inventories to sales) as the main right-hand side variable (see Table 7, Columns 5 and 6). The sample covers 93 countries, variables are averaged over the period 1970 to 2007. Tests show that multicollinearity is not an issue, here. Both coefficients on export concentration are negative and significant, that is lower diversification of exports is correlated with weaker financial markets. Furthermore, the proxy for short-term credit demand  $EFNX$  is insignificant in both specifications. This corresponds to the findings of the panel analysis. The results basically hold when I vary the measure of financial development or the sample (110 countries from 1992 to 2007). They by and large continue to hold when the equation is estimated with 2SLS, applying the predicted  $EFNX$  as an instrument (not depicted in the tables).



Hence, export concentration might be the omitted variable, which was partly controlled for in the fixed-effects panel estimation. This additional result suggests that the hypothesis of lower credit demand causing weaker financial development in resource-based economies has to be rejected.

Financial Development and External Finance Need of Exports  
Quality of Institutions and Export Concentration, OLS Cross Section, Averages, 1970-2007

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var. (FD)	Pr.Credit /GDP	Pr.Credit /GDP	Pr.Credit /GDP	Pr.Credit /GDP	Pr.Credit /GDP	Pr.Credit /GDP
EFNX	1.632*** (0.417)	2.078*** (0.497)	1.435*** (0.517)	0.362 (0.502)	0.602 (0.555)	0.718 (0.659)
Polity IV	-0.0002 (0.005)					
Government Size		-0.008** (0.004)				
Property Rights			0.425** (0.165)			
Economic Freedom Index				0.145*** (0.038)		
Concentration Ratio (4)					-0.686*** (0.175)	
Herfindahl-Hirschman Index						-0.389*** (0.118)
Other Controls	Log(Income), Log(Trade Openness), Legal Origin Dummies					
Constant	-1.283*** (0.264)	-1.456*** (0.298)	-1.309*** (0.316)	-1.018*** (0.285)	-0.405 (0.416)	-0.977** (0.380)
Observations	90	93	93	88	93	93
$R^2$	0.71	0.71	0.72	0.74	0.74	0.72

Robust standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at the 1%, 5% and 10% level. Variables are averaged over the period 1970-2007. The measure of financial development (*FD*) is private credit to GDP. *EFNX* is the external finance need of exports, which is calculated using inventories to sales. Log(Income) is the log of real GDP per capita, and Log(Trade Openness) is the log of total trade to GDP (both from Penn World Tables). The legal origin dummies come from La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998). The quality of institutions is measured by the Polity IV index (Marshall, Jaggers and Gurr 2011), government size (government consumption spending to GDP, Penn World Tables), the property rights index by the Heritage Foundation as well as the Economic Freedom of the World Index (Gwartney, Lawson and Hall 2012). Export concentration is measured by the concentration ratio, which sums up the export share of the four largest export sectors, as well as the Herfindahl-Hirschman Index, which sums up the square of export shares of all export sectors.

Table 7

## 6 Conclusion

This paper argues that natural resource abundance might weaken a country's financial system. Since finance is considered to be important for economic growth, we can, therefore, say that the natural resource curse, *inter alia*, operates through a financial channel. I find a significant negative link between resource abundance and financial development, which confirms previous results found by the literature. This empirical result continues to hold when the endogenous export share of resources as a measure of resource abundance is replaced by more exogenous measures of pure subsoil wealth.

Furthermore, the paper seeks to offer an explanation for this negative relationship between resources and finance. It assumes that a country's financial development is in part shaped by the external credit demand of its industry. According to the finance literature, sectors systematically differ in their dependence on the financial system due to technological characteristics in the production process. In particular, resource sectors appear to be financially independent when external dependence is calculated with inventories to sales, a measure that captures short-term dependence. Thus, resource-based economies are expected to have lower aggregate credit demand. In case short-term credit demand influences financial development, there would be good reason to believe that the resource curse operates through this channel.

The hypothesis is tested with OLS regressions in a cross section of countries and in a panel specification with time and country fixed effects that additionally exploits the time variation in the variables. Furthermore, I estimate a 2SLS regression where aggregate credit demand is predicted using a gravity estimation with exogenous geographic determinants in order to overcome the endogeneity problem.

In a cross section of 93 (110) countries with averages from 1970 to 2007 (1992 to 2007), external finance need of exports ( $EFNX$ ), the proxy for an economy's aggregate credit demand, is positively related to the level of financial development. This result is supported by the instrumentation strategy. When estimating panel specifications with similar samples, the opposite is true.  $EFNX$  calculated with inventories to sales appears not to be significant. The results are robust to the variation of financial development measures, and robust to the inclusion of different control variables such as GDP per capita and trade openness.

Thus, in the cross section, there is evidence for a resource curse to operate via a demand-

side effect in the financial system. In contrast, the panel analysis does not support this hypothesis. This points to important omitted variables in the cross section. While the consideration of a country's institutional quality does not alter the results, external finance need of exports is insignificant in all specifications when export concentration is included. This contradicts the main hypothesis and indicates that export concentration rather than credit demand explains the negative link between resources and finance.

Further research on the financial channel of the resource curse should concentrate on alternative explanations emphasizing the supply side of the financial system. Suggested theories such as interest groups preventing reforms and volatility of commodity prices will have to be explored in more detail. In particular, explanations linked to export concentration and to a lack of economic diversity seem to provide an answer.

## 7 Appendix

External Dependence  
Ranking of Sectors

RZ-type Measure (1)	Inventories to Sales (2)
Tobacco	<b>Crude petroleum and natural gas</b>
Footwear	Printing and publishing
Furniture	<b>Coal mining</b>
Printing and publishing	<b>Petroleum refineries</b>
Metal products	Beverages
Wood products	Drugs
Apparel	Industrial chemicals
Textile	Wood products
Paper and products	Furniture
Other chemicals	Paper and products
Machinery	Food products
Food products	Plastic products
<b>Petroleum refineries</b>	Motor vehicles
Iron and steel	Nonmetal products
Industrial chemicals	Office and computing
Plastic products	Other chemicals
Electric machinery	Metal products
<b>Other mining</b>	<b>Other mining</b>
<b>Coal mining</b>	Nonferrous metal
Motor vehicles	Rubber products
Nonferrous metal	<b>Metal ore mining</b>
Transportation equipment	Iron and steel
Nonmetal products	Textile
Rubber products	Communication equipment
Beverages	Other industries
Communication equipment	Apparel
Other industries	Tobacco
Professional goods	Transportation equipment
<b>Crude petroleum and natural gas</b>	Petroleum and coal products
Office and computing	Machinery
<b>Metal ore mining</b>	Electric machinery
Petroleum and coal products	Professional goods
Drugs	Footwear

The table reports the ranking of natural resource and manufacturing sectors for both measures of financial dependence (in ascending order). (1) The *RZ-type measure* is calculated as  $(CAPX_t - OANCF_t)/CAPX_t$  where  $CAPX$  denotes capital expenditures and  $OANCF$  net cash flow from operative activities (in Compustat mnemonics). (2) The ratio of *inventories to sales* is calculated as  $INVT/SALE$ . Sector classification is ISIC Rev.2. See Hattendorff (2012).

Table 8

Financial Development and Resource Abundance  
 OLS Cross Section, Averages, 1992-2007

	(1)	(2)	(3)	(4)	(5)
Dep. Var. (FD)	Pr.Credit/GDP	Pr.Credit/GDP	Pr.Credit/GDP	Stock Market Trade Value/GDP	Stock Market Turnover/GDP
Resource Abundance Measure	Export Share of Resources	Subsoil Wealth p.c.	Subsoil in Total Wealth	Export Share of Resources	Export Share of Resources
Resource Abundance	-0.302*** (0.090)	-1 * 10 <sup>-5</sup> ** (4.3*10 <sup>-6</sup> )	-0.260** (0.118)	-0.337*** (0.116)	-0.532*** (0.162)
Other Controls	Log(Income), Log(Trade Openness), Legal Origin Dummies				
Constant	-1.294*** (0.330)	-1.495*** (0.349)	-1.508*** (0.323)	-0.707 (0.497)	0.784 (0.659)
Observations	84	84	84	71	71
R <sup>2</sup>	0.71	0.70	0.71	0.49	0.41

Robust standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at the 1%, 5% and 10% level. Variables are averaged over the period 1992-2007. The resource abundance measure is varied using the export share of resources (1, 4 and 5), subsoil wealth per capita (2) and subsoil in total wealth (3). Selected measures of financial development (*FD*) are private credit to GDP (1 to 3), the stock market trade value (4) and the stock market turnover to GDP (5). Log(Income) is the log of real GDP per capita, and Log(Trade Openness) is the log of total trade to GDP (both from Penn World Tables). The legal origin dummies come from La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998).

Table 9

Gravity Approach  
Sector-level Gravity Estimations, 1992-2007

Sector (ISIC Rev.2)	(1) 210	(2) 220	(3) 230	(4) 290	(5) 311	(6) 313	(7) 314	(8) 321	(9) 322
Dep. Var.	Log of bilateral exports to GDP $LogEXP_{icd}$								
$ldist_{cd}$	-1.031*** (0.203)	-1.921*** (0.190)	-0.865*** (0.162)	-1.564*** (0.077)	-1.496*** (0.061)	-1.171*** (0.075)	-1.452*** (0.094)	-1.677*** (0.057)	-1.998*** (0.072)
$lpop_c$	-1.602*** (0.138)	-1.243*** (0.170)	-0.473*** (0.118)	0.242*** (0.058)	-0.190*** (0.047)	-0.217*** (0.059)	-0.409*** (0.083)	0.356*** (0.044)	0.592*** (0.056)
$larea_c$	1.330*** (0.163)	1.021*** (0.151)	0.124 (0.141)	-0.032 (0.062)	0.045 (0.047)	-0.238*** (0.057)	0.071 (0.077)	-0.318*** (0.044)	-0.490*** (0.056)
$lpop_d$	0.613*** (0.174)	0.435*** (0.154)	0.800*** (0.123)	0.849*** (0.059)	0.527*** (0.044)	0.151*** (0.056)	-0.041 (0.073)	0.687*** (0.041)	0.458*** (0.053)
$larea_d$	-0.081 (0.172)	0.258* (0.151)	-0.002 (0.117)	0.071 (0.056)	0.126*** (0.042)	0.276*** (0.053)	0.278*** (0.071)	0.193*** (0.039)	0.323*** (0.049)
$landlocked_{cd}$	-0.485 (0.892)	-2.183*** (0.702)	-1.052** (0.476)	-1.133*** (0.203)	-1.602*** (0.140)	-0.761*** (0.175)	-0.580** (0.276)	-1.235*** (0.122)	-0.904*** (0.160)
$border_{cd}$	8.917 (5.748)	17.822*** (6.278)	3.409 (5.775)	-2.687 (3.486)	5.394* (3.056)	6.477* (3.598)	6.223* (3.585)	-2.598 (2.856)	0.287* (3.545)
$border_{cd} * ldist_{cd}$	0.040 (0.984)	0.756 (1.258)	-0.907 (1.000)	-0.052 (0.643)	0.924 (0.564)	0.583 (0.662)	0.344 (0.660)	1.247** (0.528)	0.810 (0.654)
$border_{cd} * pop_c$	0.569 (0.604)	0.422 (0.765)	-0.059 (0.690)	-1.200*** (0.428)	0.258 (0.381)	-0.082 (0.447)	0.268 (0.448)	-0.556 (0.356)	-0.701 (0.441)
$border_{cd} * area_c$	-0.349 (0.610)	-1.113 (0.770)	0.291 (0.694)	1.024** (0.433)	-0.794** (0.391)	-0.405 (0.460)	-0.605 (0.471)	-0.132 (0.366)	-0.105 (0.454)
$border_{cd} * pop_d$	0.824 (0.597)	0.073 (0.742)	0.236 (0.587)	0.452 (0.372)	-0.260 (0.332)	0.012 (0.391)	-0.135 (0.392)	0.214 (0.311)	-0.232 (0.386)
$border_{cd} * area_d$	-0.747 (0.675)	-0.791 (0.770)	-0.044 (0.613)	-0.522 (0.400)	-0.020 (0.354)	-0.287 (0.415)	-0.024 (0.423)	-0.074 (0.331)	-0.041 (0.410)
$border_{cd} * landl_{cd}$	0.569 (1.284)	-0.253 (1.342)	0.596 (1.126)	1.722** (0.749)	1.350** (0.637)	0.860 (0.750)	-0.843 (0.773)	1.560*** (0.594)	1.154 (0.738)
$lsubsoilintotalwealth_c$	-0.149 (0.095)	-0.099 (0.076)	-0.259*** (0.067)	0.002 (0.029)	0.016 (0.021)	-0.160*** (0.027)	-0.039 (0.020)	-0.049** (0.020)	0.117*** (0.026)
$lsubsoilintotalwealth_d$	-0.054 (0.069)	-0.238*** (0.066)	-0.237*** (0.054)	-0.187*** (0.025)	-0.163*** (0.194)	-0.207*** (0.025)	-0.121*** (0.032)	-0.199*** (0.018)	-0.319*** (0.023)
Constant	-14.86*** (3.126)	-8.785*** (2.701)	-5.383** (2.462)	-0.246 (1.092)	-0.149 (0.829)	-2.044** (1.022)	-1.884 (1.312)	3.504*** (0.779)	6.079*** (0.987)
Observations	350	631	834	1749	2403	2101	1221	2442	2286
$R^2$	0.39	0.29	0.24	0.40	0.40	0.31	0.32	0.50	0.44

Standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at the 1%, 5% and 10% level. Variables are averaged over the period 1992-2007. Each column shows the results of a sector-level gravity estimation. The left-hand side variable  $LogEXP_{icd}$  denotes the log of exports from country  $c$  to  $d$  relative to GDP in industry  $i$ . The geographical variables at the right-hand side include the log of bilateral distance between the two countries major cities  $ldist_{cd}$ , the log of country  $c$ 's population  $lpop_c$ , the log of its land area  $larea_c$  and both variables for trade partner  $d$ , respectively. The dummy variable  $landlocked_{cd}$  indicates whether none, one or both of the countries are landlocked by taking the value of zero, one or two.  $border_{cd}$  is a common-border dummy. The following variables are interaction terms with  $border_{cd}$ .  $lsubsoilintotalwealth$  is the log of subsoil wealth in total wealth for both the exporter and importer.

Table 10

Gravity Approach  
Sector-level Gravity Estimations, 1992-2007

Sector (ISIC Rev.2)	(10) 324	(11) 331	(12) 332	(13) 341	(14) 342	(15) 351	(16) 352	(17) 3522	(18) 353
Dep. Var.	Log of bilateral exports to GDP $LogEXP_{icd}$								
$ldist_{cd}$	-1.783*** (0.075)	-1.843*** (0.068)	-1.527*** (0.072)	-1.974*** (0.064)	-1.750*** (0.065)	-1.432*** (0.053)	-1.610*** (0.061)	-1.290*** (0.065)	-1.573*** (0.086)
$lpop_c$	0.437*** (0.058)	-0.063 (0.052)	0.291*** (0.056)	-0.140*** (0.049)	0.674*** (0.050)	0.154*** (0.041)	0.257*** (0.047)	0.191*** (0.050)	-0.117* (0.068)
$larea_c$	-0.394*** (0.059)	0.133** (0.053)	-0.152*** (0.057)	0.144*** (0.048)	-0.481*** (0.049)	-0.351*** (0.039)	-0.400*** (0.046)	-0.403*** (0.052)	-0.553*** (0.062)
$lpop_d$	0.345*** (0.056)	0.635*** (0.051)	0.397*** (0.055)	0.846*** (0.046)	0.586*** (0.048)	0.963*** (0.039)	0.701*** (0.045)	0.707*** (0.048)	0.608*** (0.067)
$larea_d$	0.329*** (0.053)	0.156*** (0.047)	0.286*** (0.052)	0.046 (0.044)	0.255*** (0.045)	0.133*** (0.037)	0.146*** (0.042)	0.120*** (0.045)	0.249*** (0.064)
$landlocked_{cd}$	-1.197*** (0.171)	1.024*** (0.159)	-0.685*** (0.168)	-1.016*** (0.143)	-1.111*** (0.144)	1.453*** (0.115)	-1.292*** (0.134)	-0.752*** (0.142)	-1.856*** (0.227)
$border_{cd}$	-0.163 (3.373)	3.672 (3.260)	5.390 (3.337)	-1.204 (3.135)	-4.523 (3.229)	-1.647 (2.681)	-4.488 (3.061)	0.086 (3.480)	-0.789 (3.864)
$border_{cd} * ldist_{cd}$	0.999 (0.616)	1.398** (0.601)	0.439 (0.616)	0.972* (0.578)	0.665 (0.596)	0.405 (0.495)	0.717 (0.565)	0.302 (0.631)	-0.322 (0.712)
$border_{cd} * pop_c$	-0.290 (0.416)	-0.456 (0.405)	-0.197 (0.418)	-0.662* (0.390)	-1.185*** (0.402)	-0.668** (0.334)	-0.751** (0.381)	-0.123 (0.416)	-0.533 (0.480)
$border_{cd} * area_c$	-0.472 (0.426)	-0.279 (0.417)	-0.502 (0.428)	0.303 (0.401)	0.753* (0.413)	0.372 (0.343)	0.256 (0.392)	-0.129 (0.433)	0.546 (0.480)
$border_{cd} * pop_d$	-0.710** (0.363)	-0.060 (0.354)	-0.461 (0.370)	-0.116 (0.341)	0.209 (0.351)	-0.295 (0.292)	-0.277 (0.333)	-0.577 (0.415)	0.266 (0.415)
$border_{cd} * area_d$	0.334 (0.385)	-0.533 (0.377)	0.098 (0.391)	-0.494 (0.363)	-0.406 (0.374)	-0.138 (0.310)	0.058 (0.354)	0.187 (0.392)	-0.193 (0.447)
$border_{cd} * landl_{cd}$	1.499** (0.696)	0.911 (0.680)	1.479** (0.696)	1.421** (0.653)	1.628** (0.672)	1.628*** (0.557)	1.549** (0.637)	0.818 (0.682)	2.119*** (0.794)
$lsubsoilintotalwealth_c$	-0.010 (0.028)	0.111*** (0.024)	0.048* (0.027)	-0.152*** (0.022)	-0.264 (0.023)	0.037** (0.018)	-0.157*** (0.021)	-0.013 (0.024)	0.186*** (0.028)
$lsubsoilintotalwealth_d$	-0.240*** (0.024)	-0.225*** (0.022)	-0.234*** (0.023)	-0.098*** (0.020)	-0.182*** (0.021)	-0.167*** (0.017)	-0.122*** (0.020)	-0.119*** (0.021)	-0.158*** (0.029)
Constant	3.776*** (1.034)	0.471 (0.933)	-2.206** (1.006)	2.192** (0.866)	2.208** (0.887)	3.703*** (0.718)	4.689*** (0.829)	2.967*** (0.918)	5.415*** (1.168)
Observations	1853	2173	1967	2304	2339	2477	2384	2145	1643
$R^2$	0.41	0.44	0.35	0.49	0.46	0.56	0.48	0.39	0.44

Standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at the 1%, 5% and 10% level. Variables are averaged over the period 1992-2007. Each column shows the results of a sector-level gravity estimation. The left-hand side variable  $LogEXP_{icd}$  denotes the log of exports from country  $c$  to  $d$  relative to GDP in industry  $i$ . The geographical variables at the right-hand side include the log of bilateral distance between the two countries major cities  $ldist_{cd}$ , the log of country  $c$ 's population  $lpop_c$ , the log of its land area  $larea_c$  and both variables for trade partner  $d$ , respectively. The dummy variable  $landlocked_{cd}$  indicates whether none, one or both of the countries are landlocked by taking the value of zero, one or two.  $border_{cd}$  is a common-border dummy. The following variables are interaction terms with  $border_{cd}$ .  $lsubsoilintotalwealth$  is the log of subsoil wealth in total wealth for both the exporter and importer.

Table 11

Gravity Approach  
Sector-level Gravity Estimations, 1992-2007

Sector (ISIC Rev.2)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
	354	355	356 <sup>a</sup>	369	371	372	381	382	3825
Dep. Var.	Log of bilateral exports to GDP $LogEXP_{icd}$								
$ldist_{cd}$	-0.436*** (0.167)	-1.489*** (0.060)		-1.617*** (0.063)	-1.688*** (0.062)	-1.571*** (0.074)	-1.786*** (0.058)	-1.364*** (0.051)	-1.545*** (0.066)
$lpop_c$	-0.981*** (0.134)	0.476*** (0.045)		0.438*** (0.049)	0.013 (0.048)	-0.242*** (0.057)	0.491*** (0.045)	0.147*** (0.039)	-0.165*** (0.049)
$larea_c$	0.249* (0.127)	-0.463*** (0.045)		-0.237*** (0.049)	-0.098** (0.046)	0.037 (0.059)	-0.357*** (0.044)	-0.170*** (0.038)	-0.195*** (0.050)
$lpop_d$	0.168 (0.142)	0.461*** (0.044)		0.538*** (0.046)	0.768*** (0.045)	1.042*** (0.055)	0.593*** (0.042)	0.719*** (0.036)	0.693*** (0.048)
$larea_d$	0.178 (0.140)	0.305*** (0.041)		0.208*** (0.044)	0.124*** (0.042)	0.092* (0.052)	0.200*** (0.040)	0.180*** (0.035)	0.219*** (0.046)
$landlocked_{cd}$	-1.527** (0.660)	-1.099*** (0.132)		-0.978*** (0.144)	-2.123*** (0.140)	-1.461*** (0.174)	-1.538*** (0.126)	-1.418*** (0.109)	-0.865*** (0.141)
$border_{cd}$	0.849 (5.047)	-2.089 (2.904)		-0.596 (3.030)	-1.343 (3.052)	2.683 (3.508)	-3.964 (2.961)	-2.308 (2.614)	1.926 (3.209)
$border_{cd} * ldist_{cd}$	-1.500 (0.957)	0.670 (0.551)		1.139** (0.559)	0.637 (0.563)	0.934 (0.646)	0.954* (0.547)	0.939* (0.483)	0.714 (0.613)
$border_{cd} * pop_c$	0.720 (0.604)	-0.752** (0.363)		-0.490 (0.377)	-0.716* (0.380)	-0.605 (0.436)	-0.826** (0.369)	-0.471 (0.303)	-0.409 (0.401)
$border_{cd} * area_c$	-0.190 (0.635)	0.186 (0.382)		-0.101 (0.387)	0.134 (0.391)	-0.150 (0.448)	0.241 (0.379)	0.016 (0.335)	-0.283 (0.425)
$border_{cd} * pop_d$	0.007 (0.600)	-0.100 (0.320)		-0.327 (0.329)	-0.119 (0.332)	0.043 (0.381)	-0.263 (0.322)	-0.387 (0.285)	-0.084 (0.355)
$border_{cd} * area_d$	0.729 (0.601)	-0.070 (0.346)		-0.156 (0.350)	-0.101 (0.353)	-0.302 (0.405)	-0.103 (0.343)	-0.058 (0.303)	-0.059 (0.384)
$border_{cd} * landl_{cd}$	1.902* (1.151)	1.337** (0.604)		1.330** (0.632)	2.362*** (0.636)	1.236* (0.732)	1.849*** (0.616)	1.756*** (0.543)	1.347** (0.667)
$lsubsoiltotalwealth_c$	0.245*** (0.062)	-0.126*** (0.021)		-0.124*** (0.023)	-0.022 (0.021)	0.052* (0.028)	0.040** (0.020)	-0.117*** (0.017)	-0.009 (0.024)
$lsubsoiltotalwealth_d$	-0.104* (0.060)	-0.133*** (0.019)		-0.158*** (0.020)	-0.083*** (0.020)	-0.256*** (0.024)	-0.134*** (0.019)	-0.061*** (0.016)	-0.197*** (0.021)
Constant	-6.939*** (2.381)	2.405*** (0.808)		-0.128 (0.863)	3.182*** (0.837)	0.126 (1.049)	5.460*** (0.792)	0.085 (0.689)	2.912*** (0.898)
Observations	612	2217		2183	2303	2172	2466	2542	2201
$R^2$	0.19	0.46		0.42	0.48	0.47	0.48	0.50	0.46

Standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at the 1%, 5% and 10% level. Variables are averaged over the period 1992-2007. Each column shows the results of a sector-level gravity estimation. The left-hand side variable  $LogEXP_{icd}$  denotes the log of exports from country  $c$  to  $d$  relative to GDP in industry  $i$ . The geographical variables at the right-hand side include the log of bilateral distance between the two countries major cities  $ldist_{cd}$ , the log of country  $c$ 's population  $lpop_c$ , the log of its land area  $larea_c$  and both variables for trade partner  $d$ , respectively. The dummy variable  $landlocked_{cd}$  indicates whether none, one or both of the countries are landlocked by taking the value of zero, one or two.  $border_{cd}$  is a common-border dummy. The following variables are interaction terms with  $border_{cd}$ .  $lsubsoiltotalwealth$  is the log of subsoil wealth in total wealth for both the exporter and importer. <sup>a</sup> The plastic products sector (356) must be dropped due to inconsistencies in the matching of sector classifications ISIC Rev. 2 and 3 for sectoral GDP data.

Table 12



Gravity Approach  
Sector-level Gravity Estimations, 1992-2007

Sector (ISIC Rev.2)	(28)	(29)	(30)	(31)	(32)	(33)
	383	3832	384	3843	385	390
Dep. Var.	Log of bilateral exports to GDP $LogEXP_{icd}$					
$ldist_{cd}$	-1.557*** (0.058)	-1.511*** (0.067)	-1.232*** (0.071)	-1.524*** (0.060)	-1.252*** (0.061)	-1.480*** (0.066)
$lpop_c$	0.188*** (0.044)	-0.107** (0.051)	0.219*** (0.054)	0.222*** (0.046)	0.086* (0.046)	0.302*** (0.051)
$larea_c$	-0.165*** (0.044)	-0.183*** (0.051)	-0.266*** (0.053)	-0.397*** (0.046)	-0.073 (0.048)	-0.407*** (0.051)
$lpop_d$	0.848*** (0.042)	0.688*** (0.049)	0.720*** (0.052)	0.477*** (0.044)	0.792*** (0.044)	0.668*** (0.049)
$larea_d$	0.091** (0.040)	0.211*** (0.047)	0.147*** (0.050)	0.258*** (0.042)	0.158*** (0.042)	0.235*** (0.046)
$landlocked_{cd}$	-1.182*** (0.125)	-1.355*** (0.145)	-0.653*** (0.163)	-1.206*** (0.132)	-1.101*** (0.132)	-1.323*** (0.149)
$border_{cd}$	-4.490 (2.929)	-1.379 (3.326)	-0.373 (3.445)	-1.371 (2.987)	-2.089 (3.040)	-0.524 (3.302)
$border_{cd} * ldist_{cd}$	0.810 (0.541)	0.890 (0.614)	0.136 (0.635)	-1.051* (0.551)	0.821 (0.561)	0.686 (0.610)
$border_{cd} * pop_c$	-0.664* (0.365)	-0.385 (0.414)	-0.874** (0.429)	-0.898** (0.372)	-0.537 (0.379)	-0.409 (0.411)
$border_{cd} * area_c$	0.199 (0.375)	-0.142 (0.426)	0.467 (0.441)	-0.009 (0.382)	0.041 (0.389)	-0.061 (0.423)
$border_{cd} * pop_d$	-0.368 (0.319)	-0.072 (0.362)	0.235 (0.375)	-0.055 (0.325)	-0.294 (0.331)	-0.360 (0.359)
$border_{cd} * area_d$	0.026 (0.339)	-0.053 (0.385)	-0.281 (0.398)	-0.103 (0.346)	-0.026 (0.352)	0.013 (0.382)
$border_{cd} * landl_{cd}$	1.581*** (0.609)	1.392** (0.691)	1.433** (0.718)	1.003 (0.621)	1.656*** (0.632)	1.462** (0.688)
$lsubsoilintotalwealth_c$	-0.198*** (0.020)	0.068*** (0.024)	0.047* (0.025)	-0.128*** (0.021)	-0.068*** (0.023)	-0.040* (0.024)
$lsubsoilintotalwealth_d$	0.116*** (0.019)	-0.189*** (0.022)	-0.126*** (0.023)	-0.161*** (0.019)	-0.147*** (0.019)	-0.214*** (0.021)
Constant	2.011** (0.789)	2.219** (0.920)	0.763 (0.959)	2.719*** (0.822)	-1.717** (0.855)	2.707*** (0.909)
Observations	2437	2294	2207	2324	2371	2355
$R^2$	0.49	0.42	0.33	0.46	0.42	0.42

Standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at the 1%, 5% and 10% level. Variables are averaged over the period 1992-2007. Each column shows the results of a sector-level gravity estimation. The left-hand side variable  $LogEXP_{icd}$  denotes the log of exports from country  $c$  to  $d$  relative to GDP in industry  $i$ . The geographical variables at the right-hand side include the log of bilateral distance between the two countries major cities  $ldist_{cd}$ , the log of country  $c$ 's population  $lpop_c$ , the log of its land area  $larea_c$  and both variables for trade partner  $d$ , respectively. The dummy variable  $landlocked_{cd}$  indicates whether none, one or both of the countries are landlocked by taking the value of zero, one or two.  $border_{cd}$  is a common-border dummy. The following variables are interaction terms with  $border_{cd}$ .  $lsubsoilintotalwealth$  is the log of subsoil wealth in total wealth for both the exporter and importer.

Table 13

List of Countries

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Sample 1970-2007

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Algeria	Egypt	Kenya	Rwanda
Argentina	El Salvador	Republic of Korea (IV)	Saudi Arabia
Australia (IV)	Ethiopia	Kuwait	Senegal
Austria (IV)	Finland (IV)	Madagascar	Sierra Leone
Bahrain	France (IV)	Malawi	Singapore
Bangladesh	Gabon	Malaysia	South Africa (IV)
Belgium and Lux. (IV)	Gambia	Mexico (IV)	Spain (IV)
Bolivia	Germany (IV)	Morocco	Sri Lanka
Brazil (IV)	Ghana	Nepal	Sudan
Burkina Faso	Greece (IV)	Netherlands (IV)	Sweden (IV)
Burundi	Guatemala	New Zealand	Switzerland and Liecht.
Cameroon	Haiti	Nicaragua*	Syria
Canada	Honduras	Niger	Thailand
Central African Rep.	Hungary	Nigeria	Togo
Chile	Iceland	Norway (IV)	Trinidad and Tob. (IV)
China*	India (IV)	Pakistan	Tunisia
China (Hongkong)	Indonesia	Panama	Turkey (IV)
Colombia	Iran (IV)	Papua New Guinea	United Kingdom (IV)
Congo	Ireland (IV)	Paraguay	United States
Costa Rica	Israel	Peru (IV)	Uganda
Côte d'Ivoire	Italy (IV)	Philippines	Uruguay
Denmark (IV)	Jamaica	Poland	Venezuela
Dominican Republic	Japan (IV)	Portugal (IV)	Zambia
Ecuador (IV)	Jordan	Romania (IV)	Zimbabwe*

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Sample 1992-2007, Additional Countries

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Albania	Estonia (IV)	Latvia	Russia (IV)
Armenia	Georgia (IV)	Lithuania	Slovakia
Bulgaria (IV)	Hungary (IV)	TFYR Macedonia	Slovenia
Czech Republic	Kazakhstan	Republic of Moldova	
Croatia	Kyrgyzstan	Mongolia	

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The exact number of countries included in the regressions depends on the data available and may vary. (IV) indicates that the country is included in the instrumentation strategy, which exploits the time period 1992-2007. \*Not included in basic regressions with private credit to GDP.

Table 14

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