DO NATURAL RESOURCES ATTRACT NONRESOURCE FDI?

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Abstract—A new and extensive panel of outward nonresource and resource FDI is used to investigate the effect of natural resources on the different components of FDI. Our main findings are as follows. First, for countries which were not a resource producer before, a resource discovery causes nonresource FDI to fall 16% in the short run and by 68% in the long run. Second, for countries that were already a resource producer, a doubling of resource rents induces a 12.4% fall in nonresource FDI. Third, on average, the contraction in nonresource FDI outweighs the boom in resource FDI. Aggregate FDI falls by 4% if the resource bonanza is doubled. Finally, these negative effects on nonresource FDI are amplified through the positive spatial lags in nonresource FDI. We also find that resource FDI is vertical, whereas nonresource FDI is of the export-fragmentation variety. Our main findings are robust to different measures of resource reserves and the oil price and to allowing sample selection bias.

I. Introduction

FOREIGN direct investment (FDI) is an important driver of technology transfer, economic growth, and development, but many resource-rich countries do not attract as much FDI as resource-poor countries do. In this light, it is surprising that there is no research available on the effects of natural resources on both the composition and volume of FDI. In line with the resource curse literature that documents adverse effects of natural resources on growth performance,[1] war and conflict,[2] and social conditions,[3] one might expect a negative effect of natural resource endowments on nonresource FDI. Natural resources are often extracted by foreign multinationals that bring in capital and knowledge. However, resource FDI is very capital intensive, and we conjecture that it leads to fewer spillover effects into the nonresource sectors of the host economy because it relies less on local subcontractors or suppliers. The reallocation of factors of production may even cause resources to depress nonresource FDI. Since nonresource FDI promises more scope for spillover effects, it is more attractive for receiving countries. If natural resources indeed crowd out nonresource FDI, then this is an additional channel through which natural resource abundance can be a drag on economic development.

Our main objective is to assess the importance of subsoil assets as a determinant of resource and nonresource FDI. We deal with the thorny econometric issue that standard gravity equation errors in a panel are heteroskedastic by allowing FDI to be $I(1)$ and estimating various co-integrating relationships to arrive at a satisfactory error-correction-mechanism specification with spatial lags. Our main findings are as follows. First, for countries that were not a resource producer before, a resource discovery causes nonresource FDI to fall by 16% in the short run and 68% in the long run. Second, for countries that were already a resource producer, a doubling of resource rents induces a 12.4% fall in nonresource FDI. Third, on average, the contraction in nonresource FDI outweighs the boom in resource FDI. Aggregate FDI falls by 4% if the resource bonanza is doubled. Finally, these negative effects on nonresource FDI are amplified through the positive spatial lags in nonresource FDI. Third-country effects, motivated by multinationals' complex production chains, thus extend the negative impact of resource abundance on nonresource FDI to neighboring countries.

Our results also indicate that controlling for host market potential, population size, distance, quality of institutions, trade openness, and so on, nonresource FDI is mostly of the complex-vertical fragmentation variety, as indicated by the positive effect of surrounding FDI—the spatial lag—and a

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[1] The resource curse states that natural resource exports harm growth prospects, even after controlling for the effects of initial income per capita, human capital, investments, trade openness, and institutional quality on economic growth (Sachs & Warner, 1997). However, in countries with good institutions, the curse is turned into a blessing, whereas in countries with a bad rule of law natural resource dependence harms growth prospects (Mehlum, Moene, & Torvik, 2006). The curse is most severe for more easily appropriable resources such as oil, gas, gold, or diamonds (Boschini, Pettersson, & Roine, 2007). Furthermore, commodity prices are notoriously volatile and contribute to the resource curse so that a well-developed financial system helps to turn the curse into a blessing (van der Ploeg & Poelhekke, 2009). If natural resource exports are instrumented by natural resource abundance, as measured by the World Bank (1997) estimates of subsoil assets, and institutional and constitutional variables, the resource curse turns out to be a red herring, while resource abundance has a significant positive effect on growth (Brunnschweiler & Bulte, 2008). Resources do, however, have a negative impact on growth performance via volatility (van der Ploeg & Poelhekke, 2010). Detailed data for Brazilian municipalities show no evidence for an effect of oil discovery and exploitation on nonoil GDP (Caselli & Michaels, 2008).

[2] Cross-country evidence suggests that natural resources fuel war and conflict (Collier & Hoeffler, 1998, 2004, 2005; Reynal-Querol, 2002; Ross, 2004; Ron, 2005; Fearon, 2005). Once natural resource dependence is instrumented for, this effect disappears, but resource abundance is associated with a reduced probability of the onset of war and conflict increases dependence on natural resources (Brunnschweiler & Bulte, 2009). Detailed evidence for Colombia suggest that increases in the price of capital-intensive commodities like oil lower wages and fuel conflict, whereas increases in the price of labor-intensive commodities such as coffee or banana boost wages and dampen conflict (Dube & Vargas, 2007).

[3] For example, exploiting variations in world commodity prices to identify resource booms, panel data evidence for ninety countries between 1965 and 1999 suggest that inequality falls immediately after a boom and then gradually returns to its original level (Goderis & Malone, 2011). A detailed survey is given in van der Ploeg (2011).

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negative effect of surrounding market potential on FDI in the host country. This is in line with earlier results for aggregate FDI (Blonigen et al., 2007; Baltagi, Bresson, & Pirotte, 2007; Poelhekke & van der Ploeg, 2009). In contrast, the spatial lag and surrounding market potential are insignificant determinants of resource FDI. This suggests that resource FDI is mostly vertical, with distance and human capital having much less effect, because extraction relies less on regional suppliers (and processing and refining is often done in home markets close to the final consumers).

Of course, there are rival stories as to why natural resource abundance results in less nonresource FDI. For example, bad institutions may play an important role. To test this rival hypothesis and tackle the problem that institutional quality and market potential in the host country may not be exogenous with respect to FDI, we provide panel estimates and include the initial value of institutional quality in every five-year period and lag market potential by one year. Since institutions are an insignificant explanatory variable of nonresource FDI, we conclude that it is natural resource abundance rather than poor institutional quality that deters FDI. We also considered the conjecture that the ruling elite of a country forms a coalition with foreign resource companies to appropriate resource rents at the expense of the people in an environment where information on resource exploration and exploitation and returns to companies and the government is not very transparent.[4] However, we could not find empirical support for the hypothesis that resource sectors attract more FDI in badly governed countries. If anything, our empirical evidence suggests that institutional quality stimulates resource FDI as then the hold-up problem for investment is less severe.

We also tackle the problem that FDI outflows to some sectors of some countries are zero. Building on the econometric literature on sample selection bias as specification error (Heckman, 1979) and the recent literature on estimating trade flows allowing for the number of trading partners (Helpman, Melitz, & Rubinstein, 2008), we provide two-stage estimates of the determinants of both the external and internal margin in FDI. We allow spatial dependence in both the selection and the volume of FDI equation. This does not alter our qualitative conclusions on the determinants of the volume of nonresource and resource FDI. However, we do find differences in the determinants of whether to locate FDI, or not, in a particular host country. For example, distance has a positive impact on the location decision but a negative impact on the volume of nonresource FDI. This suggests that setting up an affiliate in a distant country might be a substitute for international trade.

The outline of our paper is as follows. Section II specifies our econometric model and puts forward the key hypotheses we wish to test. Section III discusses the unique data set on FDI outflows from the Netherlands and also the problem of obtaining reliable data on subsoil assets. Section IV establishes that FDI is $I(1)$ and puts forward an error correction mechanism to estimate the core determinants of nonresource FDI. Section V tests whether institutional quality rather than natural resource endowments deters nonresource FDI and finds no support for this rival hypothesis. It also performs robustness tests by allowing trade openness and free trading arrangements and using detailed data on oil, gas, and coal reserves and the price of crude oil as determinants of FDI. Section VI corrects for sample selection bias by estimating the external and internal margin of FDI. Section VII estimates the determinants of resource FDI and discusses the negative impact of resource endowments on aggregate FDI. Section VIII concludes.

II. Theoretical Determinants of Resource and Nonresource FDI

We are interested in two sets of hypotheses. The first set comes from a three-sector, Scandinavian two-sector model of international trade where all capital is imported through FDI for producing tradables and resources. In that case, resource endowments or an increase in the resource price attracts resource FDI but deters nonresource FDI.[5] The negative effect on nonresource FDI might be overturned if the expansion of the domestic supply of capital is substantial enough. We will test empirically whether this effect is negative or positive. If natural resource production also requires labor, more labor would also attract more resource FDI. This labor force determinant of FDI results from an abundance of labor rather than market potential. The second set of hypotheses gives a prominent role to the signs of the effects of surrounding market potential and surrounding FDI on FDI to distinguish whether FDI is horizontal, vertical, export platform, or vertically fragmented.

These sets of hypotheses give rise to the following econometric specification:

$$f_{it}^R = \alpha_0 + \alpha_1 s_{it} + \alpha_2 q_{it} + \alpha_3 n_{it} + \boldsymbol{\alpha}_4' \mathbf{x}_{it} + \alpha_5 m_{\bar{j}t} + \alpha_6 f_{\bar{j}t}^R + \varepsilon_{it}^R, \quad \varepsilon_{it}^R - \mathrm{N}\ 0, \sigma_i^{R2} \tag{1}$$

$$f_{it}^N = \beta_0 + \beta_1 s_{it} + \beta_2 q_{it} + \beta_3 n_{it} + \boldsymbol{\beta}_4' \mathbf{x}_{it} + \beta_5 m_{\bar{j}t} + \beta_6 f_{\bar{j}t}^N + \varepsilon_{it}^N, \quad \varepsilon_{it}^N - \mathrm{N}\ 0, \sigma_i^{N2}, \tag{2}$$

where f_{it}^R and f_{it}^N denote, respectively, resource FDI and nonresource FDI going to country i at time t, s_{it} the subsoil assets of country i at time t, q_{it} the world commodity prices corresponding to the export basket of these subsoil assets in country i at time t, n_{it} the population size (a proxy for the labor force) of country i at time t, $\mathbf{x}_{it}$ the vector of other explanatory variables in country i at time t (for example,

[4] Predatory governments may induce corporations to become less transparent and less efficient, especially in industries whose profits are highly correlated with oil prices (Durnev & Guriev, 2007).

[5] An analytical explanation based on the Scandinavian two-sector model is given in online appendix 1.

income per capita, distance, institutional quality, trade openness, and host country taxation), $m_{\bar{i}t}$ and $f_{\bar{i}t}^R$, respectively, surrounding market potential and surrounding resource FDI of countries neighboring country i at time t, $f_{\bar{i}t}^N$ surrounding nonresource FDI, and ε_{it}^R and ε_{it}^N the stochastic error terms for the resource and nonresource FDI equations with zero means and variances σ_i^{R2} and σ_i^{N2}, respectively.

Based on our model, the null hypothesis for the effect of subsoil assets is $\alpha_1 > 0$ and $\beta_1 < 0$. We also expect higher world commodity prices to boost resource FDI and curb nonresource FDI, so our null hypothesis for the effect of the world price of natural resources on the two types of FDI is $\alpha_2 > 0$ and $\beta_2 < 0$. Our null hypothesis for the effect of population size is that $\alpha_3 = 0$ and $\beta_3 > 0$. However, if the resource sector uses some labor, there will be a positive effect of population size on mineral or mining FDI, $\alpha_3 > 0$. If population size also captures host market potential, it will have an extra positive impact on FDI.

As far as the second set of hypotheses is concerned, if exports to third countries are unattractive, a 0 coefficient on the spatial lag of FDI and a 0 coefficient on surrounding market potential ($\beta_5 = 0$ and $\beta_6 = 0$ for nonresource FDI) suggest evidence for horizontal FDI. Horizontal FDI allows production in multiple locations close to the market to cut trade and transportation costs, in which case the market size of the host country (captured by income per capita and population size of the host country) and distance from parent company in line with the gravity model are key determinants of FDI (Markusen, 1984, 2002). A negative coefficient on the spatial lag of FDI and a zero coefficient on surrounding market potential ($\beta_5 = 0$ and $\beta_6 < 0$) provide evidence for purely vertical FDI. Such FDI is driven by multinationals profiting from the lowest-cost destinations by chopping up their production chains into skill-intensive headquarters and R&D at home and offshoring production in countries abundant in low-skilled labor (Helpman, 1984). This applies to nonresource FDI but not to resource FDI, since the latter is determined not so much by cost advantage as by the presence of natural resources in the crust of the earth. Resource FDI is thus by nature vertical in nature.

Export platform FDI has the proximity benefits of horizontal FDI without the costs of setting up affiliates in surrounding countries (Ekholm et al., 2007; Baltagi, Egger, & Pfaffermayr, 2007). This type of FDI occurs if trade protection between destination markets is less than frictions between parent and destination countries. In that case, one expects a negative coefficient for the spatial lag on FDI and a positive one for surrounding market potential ($\beta_5 > 0$ and $\beta_6 < 0$). However, with intermediate levels of border costs between the host country and its neighbors and a large peripheral (not centrally located within the group of neighboring countries) host market, surrounding market potential may have a negative effect. With complex-vertical fragmentation FDI, we expect a positive coefficient for the spatial lag on FDI ($\beta_6 > 0$). The reason is that more suppliers, ports, and other agglomeration advantages in surrounding countries make fragmentation FDI more attractive (Yeaple, 2003). A negative effect of surrounding GDP per capita supports the border-cost hypothesis ($\beta_5 < 0$). Evidence for aggregate FDI suggests a positive coefficient on the spatial lag of FDI and a negative coefficient for surrounding market potential. This points toward complex-vertical fragmentation FDI and the border cost hypothesis (Blonigen et al., 2007). Our prior is that we expect most nonresource FDI to be of this sort.

Section IV establishes that FDI is $I(1)$, so that we will estimate an error correction version of equations (1) and (2). Because of the spatial coefficients α_6 and β_6, we estimate by ML instead of OLS (see online appendix 2).

III. Data on Outward FDI and Subsoil Assets

A. *Outward FDI Data*

We test our hypotheses with outward FDI data on investments done by multinationals in the natural resource and other sectors in as many countries as possible. Since available FDI data sets either have large gaps in them for reasons of confidentiality or do not contain much resource FDI, we use a unique data set on outward FDI from the Netherlands collected by De Nederlandsche Bank.[6] This data set benefits from all firms being legally required to report their current-account transactions, including foreign investment flows and positions collected by banks, stating the balance sheet current euro value of FDI stocks and the value of new investment flows. Aggregate FDI and disaggregated FDI data for several broad sectors and large countries are available through the central bank's website.[7] At the more detailed level of specific countries and sectors, the data are confidential and accessible by special permission. They cover 183 host countries for the years 1984 to 2002 for the whole population of affiliates of multinationals; 133 countries receive positive nonresource FDI and 100 countries positive resource FDI.[8] Five of these firms were among the 100 largest nonfinancial multinationals in the world in 2002 by foreign assets.[9] In 2007 Dutch FDI represented 5.5% of World FDI, while U.S. FDI represented 18% (UNCTAD, 2008). Due to limited data availability of regressors, we can

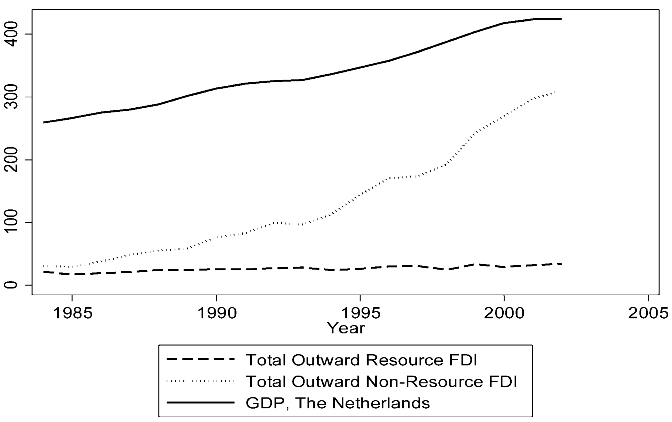
[6] For example, the largest sector sample from publicly available data on U.S. outward FDI in Blonigen et al. (2007) is services. Assuming sixteen years are available, there are at most fourteen host countries for which FDI is positive and reported, which underestimates outward U.S. FDI. For petroleum, at most nine host countries are available.

[7] See http://www.statistics.dnb.nl/index.cgi?lang=uk&todo=Balans, Table T12.6.2.

[8] Following the standard definition, an affiliate is counted as FDI if the parent company owns at least a 10% stake. A change in the way FDI was reported caused a break in 2003. Before this date, all data were reported through the banking system, since they collect balance sheet data for loan purposes and perform the actual transactions. After April 2003, a new system was introduced based on direct reporting by resident parent companies, although since then, a sample has been used based on gathering about 95% of the total value of capital stocks and flows.

[9] These are (rank; industry): Shell (6; petroleum), Unilever (36; food product), Philips (37; electrical and electronic equipment), Ahold (51; retail), and Reed Elsevier (90; publishing and printing) (UNCTAD, http://www.unctad.org/Templates/Page.asp?intItemID=2443&lang=1).

FIGURE 1.—TOTAL OUTWARD FDI



use only 1,602 of the 3,477 (19 × 183) observations. A further 358 observations are lost when taking logs of resource FDI. The natural resource sector includes extraction of oil, natural gas, and other minerals; processing industries of oil, coal, and fissionable material; and the base metal industry. Following the Eurostat classification of FDI, outward stocks are classified according to the activity of the nonresident enterprise.

We measure FDI by the value to the parent firm of investments made abroad. It makes more sense to measure FDI by sales volume of affiliate sales if FDI is horizontal, that is, if multinationals invest locally to sell in the local market. For vertical FDI, local sales may be zero, because the affiliate is a link in a longer product chain and sales are made in third or in home countries. Sales within a vertically integrated MNE are also not traded, which makes it unclear how the price is determined. The stock of FDI (book value) seems a more accurate reflection of actual investment in the resource sector and other vertical industries. For natural resource extraction, it is unlikely that extracted resources are all sold to third parties by the affiliate directly. Royal Dutch/Shell, for example, a large oil and gas company, extracts oil in one place, but then ships the oil to refineries closer to markets where actual sales are made.

Among all countries, 149 countries attracted natural resource investment, showing the wide geographical scope of our data.[10] Among the top ten of the largest destination countries for resource FDI in 2002 are the United Kingdom, Canada, Nigeria, and Brazil. The last two countries were not in the top 10 in 1984, ranking below Malaysia and Saudi Arabia. Top nonresource FDI destination countries in 2002 include the United States, Germany, Belgium, and France. China ranks a mere 31st among all countries in terms of nonresource FDI. Interestingly, total FDI to China is in our sample period less than that to Nigeria. Figure 1 shows the relative size of natural resource FDI versus nonresource FDI. Although resource FDI has declined as a share of total FDI, it amounted to $22 billion in 1984 and almost $45 billion in 2002.

Table 1 offers some stylized facts on outward FDI. About 85% to 100% of outward resource FDI consists of oil, gas, and coal, so minerals and metals constitute a relatively small fraction of resource FDI. Although total resource FDI is 72.3% of nonresource FDI in 1984, it falls substantially to 14.5% of nonresource FDI in 2002. Nonresource FDI has grown much more during this period (13.7% per year on average) than resource FDI (4% per year). Although resource FDI toward the United States has almost halved, FDI stocks toward other parts of the world, including Europe, have grown considerably.

We have also tried using the publicly available BEA data for outward U.S. FDI. Since these lack data points whose absolute value is less than $500,000 and many others that have been suppressed to avoid disclosure of data of individual companies, contain a break in 1999, and for many countries groups resource FDI under "other" categories, of the resulting sample, only about half of the observations are usable. Furthermore, the sample is a selection from countries with more than one company undertaking resource FDI. Although we find less well-determined estimates of the determinants of outward aggregate FDI for the United States for which censoring is much less severe (Blonigen et al., 2007), the results for resource and nonresource FDI are insignificant when using the U.S. Bureau of Economic Analysis (BEA) data. This is not surprising given the problems noted with the BEA data.

B. *Measuring Subsoil Assets*

To estimate equations (1) and (2), we must measure subsoil assets s_{it} with enough coverage across both countries and time. But it is difficult to estimate the value of energy and mineral resources (World Bank, 2006). First, the importance of natural resources in national accounting has only recently been recognized, and most efforts to estimate their value have been undertaken by international organizations (such as the United Nations or the World Bank). Second, there are no liquid private markets for natural resource deposits that might convey information on their value. Third, reported reserves are only those that are economically worthwhile to extract at the time of determination and thus depend on the prevalent price of resources and cost of extraction. World Bank (2006) values the stocks of hydrocarbon resources (oil, gas, and coal) using reserves data from the BP Statistical Review of World Energy and the Energy Information Administration (EIA), and the stocks of ten metals and minerals (bauxite, copper, gold, iron, ore, lead, nickel, phosphate rock, silver, tin, and zinc) for countries that report production figures. In many cases, actual reserves data are not available, in which case the World Bank makes the bold assumption that resources last another twenty years, regardless of the type or country (making reserves proportional to rents). Production costs themselves are often proxied by costs from other countries. Using these data as measure of reserves (subsoil assets) can lead to

[10] There are currently 203 de facto states in the world.

TABLE 1.—FDI OUTFLOWS (STOCKS, 2000 $MILLIONS)

Region	Total Resource FDI		Percentage of Oil and Coal Processing Industry and Oil and Gas Extraction		Total Nonresource FDI	
	1984	2002	1984	2002	1984	2002
East Asia and Pacific	624	5,095	88.1%	92.7%	1,722	18,603
Eastern Europe and Central Asia	86	1,269	100.0%	94.8%	46	8,957
Latin America and Caribbean	955	3,877	92.7%	97.9%	3,751	13,303
Middle East and North Africa	917	2,169	99.8%	99.9%	251	1,506
North America	15,016	8,006	99.2%	94.5%	9,504	74,296
South Asia	16	553	100.0%	99.2%	52	642
Sub-Saharan Africa	298	3,414	78.7%	96.4%	247	1,486
Western Europe	4,048	20,350	90.1%	84.4%	14,814	188,995
Total	21,960	44,733	90.4%	90.4%	30,387	307,509

biased results, since reserve estimates are sensitive to prices, time to depletion, the social discount rate, and extraction costs (van der Ploeg & Poelhekke, 2010).

Reserve data for nonhydrocarbon minerals have been collected by Norman (2009) for 1970 using a variety of sources. However, past production was used to infer 1970 reserves from observed reserves in 2002, so this estimate of reserves depends to a large extent on FDI used for exploration and production after 1970 and thus overestimates known reserves in 1970. Using only 1970 values would make inefficient use of the time variation in FDI.

Reserves data for oil, gas, and coal measured in tons or cubic meters are available for a broad sample of countries and years from BP and the EIA. They report economically extractable reserves and production between (at most) 1965 and 2008, but the data are internally inconsistent for many country-years.[11]

To get around these issues we adopt different strategies. The World Bank (2006) has also constructed data on rents: the value of resource exports net of production costs. We use these data as a proxy for the value of resource deposits, using that the amount of rents correlates positively and strongly with the value of reserves.[12] This means that there is enough time variation to distinguish long- and short-run effects of resource booms. Furthermore, rents depend, given the long lags in exploration investments, on past resource FDI and are thus unlikely to be endogenous, especially as rents are net of the take of exploration companies. Alternatively, we summarize the World Bank rents data into a dummy variable, taking the value 1 if rents for any of the minerals are positive and 0 else. We assume that subsoil resource levels are positive if rents are nonzero.[13] Instead of measuring the effect of changing reserve levels, we thus measure the effect of resource discovery. Such a discovery should lead to factor allocation toward the resource sector and less FDI into other sectors.[14] An added benefit is that we can allow for countries with zero reserves, since we do not have to take logs of reserve levels.

Since much resource FDI concerns the hydrocarbon sector, we can distinguish between hydrocarbons and other minerals and create two dummy variables. In additional regressions, we also show the results for taking the oil, gas, and coal reserve data from BP/EIA as given (where we convert all reserves to British thermal units and take logs). Although there may be measurement error in this variable, it allows us to distinguish between the effects of reserve quantities and their price.[15]

In general, it is difficult to deal with the measurement errors in the value of resource rents, which vary by country. Instrumental variables can be used to deal with left censoring and incidental truncation of the main explanatory variable (Wooldridge, 1995), but the rents depend mostly on whether a country has resources and on how hard it is to extract them, and both of these depend on geology and are not available for each country in our sample. The alternative of modeling measurement error and simulating data is infeasible without a good model and information on how and when data are measured. However, we do report signifi-

[11] Proven oil and gas reserves data start in 1980, and coal reserves are recorded only for 2005, while oil, gas, and coal production data start in, respectively, 1965, 1970, and 1980. These refer to reserves, "which geological and engineering data demonstrate with reasonable certainty (i.e., on the basis of successful pilot projects) to be recoverable in future years from known reservoirs under existing economic and operating conditions" (BP, 2009). For example, a country may report production during a number of years, while reporting unchanging reserve levels during that period. This implies that either as much oil was discovered as was produced or that production or reserve data, or both, are inaccurate. We might be willing to assume that reserve data are accurate if new discoveries require updating the data. An increase in the reported level of reserves should indicate new discoveries. Subtracting subsequent production data may then yield more precise reserve levels in the years where original reserve levels did not change. In some cases where reserve data show little variation over time, production is high enough to yield negative implied reserve levels, casting doubt on the assumption that new discoveries are accurately recorded.

[12] A simple regression tells us that a 1% increase in log amount of hydrocarbon reserves correlates with a 0.8% increase in the log value of hydrocarbon rents. For other minerals, we have only reserve data in 1970 from Norman (2009). In this case, the correlation with nonhydrocarbon rents in 1970 is 0.7%.

[13] We lag both variables by one year to avoid reverse causality.

[14] For some countries, rents are 0 in some years and positive in later and earlier years because of (civil) war. During such periods subsoil resources are not economically extractable, so resource FDI may well be 0 then.

[15] Assuming perfect substitutability between coal, gas, and oil, we will use the oil price as the price of BTUs.

TABLE 2.—CIPS PANEL UNIT ROOT TESTS

	(a) Intercept		(b) Intercept + Trend		(c) Intercept + First Difference	
	$CADF_i(0)$	$CADF_i(1)$	$CADF_i(0)$	$CADF_i(1)$	$CADF_i(0)$	$CADF_i(1)$
ln nonresource FDI	−1.86**	0.92	0.86	4.33	−16.23***	−3.32***
ln population	−7.01***	0.12	10.43	3.40	5.82	0.05
ln human capital	0.67	5.83	3.76	10.52	−15.20***	−1.01
ln GDP per capita ($t-1$)	4.92	5.06	2.76	2.21	−9.76***	−2.41***
ln GDP surrounding market potential	−2.66***	2.20	−3.29***	0.91	−10.46***	−0.62
Real exchange rate with NL based on GDP price level	−0.33	−0.94	1.49	1.07	−11.98***	−2.09**
Government share of GDP × 100	−1.01	0.89	0.342	1.51	−12.91***	−3.85***
ln hydrocarbon resource rents ($t-1$)	−0.91	1.97	−2.67***	0.94	−18.54***	−4.90***
ln nonresource FDI ($i-1$)	−1.56*	2.95	0.96	5.44	−11.91***	−2.55***

H0: All series are nonstationary. $N = 65$; $T \approx 16.86$. The statistics are the standardized version of the CIPS(p) statistic for an unbalanced panel. The CIPS(p) statistic is the cross-section average of the cross-sectionally augmented Dickey-Fuller test statistic ($CADF_i(p)$)). Following Pesaran (2007), extreme t values are truncated to avoid any undue influence of extreme outcomes, because t is small (10–20). ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. For the first difference of ln population, we also reject the null if we restrict the sample to a balanced panel ($N = 43$; $T = 18$; CADF(1) = −11.215***).

cant results despite the inflated standard errors resulting from measurement errors.

IV. Core Results: Determinants of Nonstationary Outward Nonresource FDI Stocks

The strong upward trend of aggregate outward FDI reported in figure 1 suggests that FDI is nonstationary. Before we can offer our core estimates, we need to deal with nonstationarity. Since FDI may be heterogeneously nonstationary at the country level, it is not enough to allow for a common deterministic trend. Recent studies that do not deal with these issues assume that each time period is independent from the next and that investment in a specific host country is independent from investments done earlier in the same host country. For example, Baltagi et al. (2007) estimate the (spatial) determinants of U.S. outward FDI stocks and affiliate sales between 1989 and 1999 using as much industry-level data as are publicly available. Although they carefully allow for third-country effects and industry-time dummies to capture industry-time specific effects common to host countries, they do not test for stationarity of FDI or other regressors. If FDIs to specific host countries trend heterogeneously, the estimated coefficients and standard errors on the pooled data are unreliable. Similarly, Blonigen et al. (2007) use the same data source on affiliate sales data over sixteen years; except for a common deterministic trend, they do not investigate the time series properties of the data. The instability created by potentially trending variables can affect the estimates as well. Carr, Markusen, and Maskus (2001) and Markusen and Maskus (2002) do not allow for cross-sectional dependence and treat each host country as an independent destination, and are thus susceptible to a similar critique. Brainard (1997) circumvents the problem of nonstationarity by limiting the analysis to cross sections, but this is less efficient than working with panels of observations.

Apart from outward FDI, human capital, GDP, and the size of the population may also be nonstationary. This need not be a problem if ε_{it} is stationary, because equations (1) and (2) then form a cointegrated relationship from which we can deduce the long-run effects on FDI. To verify whether this is the case, we test whether the independent variables have a unit root taking into account cross-sectional dependence arising from spatial effects. Such cross-sectional dependence renders standard IPS tests for a unit root (Im, Pesaran, & Shin, 2003) invalid, but CIPS unit root tests take into account general cross-sectional dependence by augmenting ADF regressions for each country with cross-section averages (Pesaran, 2007). Moreover, the standardized version of the cross-sectionally augmented Dickey-Fuller (CADF) test allows for unbalanced panels.[16] Since this test cannot accommodate gaps in the data and requires at least six time periods, we drop Afghanistan, Ghana, and Congo (for which we have fewer than six observations each) and remove gaps in the data.[17]

Before we present our panel error correction estimates, we demonstrate the presence of cointegrating relationships. Table 2 presents the results of the CADF(p) test for orders $p = 0$ and $p = 1$ and for two types of deterministic components in columns a and b. In almost all cases we cannot reject the unit root hypothesis at the 10% level. For population and surrounding market potential, we also cannot reject the null if we restrict the sample to a balanced panel. Column c performs the same tests on the first difference of every variable to test for a possible mixture of $I(1)$ and $I(2)$ variables. This time we almost always comfortably reject the null, including when we test a balanced panel of observations for the log of population. Overall, we can thus regard all variables as $I(1)$.

We now test the null of no cointegration between FDI, control variables, and resource wealth, using the residuals from equation (2) for the sample without gaps used in table 2. The regression is presented in column a of table 3. Because cross-sectional dependence is best taken care of by allowing for a spatially lagged dependent variable accord-

[16] Baltagi et al. (2007) show that if spatial dependence is present in the data, the Pesaran (2007) test performs much better than the first-generation panel unit root test, which does not take cross-sectional dependence into account. In our case this matters because we expect spatial dependence in FDI and GDP.

[17] There are thirteen gaps in the data, so we delete Bahrain and Barbados after 2000, Bolivia before 1987, Cameroon, Iran, and Kuwait after 2001, Mozambique before 1991, Rwanda after 1997, and Venezuela before 1990, affecting 55 observations in total.

TABLE 3.—DYNAMIC ESTIMATION OF THE COINTEGRATION RELATIONSHIP

Dependent Variable	(a) SAR: ln Nonresource FDI	(b) Dynamic SAR: ln Nonresource FDI
ln population	1.166***	1.132***
	(0.041)	(0.043)
ln human capital	1.562***	1.728***
	(0.163)	(0.165)
ln distance from NED (Vincenty)	−1.643***	−1.656***
	(0.100)	(0.108)
Trend	0.136***	0.128***
	(0.014)	(0.014)
ln GDP per capita ($t-1$)	1.183***	1.047***
	(0.111)	(0.109)
ln GDP surrounding market potential	−3.083***	−3.040***
	(0.221)	(0.231)
Real exchange rate with	−0.369***	−0.416***
NL based on GDP price level	(0.044)	(0.054)
Government share of GDP × 100	−0.059***	−0.065***
	(0.007)	(0.007)
ln hydrocarbon resource rents ($t-1$)	−0.142***	−0.144***
	(0.019)	(0.021)
ln nonresource FDI ($i-1$)	0.365***	0.397***
	(0.065)	(0.069)
Constant	14.581***	15.840***
	(2.411)	(2.655)
Observations	1,096	901
Log likelihood	−1,944	−1,506
Robust LM rho = 0	31.25***	29.78***
Robust LM lambda = 0	4.152**	2.501
Variance ratio	0.799	0.825

SAR = spatial autoregression. Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE 4.—COINTEGRATION TEST ON RESIDUALS OF EQUATION (2)

IPS	ADF(0) $N = 65$; $T \approx 16.86$	ADF(1) $N = 65$; $T \approx 16.86$
	−2.51***	−2.56***
LLC	ADF(0) $N = 43$; $T = 19$	ADF(1) $N = 43$; $T = 19$
	−5.52***	−4.76***

IPS: H0: All panels contain unit roots. Allows for panel specific autoregressive parameter and includes panel means. LLC: H0: Panels contain unit roots. Assumes homogenous autoregressive parameter. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

ing to the robust Lagrange multiplier (LM) tests, we test for cointegration using the standard IPS test procedure, which allows for heterogeneous autoregressive parameters.[18] The alternative LLC test (Levin, Lin, & Chu, 2002) has more power but also requires balanced data and assumes a homogeneous autoregressive parameter (Banerjee & Wagner, 2009). For completeness, we also report the results from the LLC test in table 4. The null of no cointegration is rejected at the 1% level for two augmentation orders. Hence, the variables in regression a of table 3 are cointegrating and represent a relationship that is stable over time, thus allowing us to interpret the coefficients as the long-run determinants of FDI. The estimates may nonetheless be biased because the error term ε_{it} in equation (2) may be correlated with each of the disturbances of the $I(1)$ processes belonging to each independent variable. One can correct for this correlation by including leads and lags of the first difference of the $I(1)$ independent variables in the regression—dynamic OLS or D-OLS (Kao & Chiang, 2000; Mark & Sul, 2003). Simulations in Wagner and Hlouskova (2010) suggest that D-OLS outperforms fully modified OLS (Phillips & Moon, 1999) and is least sensitive to $I(2)$ components, cross-sectional correlation and small T (say ≤ 25).

Column b in table 3 adds first-differenced leads and lags of the independent variables to equation (1). The resulting regression (not reporting the leads and lags) is very similar to column 1, even though we lose 195 observations because of the leads and lags. This confirms that equation (1) represents a stable and unbiased long-run relationship between nonresource FDI and the independent variables. We find evidence that hydrocarbon resource rents have a significant negative impact on nonresource FDI, thus confirming the main prediction entailed in section II (see online appendix 1). Furthermore, we find the usual determinants of nonresource FDI. Market potential (proxied by GDP per capita and population size) and human capital significantly attract nonresource FDI, while distance and a high implicit tax rate (proxied by the share of government spending) in the host country significantly deter it. Furthermore, we find statistically significant support for the hypothesis that given informational imperfections in globally integrated capital markets, destination countries where the currency is weak in real terms attract more FDI due to more spending power of home firms or lower nontradables costs in the destination country (Froot & Stein, 1991).

Finally, the significant negative effect of surrounding on market potential and the significant positive spatial lag of the independent variable suggest that nonresource FDI is mainly of the complex-vertical fragmentation variety (Blonigen et al., 2007). Interestingly, the positive spatial lag implies that the negative effect of resource abundance on nonresource FDI also spreads to other countries (about 40%). This increases the negative effect of resource abundance on FDI even more, as there will be fewer potential suppliers of nonresource FDI in neighboring countries.

Since equation (2) is a cointegrating relationship, we present in table 5 the estimates of both the short- and long-run dynamics of the following panel error correction model:

$$\begin{aligned}\Delta f_{it}^{N} = {} & \beta_0 + \xi[f_{i,t-1}^{N} - \beta_1 s_{i,t-1} - \beta_2 q_{i,t-1} - \beta_3 n_{i,t-1} \\ & - \boldsymbol{\beta}_4' \mathbf{x}_{i,t-1} - \beta_5 m_{\bar{j},t-1} - \beta_6 f_{\bar{j},t-1}^{N}] + \kappa_1 \Delta s_{it} \\ & + \kappa_2 \Delta q_{it} + \kappa_3 \Delta n_{it} + \boldsymbol{\kappa}_4' \Delta \mathbf{x}_{it} + \kappa_5 \Delta m_{\bar{j}t} \\ & + \kappa_6 \Delta f_{\bar{j}t}^{N} + \kappa_7 \Delta f_{i,t-1}^{N} + \upsilon_{it}^{N}, \quad \xi > 0. \qquad (2')\end{aligned}$$

The error correction coefficient ξ is significant at the 1% level which confirms convergence toward the steady state after short-term shocks (down to 10% of steady state in fifteen years for columns a and b). Still, column a indicates that few of the short-run dynamic effects κ_i are statistically significant. For example, a temporary shock in the price of natural resources leading to higher rents does not induce a statistically robust immediate decline in FDI. However, a

[18] The tests are based on a whether the general regression $\mathbf{y} = \mathbf{Xb} + \boldsymbol{\varepsilon}$ can be significantly improved by including either of the terms $\boldsymbol{\rho}\mathbf{Wy}$ or $\boldsymbol{\lambda}\mathbf{W}\boldsymbol{\varepsilon}$, robustified against the alternative of the other form. See also appendix 1 in the online appendix.

TABLE 5.—PANEL ERROR CORRECTION ESTIMATES (SAR WITH ERROR CORRECTION)

Dependent Variable: Δ(1) ln Nonresource FDI Error Correction	(a)	(b)	(c)
ln nonresource FDI ($t-1$)	−0.145***	−0.145***	−0.527***
	(0.035)	(0.031)	(0.080)
ln population ($t-1$)	0.150***	0.150***	1.985**
	(0.038)	(0.037)	(0.972)
ln human capital ($t-1$)	0.376***	0.376***	0.771**
	(0.094)	(0.094)	(0.352)
ln distance from NED (Vincenty) ($t-1$)	−0.193***	−0.193***	
	(0.067)	(0.058)	
trend ($t-1$)	0.002	0.002	2.117***
	(0.007)	(0.007)	(0.366)
ln GDP per capita ($t-2$)	0.060	0.060	0.604
	(0.046)	(0.053)	(0.372)
ln GDP surrounding market potential ($t-1$)	−0.297**	−0.297***	−0.028
	(0.122)	(0.109)	(0.483)
Real exchange rate with NL based on GDP price level ($t-1$)	−0.075***	−0.075***	0.269***
	(0.025)	(0.028)	(0.101)
Government share of GDP × 100 ($t-1$)	−0.010***	−0.010***	−0.022**
	(0.003)	(0.004)	(0.011)
ln hydrocarbon resource rents ($t-2$)	−0.020**	−0.020**	−0.082**
	(0.009)	(0.009)	(0.042)
ln nonresource FDI ($i-1, t-1$)	0.091***	0.091**	0.059
	(0.031)	(0.037)	(0.073)
Short-run dynamics			
Δ(1) ln nonresource FDI ($t-1$)	−0.009	−0.009	−0.017
	(0.029)	(0.029)	(0.045)
Δ(1) ln population	1.271*	1.271**	1.317**
	(0.738)	(0.540)	(0.525)
Δ(1) ln human capital	0.122	0.122	0.163
	(0.373)	(0.325)	(0.383)
Δ(1) ln GDP per capita ($t-1$)	0.483	0.483	0.645
	(0.548)	(0.450)	(0.536)
Δ(1) ln GDP surrounding market potential	−1.182	−1.182	−1.263*
	(0.769)	(0.809)	(0.754)
Δ(1) real exchange rate with NL based on GDP price level	0.011	0.011	0.151**
	(0.036)	(0.034)	(0.067)
Δ(1) government share of GDP × 100	0.008	0.008	−0.006
	(0.011)	(0.012)	(0.017)
Δ(1) ln hydrocarbon resource rents ($t-1$)	−0.005	−0.005	−0.051
	(0.052)	(0.050)	(0.032)
Δ(1) ln nonresource FDI ($i-1$)	0.247**	0.247	0.212**
	(0.097)	(0.244)	(0.085)
Constant	1.934*	1.934**	−34.524***
	(1.074)	(0.966)	(10.018)
Clustered standard errors		yes	
Fixed effects and heterogeneous trends ($\varepsilon_{it}^{O} = f_i + d_i t + u_{it}^{O}$)			yes
Observations	998	998	998
Log likelihood	−796.4	−796.4	−573.9
Variance ratio	0.147	0.147	0.455

Robust standard errors in parentheses unless stated otherwise. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

permanent shock to resource wealth (for example, due to newly discovered reserves) significantly lowers the equilibrium volume of nonresource FDI.

Although we explicitly model cross-sectional dependence and the long- and short-run dynamics, exogenous shocks might still be correlated within countries. Column b therefore provides an additional robustness test by allowing for clustered standard errors at the country level. This hardly changes the results. As a final test, we allow in column c for fixed-country effects to control for time-invariant unobservables, such as distance and other (unmeasured) time-invariant determinants of FDI, and for country-specific deterministic time trends to control for trends in country-specific unobservables.[19] This changes the coefficients but does not alter our qualitative results. The estimated average speed of convergence, conditional on a country-specific trend, is higher (down to 10% in only three years) and a resource boom has a stronger effect on the demeaned and detrended (by country) level of FDI.

We conclude that resource abundance mainly has a negative impact on nonresource FDI in the long run, but short-run dynamics mostly arise from shocks to nonresource FDI

[19] Moreover, controlling for a lagged dependent variable also controls to a large extent for anything that determined last period's stock of investment.

TABLE 6.—TESTING FOR THE IMPACT OF INSTITUTIONS, TRADE OPENNESS, AND FTA ON FDI

	ln Nonresource FDI				
Dependent variable	(a) STAR	(b) STAR	(c) STAR	(d) STAR	(e) STAR
				(Preferred estimate)	
ln population	0.221***	0.201***	0.175***	0.168***	0.135***
	(0.075)	(0.049)	(0.042)	(0.036)	(0.030)
Openness dummy	0.117	0.080			
	(0.080)	(0.073)			
ln human capital	0.409**	0.284***	0.303***	0.372***	0.323***
	(0.163)	(0.098)	(0.087)	(0.093)	(0.105)
ln distance from NED (Vincenty)	−0.290***	−0.192***	−0.172***	−0.181***	−0.130***
	(0.107)	(0.070)	(0.050)	(0.047)	(0.037)
Trend	0.022*	0.010			
	(0.013)	(0.009)			
ln GDP per capita ($t-1$)	0.131	0.182***	0.163***	0.099**	0.101**
	(0.084)	(0.068)	(0.057)	(0.043)	(0.046)
ln GDP surrounding market potential	−0.529**	−0.253**	−0.197*	−0.304***	−0.186**
	(0.246)	(0.126)	(0.102)	(0.098)	(0.085)
FTA with The Netherlands	0.220	0.135			
	(0.163)	(0.097)			
Real exchange rate with NL based on GDP price level	−0.134***	−0.126***	−0.121***	−0.105***	−0.088***
	(0.048)	(0.034)	(0.032)	(0.026)	(0.027)
Government share of GDP × 100	−0.017**	−0.014***	−0.013***	−0.009***	−0.010***
	(0.007)	(0.004)	(0.004)	(0.003)	(0.003)
Institutions 5-yearly	0.003	0.003			
	(0.005)	(0.004)			
ln total resource rents ($t-1$)	−0.017*				
	(0.009)				
ln hydrocarbon resource rents ($t-1$)		−0.019*	−0.026**	−0.021**	
		(0.011)	(0.011)	(0.009)	
ln other mineral resource rents ($t-1$)		0.012	0.005		
		(0.010)	(0.009)		
ln hydrocarbon reserves in BTU ($t-1$)					−0.018*
					(0.011)
Oil price (constant 2008 USD)					−0.006***
					(0.002)
ln nonresource FDI ($i-1$)	0.120***	0.109***	0.142***	0.150***	0.104***
	(0.045)	(0.036)	(0.039)	(0.035)	(0.034)
ln nonresource FDI ($t-1$)	0.751***	0.785***	0.810***	0.831***	0.854***
	(0.091)	(0.053)	(0.045)	(0.034)	(0.031)
Constant	2.857*	0.011	0.169	1.263	0.443
	(1.475)	(1.003)	(0.915)	(0.862)	(0.847)
Observations	1,160	863	915	1,085	939
Log likelihood	−1,420	−699.2	−771.7	−962.7	−797.6
Robust LM rho = 0	4.143**	6.430**	13.07***	19.00***	11.47***
Robust LM lambda = 0	0.547	2.067	1.747	5.125**	0.228
Variance ratio	0.925	0.962	0.960	0.965	0.966

Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

itself. In the following empirical sections, we therefore abstract from short-run dynamics other than those arising from FDI itself.

V. Testing for Rival Hypotheses and Robustness

Our core results presented in table 5 may be the result of the rival hypothesis that FDI is higher in countries with good institutions if natural resource endowments happen to be correlated with bad rule of law, corruption, or macroeconomic instability. An alternative rival hypothesis is that resource-rich countries attract more FDI if international trade is restricted. To test for these rival hypotheses (and avoid potential omitted variables bias), table 6 presents estimates of our space-time autoregressive (STAR) specification with institutional quality, openness to international trade, and free-trading arrangements (FTA) as additional explanatory variables. We allow for time-varying institutional quality by taking five-yearly averages of institutional quality, which also deals with the potential endogeneity of institutional quality. Column a with total resource rents and column b with hydrocarbon and other mineral resource rents entered separately indicate that none of these effects is statistically significant, so we reject the rival hypotheses that natural resource abundance is a proxy for poor-quality institutions and that trade protection might boost FDI stocks. We thus drop these variables in the other columns of table 6.[20]

[20] We also experimented by including measures of macroeconomic instability, which might deter FDI. But inflation volatility and five-yearly GDP per capita growth volatility were not significant and did not affect the results.

Our finding that institutions do not affect nonresource FDI is consistent with earlier results that a broad measure of risk does not affect FDI,[21] although we do not claim that specific characteristics related to the quality of institutions (such as corruption) could still matter.[22] For example, although FDI is related to portfolio decisions, debt securities, and loans that are sensitive to information frictions across countries, FDI is, in contrast to the other three asset classes, insensitive to the quality of institutions (Daude & Fratzscher, 2008). Since FDI implies more than these other asset classes for ownership and control, FDI may be an explicit way to overcome weak institutions.

We also examined the effects of openness to trade, where a country is considered closed to trade if average tariff rates are 40% or more, nontariff barriers cover more than 40% of trade, the black market exchange rate is at least 20% lower than the official exchange rate, the state has a monopoly on major exports, or there is a socialist economic system (Warziarg & Welch, 2008).

Although a state monopoly on major exports may be especially important for (resource) FDI, we could not find a significant effect of trade openness on outward FDI. However, in section VI, we examine the possibility that openness affects the fixed costs of engaging in FDI rather than the volume of FDI. Column c indicates that other mineral resource rents do not significantly affect nonresource FDI, and thus column d, our preferred estimate, drops this explanatory variable. The insignificance of other mineral resource rents stems from the stylized fact displayed in table 1 that most of resource FDI in our data are of the hydrocarbon type. The main message we take from our preferred estimate d in table 1 is that for countries already receiving nonresource FDI, a doubling of resource rents reduces nonresource FDI by in 2.1% in the short run and by 12.4% (2.1/(1 − 0.831)) in the long run.

For most minerals, there are no time-varying data available on the level of reserves, which is why we have used rents so far. However, detailed data on a country-by-country basis are available for oil, gas, and coal reserves and for the world price of crude oil (BP, 2009). Although these data exclude minerals, and agriculture, for example, and thus do not cover all natural resources, reserves are available for many countries, and most outward resource FDI in our sample is related to oil and gas. Column e of table 6 shows that the negative effect of natural resources on nonresource FDI is robust if hydrocarbon resource rents are replaced by hydrocarbon reserves in BTU and the world price of oil. The regression suggests that price effects are more detrimental than the effects of changing reserve levels themselves. All other core determinants of FDI remain significant in all columns of table 6.[23]

Further robustness tests using a 0-1 dummy for reserves depending on whether rents are 0 or positive rather than rents or reserves are presented in online appendix 3, table WA1, columns d to f. This yields a larger sample as now country periods with zero rents can be included (see section IIIB). They confirm our qualitative results on the determinants of nonresource FDI, but given that we now have a larger sample, some controls are now significant that were not when we excluded the country years with zero rents. For example, countries with good institutions now attract more nonresource FDI on average, but countries with good institutions within a sample of resource exporters (with positive rents) do not significantly attract more nonresource FDI than resource exporters with worse institutions. A similar result now holds for trade openness. Being a member of GATT/WTO has no effect on FDI and there is no robust (negative) effect of being landlocked on FDI either once short-run dynamics are taken into account. A boom in a particular resource (such as gold) leads to a decline in nonresource FDI. The main message we take from our preferred estimate in table WA1, regression e, is that for countries that are not already receiving nonresource FDI, the emergence of resource FDI cuts nonresource FDI by 15.8% in the short run and by a massive 67.5% in the long run.

VI. Two-Stage Estimation Procedure: Correcting for Sample Selection Bias in Outward FDI

We now check whether our estimates suffer from sample selection bias. Gravity equations to estimate bilateral trade flows (Tinbergen, 1962; Anderson & Wincoop, 2003) have been corrected for sample selection bias by allowing for external and internal margins in international trade (Helpman et al., 2008).[24] The resulting two-stage procedure

[21] Wheeler and Mody (1992) did not find a significant correlation between the size of FDI by U.S. firms and the host country's risk factor, a composite measure that includes perception of corruption as one of the components. The authors concluded that the importance of the risk factor should "be discounted, although it would not be impossible to assign it some small weight as a decision factor" (p. 70). Wheeler and Mody combined the corruption measure with twelve other indicators to form one regressor. These other indicators include "attitude of opposition groups towards FDI,'' "government support for private business activity,'' and "overall living environment for expatriates,'' which may not be very correlated with government corruption, may not be precisely measured, or may not be as important for FDI as one imagines.

[22] A study on bilateral investment from twelve sources to 45 host countries finds that a higher tax rate on multinationals or more corruption in the host country deters inward FDI (Wei, 2000). One study based its empirical analysis on two measures of activity by U.S. majority-owned foreign affiliates: panel data for aggregate real gross product in manufacturing that originates in a given host country and microdata for a single year regarding the likelihood of a firm locating in a given host country (Mutti & Grubert, 2004). Their estimates indicate that investment geared toward export markets, rather than the domestic market, is particularly sensitive to host country taxation and that this sensitivity appears to be greater in developing countries than developed countries and growing over time.

[23] We have also reestimated regression d with a pooled sample where the rents variable is replaced with lag of the log of rents whenever possible and 0 otherwise and where a dummy variable is added equal to 1 if the observation belongs to the sample of regression d. Following Baltagi (2005), we test this model, which allows for a sample-specific effect (the dummy) against the alternative of a constant effect. A likelihood ratio test yields a value of 1.44 (chi-squared, equation [1]), which does not reject the null, and thus the two samples can be pooled and are not significantly different from each other.

[24] This follows the tradition of estimating internal and external margins of labor supply to avoid sample selection bias (Heckman, 1979).

estimates selection into trade partners in the first stage and trade flows in the second stage; it indicates that traditional gravity estimates are biased and that most of the bias is due to omission of the extensive margin rather than sample selection bias. Since the volume of trade between pairs of countries that trade with each other depends on the fraction of firms that engages in foreign trade, the intensive margin of trade is substantially driven by variations in the fraction of trading firms rather than by new trade partners. The new gravity approach can explain "zeroes"—no firm may be productive enough to export from one to another country—and asymmetric bilateral trade patterns. Recently such a procedure has been used to empirically investigate FDI and the location decisions of heterogeneous multinationals with firm-level data, suggesting that the most productive French firms invest in relatively tough host countries (Chen & Moore, 2010).

We investigate outward FDI at the sectoral level, where the problem of zeroes is much less severe. In our data, there are 20% zeroes in resource FDI and 5% zeroes in nonresource FDI versus 55% zeroes in the 1986 cross section of bilateral trade flows of Helpman et al. (2008) and 92% zeroes in the mergers and acquisitions data in Head and Ries (2008). To tackle the problem of zeroes in FDI data, we correct for sample selection bias arising from omitted variables that measure the impact of the number of firms that engage in FDI to a particular country. We adopt an agnostic approach and specify probit equations for the first stage to estimate the probability that there is FDI to a particular country and use the resulting predictions in the second stage to estimate the determinants of outward FDI. The advantage of this method is that the decision to invest abroad and the decision on the amount of investment to be made are determined separately. Alternative methods such as simple OLS on the selected sample have to assume that both decisions are independent, while a tobit regression makes the strong assumption that both decisions can be captured by the same model. The nonlinear Poisson pseudo-maximum likelihood model (used in the context of trade by Santos Silva & Tenreyro, 2006) allows inclusion of both zero and nonzero trade flows and estimates the combined effect of the external and the internal margin but tends to underestimate the number of zero flows.[25] We favor the two-stage method.

Another issue is that OLS estimation of the log-linear specification may lead to inconsistent estimates under heteroskedasticity. PPML estimation provides a solution to this particular problem (Santos Silva & Tenreyro, 2006). Therefore, as an additional robustness check, we also estimated our main specifications with PPML, even though this method cannot currently incorporate spatial and time lags of the dependent variable. Because of this, the estimates reflect long-run effects only. Repeating regression d of table 6 with PPML yields an effect of ln hydrocarbon rents on ln nonresource FDI of −0.116*** (0.014), which is very close to our estimate in table 6 (−0.021/0.169 = −0.12). Moreover, repeating the effect of resource discovery on nonresource FDI of table WA1 (regression e) yields a PPML long-run estimate of −0.545*** (0.145), which is close to the long-run estimate of −0.68 (= −0.158/0.234) from table WA1. We conclude that a resource discovery causes nonresource FDI to fall by 16% in the short run and 68% in the long run.

For the two-step method, we need an instrument, for otherwise the identification comes off the functional form assumption of normality. We thus need that at least one of the variables that determine entry in foreign markets does not also determine the size of investment. For example, Helpman et al. (2008) find evidence that the decision to export is well determined by measures of the cost of entry in a foreign market, while entry costs do not affect the amount of trade. A similar argument could be made for FDI, but unfortunately the available data on entry costs combined with our FDI data do not yield country years for which FDI is 0. Instead, we argue that the fixed costs of entering a foreign market are better proxied by an index of a country's institutional openness to trade (Wacziarg & Welch, 2008) and whether it is landlocked.[26] Closed economies, whether in the physical sense of infrastructure needed or institutional sense of licenses, or something else, severely complicate setting up vertical production chains or exportplatform operations. Even for horizontal FDI (fixed), inputs may have to be initially imported, which is much more costly if the market is closed. An advantage of using openness is that it varies (slowly) over time. These two instruments are not ideal, since they may potentially also affect FDI volume as well as the decision to undertake FDI. However, our sample contains few zeros, which decreases the scope for endogeneity resulting from selection bias and increases the difficulty of finding a variable that perfectly predicts those few zeros. Furthermore, within this sample of resource exporters, we find that these instruments do predict the first-stage outcome, are not weak, have insignificant effects in the second stage (see table 7, column b), and thus do not correlate much with the amount invested. From a theoretical perspective, Helpman et al. (2004) split investment costs into fixed and variable costs and predict that only the most productive firms can overcome the fixed costs. Our interpretation is thus that both landlocked and closed economies decrease the profitability of setting up affiliates, but once a firm is sufficiently productive and makes a profit in these countries, it scales up its activities according to other variables, such as market size.

In the following we denote the selection variables by c_{it} as a determinant for the first stage that is not used in the

[25] The alternative, a two-part zero-inflated model with a negative binomial density, corrects this. However, just as with OLS on the selected sample, it requires that the decision of entry and the amount of trade are independent.

[26] There are several alternative candidates, but common language as in Helpman et al. (2008) is not helpful, as outside the Netherlands, few countries speak Dutch. A dummy for free trade areas is not included, since it perfectly predicts positive other FDI. Colonial ties also make less sense in our context.

Table 7.—Testing for Sample Selection Bias in Nonresource FDI

	Nonresource FDI Dummy		ln Nonresource FDI	
Dependent Variable	First Stage (a) SAR	Benchmark (b: STAR)	Second Stage (c) STAR	Bootstrapped SE (d) STAR
ln population	0.158***	0.176***	0.182***	0.178***
	(0.060)	(0.042)	(0.042)	(0.050)
ln human capital	0.331***	0.352***	0.387***	0.375***
	(0.131)	(0.094)	(0.103)	(0.110)
ln distance from NED (Vincenty)	0.836***	−0.225***	−0.208***	−0.237**
	(0.179)	(0.069)	(0.066)	(0.095)
Trend	0.163***	0.009	0.012	0.007
	(0.028)	(0.007)	(0.007)	(0.015)
ln GDP per capita ($t-1$)	0.436***	0.152**	0.167***	0.151
	(0.129)	(0.061)	(0.058)	(0.093)
ln GDP surrounding market potential	0.775**	−0.359***	−0.320***	−0.350***
	(0.334)	(0.125)	(0.119)	(0.128)
Real exchange rate with NL based on GDP price level	0.355***	−0.119***	−0.114***	−0.129***
	(0.171)	(0.029)	(0.028)	(0.041)
Government share of GDP × 100	−0.047***	−0.009***	−0.011***	−0.009
	(0.009)	(0.003)	(0.004)	(0.006)
ln hydrocarbon resource rents ($t-1$)		−0.020**	−0.018**	−0.018**
		(0.009)	(0.009)	(0.008)
Total resource dummy ($t-1$)	0.716***			
	(0.216)			
Openness dummy	0.518***	0.013		
	(0.187)	(0.064)		
Landlocked dummy	−0.685***	0.016		
	(0.168)	(0.084)		
Inverse Mill's ratio			0.588*	1.591
			(0.353)	(1.176)
Estimated FDI probability				0.493
				(0.732)
Estimated FDI probability^2				−0.093
				(0.169)
Estimated FDI probability^3				0.006
				(0.013)
Dependent variable ($i-1$)	−0.276	0.110***	0.106***	0.107***
	(0.239)	(0.037)	(0.034)	(0.028)
ln nonresource FDI ($t-1$)		0.823***	0.818***	0.817***
		(0.039)	(0.040)	(0.040)
Constant	−16.636***	1.514	0.860	0.747
	(3.409)	(1.090)	(1.046)	(1.921)
Observations	1,842 (6.8%=0)	1,049	1,049	1,049
Log likelihood		−913.3	−910.4	−908.9
Robust LM rho = 0		5.467**	5.005**	5.238**
Robust LM lambda = 0		6.592**	6.832***	6.774***
Variance ratio		0.965	0.965	0.965

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

second stage (satisfies the exclusion restriction).[27] Since the decision to invest and the decision that determines the amount of investment in a host country are also determined by investments potentially made in neighboring countries, we also allow for spatial dependence in the first-stage probit regression. We thus estimate the following two-stage model for nonresource FDI with the Heckman (1979) correction:

$$Pr(f_{it}^N > 0/c_{it}, s_{it}, q_{it}, n_{it}, x_{it}, m_{\bar{j}t}, f_{\bar{j}t}^N) = \Phi\left(\gamma_1 s_{it} + \gamma_2 q_{it} + \gamma_3 n_{it} + \boldsymbol{\gamma}_4' \mathbf{x}_{it} + \gamma_5 m_{\bar{j}t} + \gamma_6 f_{\bar{j}t}^N + \gamma_7 c_{it}\right) \quad (2a'')$$

$$\mathrm{E}\left[f_{it}^N / f_{it}^N > 0, s_{it}, q_{it}, n_{it}, x_{it}, m_{\bar{j}t}, f_{\bar{j}t}^N\right] = \beta_0 + \xi[\beta_1 s_{i,t-1} + \beta_2 q_{i,t-1} + \beta_3 n_{i,t-1} + \boldsymbol{\beta}_4' \mathbf{x}_{i,t-1} + \beta_5 m_{\bar{j},t-1} + \beta_6 f_{\bar{j},t-1}^N] + (1-\xi) f_{i,t-1}^N + \rho_i^N \sigma_i^N \phi_{it}^N + \varepsilon_{it}^N, \quad (2b'')$$

where $\Phi(.)$ indicates the cumulative normal density function and ρ_i^N are the correlations between unobserved determinants of decisions to start nonresource FDI and unobserved determinants of this FDI once it has already started. The term $\phi_{it}^N = \varphi(.)/[1-\Phi(.)]$ denotes the inverse Mills ratio, where $\varphi(.)$ denotes the standard normal density function. This ratio is included in the second stage, equation (2b″), to correct for sample selection bias and is calculated from the estimated parameters of the first stage, equation (2a″). By including the inverse Mills ratio in the second stage, esti-

[27] In addition, we replace the log of resource rents by the resource dummy, which is equal to 1 if rents are positive in a given country and year. This way, we avoid having selection depend also on whether rents are positive.

mating the coefficients $\beta_{7i} \equiv \rho_i^N \sigma_i^N$, and realizing that the standard deviation σ_i^N cannot be 0, the null hypothesis that $\beta_{7i} = 0$ is equivalent to testing for sample selectivity (that is, the null that $\rho_i^N = 0$). The estimates thus generated correspond to an LIML estimator. To obtain the correct standard errors, we resample with a bootstrap.[28] Consistency of the estimates requires that the error terms ε_{it}^N are normally distributed. Our two-stage estimates are presented in table 7. The dependent variable in equation (2a″) is set so that it is 0 if FDI is 0 and 1 if positive.[29] Following Helpman et al. (2008) we include predictions from the probit model but also its square and cube. They are added to control for firm heterogeneity (dropping the Pareto assumption). Since trade openness and being landlocked do not affect the amount of FDI, we include them as instruments in the first stage.

The SAR estimates of the first stage correspond to a Bayesian spatial autoregression probit model and are given in column a of table 7. The instruments trade openness and being landlocked are significant and have the correct sign, and judging from the benchmark regression b, they do not help predict the amount of investment. Column a reveals several interesting contrasts with the decision on the amount of FDI to undertake (the external margin) and the flow of FDI (the internal margin).[30] First, nonresource FDI is more likely to take place with a particular destination country if it is farther away from the home country, which is consistent with it being a substitute to trade. In contrast, the volume of nonresource FDI undertaken is less if the host country is far away, which is consistent with distance-limiting corporate control. Second, surrounding market potential increases the likelihood of setting up (export platform) nonresource FDI in a new country but reduces the flow of nonresource FDI as relatively more investment goes to larger neighboring markets. Third, nonzero resource rents have a significant positive effect on the decision to undertake nonresource investments in a particular country, which could be due to foreign companies anticipating a boost to future market potential fueled by the anticipated boom in natural resources. It could also be due to the rents relaxing credit market constraints and thus permitting investment in a new host country. In contrast, resource rents have a robust and significant negative effect on the volume of nonresource FDI flows, which might result from the reallocation of production factors from the traded to the resource sectors.[31]

Turning to the second stage reported in column c of table 7, we note that the inverse Mills ratio is significant at the 10% level. However, once we bootstrap the errors and include the predicted probability of FDI occurring and its square and cube as in column d of table 7, we find that neither the inverse Mills ratio nor the predicted probabilities that control for multinational heterogeneity are statistically significant at the 10% level. We thus conclude that there is no evidence of sample selection bias. This is also reflected in the coefficient estimates of regression d, table 7, compared to the benchmark regression b, table 7, which are all similar.

One reason that the Heckman correction may not affect the results on the internal margin of FDI very much is instrument weakness. We thus reestimate the first stage as a linear probability model and perform the Cragg-Donald F statistic for weak instruments. We abstract from the spatial lag because it is not significant. The result is an F test value of 27.97, above the rule-of-thumb value of 10. We therefore comfortably reject the null hypothesis that the equation is weakly identified. The IV estimates have a bias of less than 10% toward the corresponding OLS coefficient. Moreover, the strength of the instruments increases consistency and decreases bias due to any violation of the exclusion restriction.

The main conclusion is that hydrocarbon rents still predict a lower level of nonresource FDI if we allow for sample selection bias. Analogously (and additionally using implicit taxes as a selection variable) the two-stage estimates for resource FDI reported in table WA2 of online appendix 3 suggest that there is no evidence of sample selection bias at the 5% level. This increases our confidence in the single-stage estimates reported in sections IV and V.

VII. Does the Decline in Nonresource FDI Dominate the Boost to Resource FDI?

Before we assess the magnitude of the crowding-out effect of nonresource FDI by natural resource discoveries and booms, we discuss the determinants of resource FDI in order to assess whether the fall in resource FDI compares with the boost to FDI and analyze the dynamic positive feedback effects of spatial lags on nonresource FDI in the host and surrounding countries.

A. *Determinants of Resource FDI*

Table 8 presents estimates of the determinants of resource FDI. In addition to the variables suggested by equation (1) and the discussion of section II, we hypothesize that bad institutions, corruption, and risk of expropriation may attract resource FDI when corrupt politicians join forces with foreign mining companies to cream off surplus

[28] Because the estimation procedure is very computer intensive, we limit the bootstrap to 200 replications.

[29] The countries with zero FDI in some years are China, Democratic Republic of Congo, Congo, Ghana, Honduras, Hungary, Iceland, Mali, Mozambique, Nicaragua, Niger, Papua New Guinea, Poland, Togo, and Uganda. We also set it to 1 if FDI is negative, which occurs if the parent company is indebted to its subsidiary. This occurs rarely, but signifies an investment relationship between the home and the host country.

[30] Rerunning the first stage without the insignificant spatial lag reveals that the effect of the real exchange rate on FDI is not robust. Marginal effects have similar sign and significance (not reported). Since there are very few zeros in the data, the probability of investing is very high, and a unit increase in each variable contributes little to this probability. For example, the probability of investing increases by a mere 0.003% if a country becomes a resource exporter. Similarly, a 10% increase in surrounding market potential or in home GDP per capita increases the probability of investing by 0.015% and 0.009%, respectively.

[31] Closer inspection of the resource dummy reveals that quite a few very poor countries, such as Haiti, Mali, Malawi, El Salvador, and Nepal, have no mineral production in most years.

TABLE 8.—DETERMINANTS OF RESOURCE FDI

	ln Resource FDI		
Variables	(a) STAR	(b) OLS	(c) OLS
ln population	0.071**	0.070**	0.074**
	(0.036)	(0.033)	(0.033)
ln human capital	0.393**	0.365**	0.380**
	(0.157)	(0.147)	(0.157)
ln distance from NED (Vincenty)	−0.151**	−0.123***	−0.149**
	(0.063)	(0.038)	(0.073)
ln GDP per capita ($t-1$)	−0.163*	−0.123	−0.165**
	(0.091)	(0.079)	(0.082)
ln GDP surrounding market potential	−0.083		−0.096
	(0.130)		(0.137)
Real exchange rate with NL based on GDP price level	−0.055*	−0.063**	−0.063**
	(0.031)	(0.030)	(0.031)
Government share of GDP × 100	−0.008		
	(0.007)		
Institutions five-yearly	0.020*	0.017*	0.020**
	(0.011)	(0.010)	(0.010)
ln hydrocarbon resource rents ($t-1$)	0.048***	0.031***	
	(0.013)	(0.012)	
ln other mineral resource rents ($t-1$)	0.000		
	(0.024)		
ln hydrocarbon reserves in BTU ($t-1$)			0.029*
			(0.016)
Oil price (constant 2008 USD)			−0.004
			(0.005)
ln resource FDI ($i-1$)	0.083		
	(0.071)		
ln resource FDI ($t-1$)	0.831***	0.852***	0.847***
	(0.034)	(0.029)	(0.028)
Constant	1.010	0.461	2.059
	(1.596)	(0.686)	(1.905)
Observations	716	803	729
Log likelihood	−1,003	−1,110	−1,053
Robust LM rho = 0	0.0471		
Robust LM lambda = 0	1.460		
Variance ratio	0.863	0.871 (R^2)	0.858 (R^2)

Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

natural resource rents, which will be easier if lack of transparency allows cheating of the public. In such situations, corrupt politicians, possibly aided by foreign multinationals, deplete natural resources rapaciously, especially if the chance of being kicked out of office by rebel groups is high. However, the empirical evidence reported in table 8 rejects this hypothesis, as good institutions seem to attract resource FDI. Not surprisingly, hydrocarbon resource rents or, alternatively, hydrocarbon reserves in BTU attract resource FDI independent of the world price of oil. In all columns, distance deters resource FDI, while market potential (proxied by population but not GDP per capita), human capital, and relative cheapness of the host country's currency attract it. There does not appear to be a negative effect of the share of government spending on resource FDI.[32] Although occasionally foreign investments are expropriated in the resource sector, equivalent to a 100% tax rate, there is no evidence that implicit tax rates (proxied by the share of government spending) are high enough on average to deter resource FDI. Convergence is quite sluggish, with shocks bringing resource FDI back to 10% of its new equilibrium value in thirteen years. This is unsurprising given the long-term investments needed in mineral exploration, but the adjustment for nonresource FDI is almost as sluggish (see table 6). This implies that after a negative shock due to expropriation of existing resource FDI stocks, it takes a long time for resource FDI to recover.

There is no evidence for a spatial lag in resource FDI, so that resource FDI is neither positively nor negatively affected by resource FDI in neighboring countries. Surrounding market potential has no impact either on resource FDI. If anything, a high GDP per capita seems to have a negative effect on resource FDI. This suggests that resource FDI is very different from other FDI. It is not complex-vertical fragmentation, export platform, or horizontal, but mainly vertical as a result of being driven by the geographical necessity of local subsoil assets rather than by regional cost advantages (see section IIb) and of a type that is unrelated to neighborhood effects.

Further robustness tests with a bigger sample using a 0-1 dummy for reserves are presented in the online appendix, table WA1, columns a to c. We allow for Singapore being a large transshipment port and the very large amount of

[32] By proxying the tax rate by the government spending share of GDP, we have a more comprehensive coverage of countries, and in case of resource FDI, it is probably more relevant than the official corporate tax rate.

resource FDI going through it by including Singapore with a dummy in the regressions. The broader sample shows that hydrocarbon resource endowments attract (mostly hydrocarbon) resource FDI, while other mineral resources deter it, which implies that the reallocation of inputs from the nonresource sector to the natural resource industry after a resource boom also extends to the nonhydrocarbon resource sector. A boom in a particular resource (say, gold) thus leads to a fall in FDI of other (unrelated) resources (such as oil). Table WA2 indicates no evidence of sample selection bias in our estimates of resource FDI at the 5% level.

A critique one could levy at our estimates reported in table 8 is that we should correct for some countries having restrictions on resource FDI (for example, the need to have a license to drill and pump) and others do not. Unfortunately, we were unable to find a variable to capture such differences, although the openness dummy is also based on whether a country has significant nontariff barriers to trade or a state monopoly on major exports, the latter of which typically concerns resource exports. Another caveat we should make is that reported reserves are potentially endogenous as they may depend on the amount of outward resource FDI. We deal with this reserve causality problem by lagging the reserves variables so that they are predetermined, but given the long lags involved in resource extraction, this may not be enough. Since resource rents are defined as exported revenues minus production costs and thus net of the take of extraction companies, this endogeneity issue seems less severe for the resource rents variable.

B. *Negative Effect on World Nonresource FDI Is Smaller for Isolated Countries*

Before we investigate whether the negative effect of natural resource abundance on nonresource FDI is bigger than the positive effect on resource FDI, we gauge the dynamic effects of a shock to natural resource wealth. We therefore present a simulation exercise that takes into account the feedback effects created by the positive spatial dependence of nonresource FDI. The magnitude of the feedback effect depends on the coefficient of the spatially lagged dependent variable and on the distance between the country experiencing the resource boom and its neighboring countries. We expect to find that a resource boom in a country that is relatively isolated in space will result in less negative spillover effects to the region than when a country that has many close neighbors is hit with a similar shock. The local effect of the shock should be less severe if feedback effects through regional FDI are not taken into account.

Our baseline regression is column d of table 6. To calculate the impulse response of FDI to a shock to resources, we set all right-hand-side variables to 0 except the hydrocarbon rents variable.[33] We simulate the effect of a 1 standard deviation increase of resource rents over its mean, that is, a shock of 3.420/19.298 × 100 = 17.7%. We thus have from the regression estimates (see d of table 6) that

$$\mathbf{f}_\mathbf{t}^N = 0.83 \times \mathbf{f}_{\mathbf{t}-1}^N + 0.15 \times \mathbf{W}\mathbf{f}_t^N - 0.021 \times \mathbf{R}_t \Leftrightarrow$$

$$\mathbf{f}_\mathbf{t}^N = 0.83 \times (\mathbf{I} - 0.15 \times \mathbf{W})^{-1}\mathbf{f}_{\mathbf{t}-1}^N - 0.021 \times (\mathbf{I} - 0.15 \times \mathbf{W})^{-1}\mathbf{R}_t,$$

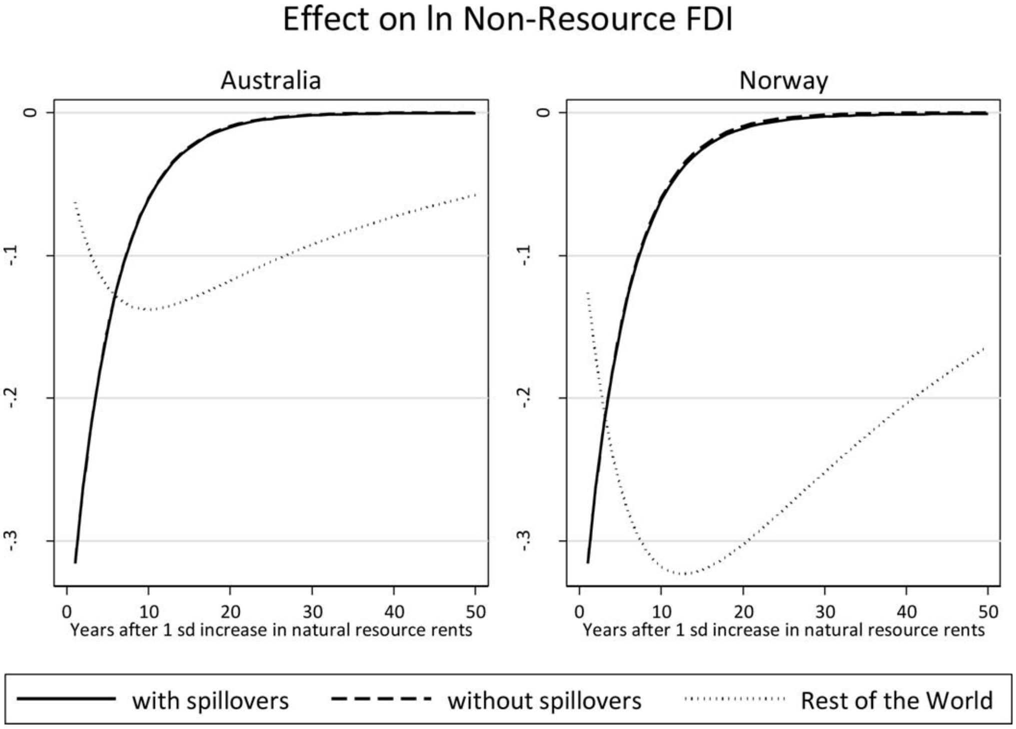
where $R_{i0} = 17.7$. The resulting impulse response functions for Norway, which is geographically close to many big markets, and Australia, which is relatively isolated, are presented in figure 2. The solid and dashed lines represent the decrease in nonresource FDI to these two countries over time after a shock to hydrocarbon rents. The high persistence in nonresource FDI causes the shock to dissipate slowly over time, taking over thirty years to disappear. The dashed line ignores the spatial spillovers (effectively setting the coefficient 0.15 to 0). Because the effect of feedback through spillovers is weak and Australia is relatively remote, the line is almost indistinguishable from the solid line. However, the dotted line represents the aggregate effect on all other countries in the world. A resource boom lowers FDI in Australia and, through regional linkages, also lowers FDI in neighboring countries. One year later, the effect of the shock can still be felt, lowering FDI in the region even further, even though the initial shock to the region is starting to dissipate. At the inflection point, the negative spillover effects from Australia to the region become weaker than the dissipation effect, causing the overall effect in the region to decrease.

The right panel of figure 2 shows the same effects for Norway, which has more and closer neighbors. In this case, the local effects look very much the same, except that Norway suffers slightly more from negative feedback effects. The big difference is the effect on the rest of the world. Because Norway is much closer to other countries, a negative shock to FDI causes the region to become much less attractive to FDI because of the decreasing availability of regional suppliers. Aggregated over all countries, this regional effect becomes as strong as the local shock and persists long after the local affect of the shock has disappeared.

We use $\partial \mathbf{f}_\infty^N / \partial \mathbf{R}_t = -0.021 \times (\mathbf{I} - 0.15 \times \mathbf{W})^{-1} / (1 - 0.831 \times (\mathbf{I} - 0.15 \times \mathbf{W})^{-1})$ to calculate the long-run effects of a resource bonanza on nonresource FDI. The diagonal elements of this matrix are larger than the long-run effect without spatial lags, 0.021/0.169 = 0.124, especially for countries that are geographically close to other big host countries. The effect of a hypothetical local doubling of resource rents on local nonresource FDI varies from −12.9% for Australia and New Zealand to −14.0% for Switzerland. For each country, the long-run effect, including spatial spillovers of a resource bonanza in that country on global nonresource FDI, is calculated from adding the elements of the corresponding column suitably weighted by

[33] Although we use the coefficients from our preferred model, we base the distance matrix **W** on all 192 countries for which we have geographic coordinates.

FIGURE 2.—EFFECTS OF RESOURCE ABUNDANCE ON LOCAL AND WORLDWIDE NONRESOURCE FDI (%)



the amount of existing nonresource FDI in that country in 2002. The resulting long-run effects of a doubling of resource rents in each country on global nonresource FDI vary from −0.2% for New Zealand to −3.2% for the United States, a large receiver of FDI. The corresponding effects for Norway and Saudi Arabia are −0.7% and −0.5%.

C. *Is There a Resource Curse for Aggregate FDI?*

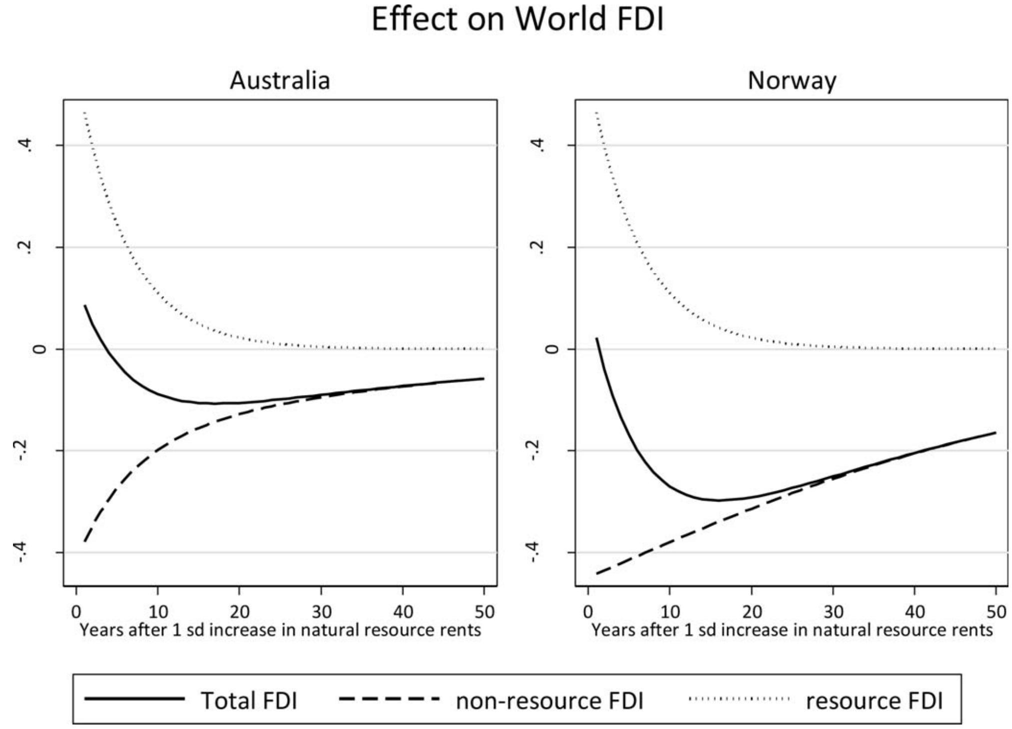
Our estimation results discussed in sections IV to VI suggest that natural resource abundance deters nonresource FDI but boosts resource FDI. Our estimates presented in columns a and b of table 4, columns a and b of table 5, and columns c and d of table 6 imply that the long-run effect of the doubling of hydrocarbon resource rents depresses nonresource FDI by 12.4% to 15.5%. The two-step estimates of table 7 suggest that the long-run drops in nonresource FDI are somewhat smaller—10% to 11%. Column e of table 6 indicates that the long-run effect of a 100% increase in hydrocarbon reserves in BTU leads to a 12.4% fall in nonresource FDI. In contrast, table 8 suggests that a doubling of hydrocarbon resource rents boosts resource FDI by 28% (column a) or 21% (column b). To illustrate that on average across countries, natural resource endowments are a "curse" for total FDI, we first calculate the long-run effect of hydrocarbon resource rents on total FDI using our preferred estimates in table 6, column d, and table 7, column b, ignoring regional spillovers:

$$\begin{aligned} d\bar{f}_{it}/d\bar{s}_{it} &= -0.745\left(\frac{0.021}{1-0.831}\right)+0.255\left(\frac{0.031}{1-0.852}\right) \\ &= -0.093+0.053=-0.039, \end{aligned}$$

where $\bar{f}_{it} \equiv \bar{f}_{it}^N + \bar{f}_{it}^R$, bars indicate country averages, and 74.5% is the average share of nonresource FDI in total FDI (see the appendix). We conclude that at the aggregate level, high hydrocarbon resource rents are a curse for total FDI even if we ignore regional spillovers. Because regional spillovers matter and because nonresource FDI is the main transmitter of knowledge and technology, the adverse effect of resource abundance on the economy will be more substantial. To gain further insight, figure 3 repeats the exercise of figure 2 for the effects on nonresource, resource, and total FDI (%). For remote countries like Australia, we find that the net effect of resource abundance on total FDI becomes negative four years after the shock, while for relatively connected countries such as Norway, the net effect turns negative after only two years. Also, for connected countries, the net effect is deeper and much more persistent, lasting several decades.

The negative effects of hydrocarbon resource rents on nonresource FDI and on total FDI persist over many decades and spill over into the region. Within the sample of regression d of table 6, there are 32 country-years in which hydrocarbon rents more than double over the course of a year. Such shocks are almost six times larger than the one

FIGURE 3.—DOES RESOURCE ABUNDANCE HAVE A NEGATIVE EFFECT ON TOTAL FDI?



displayed in the simulation exercise shown in figure 2 and have proportionally larger effects on FDI.

VIII. Conclusion

Our panel error correction estimates of a gravity model for the determinants of nonresource and resource FDI suggest a strong negative effect of natural resource bonanzas on nonresource FDI. First, for those countries that had not been a resource producer before, a resource discovery causes nonresource FDI to fall by 16% in the short run and by 68% in the long run. Second, for countries that were already a resource producer, a doubling of resource rents induces a 12.4% fall in nonresource FDI. Third, on average, the contraction in nonresource FDI outweighs the boom in resources. Aggregate FDI falls by 4% if the resource bonanza is doubled. Finally, these negative effects on nonresource FDI are amplified through the positive spatial lags in nonresource FDI. The net effect of resource endowments on total FDI quickly becomes negative, especially for countries that are geographically close to many other big markets. Our estimates also suggest that a doubling of the oil price curbs nonresource FDI by 10% in the long run. These substantial negative effects of resource bonanzas on nonresource FDI are a cause for concern because they may frustrate the process of economic development.

Our estimates also suggest that resource FDI is vertical, whereas nonresource FDI is of the export fragmentation variety. Although we do not find significant effects of trade openness, free trade agreements, and institutional quality on nonresource FDI, we do find that institutional quality has a positive effect on resource FDI, indicating the presence of hold-up problems. Our main findings are robust to different measures of resource reserves and the oil price and to allowing for sample selection bias.

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APPENDIX

Table A1 describes our data and the sources they have been taken from.

Table A2 gives the descriptive statistics of the dependent and independent variables that are used to estimate our econometric model, equations (1) and (2).

The most severe constraints on the data come from data gaps for human capital and resource rents. Our preferred regression d in table 6 would have 2,111 observations without these two variables and only 1,369 if only human capital is dropped as explanatory variable, instead of the current 1,085. Since there are few zero FDI observations in our

TABLE A1.—DATA DEFINITIONS AND SOURCES

Variable	Description	Source
ln FDI	Value of Dutch outward foreign direct investment; see also text	DNB (2008)
ln population	Log of total population (in 1,000s)	PWT6.2, from Heston, Summers, and Aten (2006)
Openness dummy	=1 if open to trade, dummy	Wacziarg and Welch (2008)
ln human capital	Average years of schooling age 25+	Barro and Lee (2000)
ln distance from NL (Vincenty)	Vincenty distance in km from the Netherlands between country centroids	CID data and Vincenty (1975)
Trend	Time trend	-
ln GDP per capita	GDP per capita in constant PPP $billions	PWT6.2, from Heston et al. (2006)
ln GDP surrounding market potential	Distance-weighted GDP in constant PPP $billions	Authors' calculation
FTA	= 1 if a country has a free trade agreement with the Netherlands in year t	Baier and Bergstrand (2007)
GATT/WTO member	= 1 if a country is a member of the GATT or WTO in year t	World Trade Organisation
Landlocked dummy	= 1 if a country has no access to sea	World Bank (2001)
Total resource dummy ($t-1$)	= 1 if natural resource rents are non-zero	World Bank (2007)
Hydrocarbon resource Dummy ($t-1$)	= 1 if natural resource rents of oil, gas, or coal are nonzero	World Bank (2007)
Other mineral resource Dummy ($t-1$)	= 1 if natural resource rents are nonzero, excluding oil, gas, and coal	World Bank (2007)
ln hydrocarbon resource Value ($t-1$)	Combined value of natural resource rents of oil, gas, and coal	World Bank (2007)
ln other mineral resource Value ($t-1$)	Combined value of natural resource rents Excluding oil, gas, and coal	World Bank (2007)
ln hydrocarbon reserves in BTU ($t-1$)	Total amount of oil, gas and coal reserves in BTUs	BP (2009)
Oil price (constant 2008 USD)	World price of oil in constant 2008 U.S. dollars	BP (2009)
Institutional quality 5-yearly	Sum of the following institutional quality indices (max value): Government Stability (12), Investment Profile (12), Corruption (6), Law and Order (6), Bureaucracy Quality (4), measured at start of nonoverlapping 5-year periods	*International Country Risk Guide*
Real exchange rate with Netherlands based on GDP price level	Country i's price level of GDP (series p in the PWT) divided by the same series for the Netherlands, where p is PPP over GDP divided by the exchange rate times 100; value of p for the US is normalized to 100	PWT6.2 from Heston et al. (2006)
Government share of GDP × 100	Government share of real GDP (series KG in PWT)	PWT6.2 from Heston et al. (2006)

TABLE A2.—DESCRIPTIVE STATISTICS

Variable	Mean	SD	Minimum	Maximum
ln nonresource FDI	3.894	3.168	−16.745	11.298
ln resource FDI	2.820	3.254	−7.161	9.645
ln population	9.330	1.577	5.475	14.062
Openness dummy	0.619	0.486	0	1
ln human capital	1.489	0.691	−1.005	2.505
ln distance from NL (Vincenty)	8.448	0.967	4.748	9.808
ln GDP per capita ($t-1$)	8.527	1.138	5.139	10.445
ln GDP surrounding market potential	6.564	0.495	5.456	8.128
FTA	0.169	0.375	0	1
GATT/WTO member	0.172	0.377	0	1
Landlocked dummy	0.181	0.385	0	1
Total resource dummy ($t-1$)	0.824	0.381	0	1
Hydrocarbon resource dummy ($t-1$)	0.661	0.474	0	1
Other mineral resource dummy ($t-1$)	0.728	0.445	0	1
ln hydrocarbon resource value ($t-1$)	19.298	3.420	6.842	25.713
ln other mineral resource value ($t-1$)	17.248	2.956	7.534	22.766
ln hydrocarbon reserves in BTU ($t-1$)	9.027	2.552	0.842	14.225
Oil price (constant 2008 USD)	31.655	9.915	17.320	58.270
Institutional quality 5-yearly	22.559	7.199	4.080	38.000
Real exchange rate with NL based on GDP price	0.578	0.626	0.111	12.490
Government share of GDP × 100	20.307	8.545	2.463	58.139

Based on largest sample of country-years (regression a of table 7).

data, we do not lose any countries from taking logs of FDI within that regression, albeit for some countries we lose early years. This leads to 133 fewer observations. If missing data on rents occur in a nonrandom way, the estimates may suffer from selection bias if there is a nonzero correlation between unobserved factors that determine the outcome and those that determine why we observe human capital or rents only in some cases. A method to deal with left censoring and incidental truncation of the main explanatory variable is proposed in Wooldridge (1995), but this requires a suitable instrument for resource rents, which is not readily available.