FIW – Working Paper

FIW Working Paper N° 144
February 2015

Aid, Infrastructure, and FDI: Assessing the Transmission Channel with a New Index of Infrastructure

Julian Donaubauer[1]
Birgit Meyer[2]
Peter Nunnekamp[3]

Abstract

We raise the hypothesis that aid specifically targeted at economic infrastructure helps developing countries attract higher FDI inflows through improving their endowment with infrastructure in transportation, communication, energy and finance. By performing 3SLS estimations we explicitly account for dependencies between three structural equations on the allocation of sector-specific aid, the determinants of infrastructure, and the determinants of FDI. We find fairly strong and robust evidence that targeted aid promotes FDI indirectly through the infrastructure channel. In addition, aid in infrastructure appears to have surprisingly strong direct effects on FDI.

Keywords: aid effectiveness, sector-specific aid, foreign direct investment, infrastructure
JEL classification: F21; F35; O18

The authors

[1] Helmut Schmidt University Hamburg
[2] University of Kiel, E-Mail: b.meyer@economics.uni-kiel.de
[3] Kiel Institute for the World Economy

The 'center of excellence' FIW (http://www.fiw.ac.at/), is a project of WIFO, wiiw, WSR and Vienna University of Economics and Business, University of Vienna, Johannes Kepler University Linz on behalf of the BMWFW.

Aid, Infrastructure, and FDI: Assessing the Transmission Channel with a New Index of Infrastructure

Julian Donaubauer, Helmut Schmidt University Hamburg

Birgit Meyer, University of Kiel

Peter Nunnenkamp, Kiel Institute for the World Economy

Draft – November, 2014

Abstract: We raise the hypothesis that aid specifically targeted at economic infrastructure helps developing countries attract higher FDI inflows through improving their endowment with infrastructure in transportation, communication, energy and finance. By performing 3SLS estimations we explicitly account for dependencies between three structural equations on the allocation of sector-specific aid, the determinants of infrastructure, and the determinants of FDI. We find fairly strong and robust evidence that targeted aid promotes FDI indirectly through the infrastructure channel. In addition, aid in infrastructure appears to have surprisingly strong direct effects on FDI.

Keywords: aid effectiveness, sector-specific aid, foreign direct investment, infrastructure

JEL classification: F21; F35; O18

1. Introduction

Official development assistance (ODA) and foreign direct investment (FDI) are widely perceived to be alternative means of supplementing domestic savings and promoting economic development in low and middle income countries. Developing countries being attractive to FDI are often contrasted with those being dependent on ODA (UNCTAD 2011; OECD 2014).[1] The argument for FDI is typically considered "compelling" as it "brings with it not only resources, but technology, access to markets, and (hopefully) valuable training, an improvement in human capital" (Stiglitz 2000: 1076). By contrast, aid critics stress the disincentive effects of ODA and contend that "successful cases of development happening due to large inflow of aid and technical assistance have been hard to find" (Easterly 2007: 329).

Possible complementarities of aid and FDI have received limited attention so far. In particular, it remains open to debate whether aid could render recipient countries more attractive to FDI. The evidence from earlier studies employing aggregate aid data is inconclusive (e.g., Yasin 2005; Harms and Lutz 2006; Asiedu et al. 2009). Furthermore, the available literature largely neglects the transmission mechanisms through which aid may help promote FDI.[2]

We address this gap in the literature by analyzing whether aid meant to improve the recipient countries' economic infrastructure helps remove specific bottlenecks that prevent higher FDI inflows. In other words, we assess whether a particular type of aid promotes FDI through the infrastructure channel. Poor infrastructure is often mentioned as an important constraint to FDI by foreign investors.[3] Asiedu (2002: 111) argues that "good infrastructure

[1] In an earlier report, UNCTAD (2005: 4) stressed the relatively low FDI flows to Africa: "A corollary of these trends is that, in contrast with all other developing regions, Africa has remained aid-dependent."

[2] This also applies to recent studies which disaggregate aid at least to some extent, including Kimura and Todo (2010), Selaya and Sunesen (2012), and Donaubauer et al. (2014a). Vijil and Wagner (2012) explicitly address the infrastructure channel to assess the effects of aid on trade, rather than FDI. See Section 2 for details.

[3] See, for example, the annual reports of the Multilateral Investment Guarantee Agency of the World Bank (MIGA) on World Investment and Political Risk: http://www.miga.org/resources/index.cfm?stid=1866 (accessed: August 2014).

increases the productivity on investments and therefore stimulates FDI." However, as stressed by Straub (2011) and Donaubauer et al. (2014b), the measurement of infrastructure suffers from serious data limitations, rendering it difficult to provide a comprehensive evaluation of the infrastructure channel.[4]

To overcome this limitation of previous studies we make use of a new and comprehensive index of infrastructure for a large number of aid-recipient countries, covering the 1990-2010 period (Donaubauer et al. 2014b). We argue that the considerably improved database on various dimensions of infrastructure allows for a more systematic analysis at three critical junctures in the transmission from aid to FDI: (i) whether the allocation of aid is needs-based by targeting recipient countries with less developed infrastructure, (ii) whether aid is effective in improving the recipient country's infrastructure, and (iii) whether aid impacts on FDI via infrastructure. We disaggregate aid accordingly, by focusing on aid in infrastructure and specific 'sub-sectors' of infrastructure (transportation, communication, energy, and finance). On this basis, we estimate a system of equations on the allocation of sector-specific aid, the determinants of infrastructure (including aid), and the determinants of FDI (including infrastructure as well as aid).

In Section 2, we shortly review the relevant literature and derive our central hypothesis. Section 3 provides details on the data and our empirical approach. We present our empirical results in Section 4, and conclude in Section 5. We find fairly strong and robust evidence that targeted aid promotes FDI indirectly through the infrastructure channel. In addition, aid in infrastructure appears to have surprisingly strong direct effects on FDI.

2. Related literature, hypotheses and previous findings

Policymakers in developing countries and international advisers largely agree that FDI has great potential to transfer technology, provide well-paid employment opportunities, and

[4] For instance, Asiedu (2002) considers a single indicator, the number of telephones per 1,000 population, to capture the role of infrastructure for FDI.

promote economic growth in the host countries (e.g., OECD 2002). According to the United Nations (2003: 9), "a central challenge, therefore, is to create the necessary domestic and international conditions to facilitate direct investment flows." Against this backdrop, we raise the hypothesis that the donors of official development assistance could help improve the attractiveness of developing countries to FDI inflows.

The effects of foreign aid on FDI flows to developing countries are theoretically ambiguous (Harms and Lutz 2006; Kimura and Todo 2010). Positive effects can be expected to the extent that aid increases the productivity of private investment by improving the supply of complementary factors of production (Selaya and Sunesen 2012). In contrast, aid could have adverse effects on FDI inflows by encouraging rent-seeking (Economides et al. 2008) and by crowding out private foreign activity in the tradable goods sector (Beladi and Oladi 2007).

The small empirical literature on the effects of foreign aid on FDI flows to developing countries mirrors the theoretical ambiguity.[5] According to the pioneering study of Harms and Lutz (2006), overall aid generally has no significant effects on FDI.[6] Another prominent study by Asiedu et al. (2009) finds even negative effects on FDI in low-income host countries, although aid tends to reduce the adverse impact of country risk on FDI. Selaya and Sunesen (2012) distinguish between two broadly defined types of aid, i.e., (i) "aid invested in complementary inputs" such as education, health, energy, transport and communication and (ii) "aid invested in physical capital" including transfers to directly productive sectors such as agriculture, industry, trade and banking.[7] Selaya and Sunesen (2012) find that the first type of aid attracts FDI, while the second type of aid crowds FDI out.

[5] See Donaubauer et al. (2014a) for a more detailed discussion of previous empirical studies.
[6] Surprisingly, however, Harms and Lutz (2006) find positive effects of aid on FDI in host countries with considerable restrictions on FDI-related activities.
[7] Likewise, Kimura and Todo (2010) roughly distinguish between project-related aid and other aid such as general budget support, debt relief and humanitarian aid. Both types of aid are not related to FDI in their empirical analysis, except for Japanese aid which helps promote Japanese FDI.

We suspect that the previous empirical literature on aid and FDI largely suffers from two related shortcomings that we attempt to overcome in our analysis below. First, the transmission mechanisms through which aid may promote FDI are insufficiently specified, if at all. Second, the rough disaggregation of aid in recent studies such as Kimura and Todo (2010) and Selaya and Sunesen (2012) is insufficient to identify those aid categories that could foster FDI through specific transmission mechanisms. Consequently, we raise the more specific hypothesis that narrowly defined categories of aid can remove critical impediments to higher FDI inflows and, thereby, promote FDI in developing countries receiving appropriately targeted sector-specific aid.

By addressing this issue we evaluate the OECD's (2002: 33) claim that "carefully targeted development assistance may assist in leveraging FDI flows and creating a virtuous circle of increasing savings and investment." The aid effectiveness literature provides some, though typically disputed evidence on possible transmission mechanisms through which aid helps remove impediments to higher FDI inflows: "Efforts to improve physical infrastructure, human capital and health in developing countries are all cases in point" (OECD 2002: 34). For instance, Vijl and Wagner (2012) provide cross-country evidence supporting the view that well-targeted aid improves the recipient country's infrastructure. According to Mishra and Newhouse, health aid reduces infant mortality in the recipient countries.[8] Dreher et al. (2008) and D'Aiglepierre and Wagner (2013) find aid in education to be effective in improving educational outcome variables.

Donaubauer et al. (2014a) refer to the literature on effective aid in education, arguing that this type of aid may promote FDI by working through the channel of better education and qualification. Indeed they find aid in education to be positively associated with FDI flows to Latin American host countries, but their empirical model does not explicitly account for the assumed transmission mechanism. By contrast, we focus on bottlenecks related to economic

[8] By contrast, Williamson (2008) finds that health aid is ineffective with respect to several health indictors.

infrastructure and we explicitly account for the infrastructure channel in our empirical model to assess the effectiveness of aid in infrastructure in terms of promoting FDI in developing countries (see Section 3). Vijil and Wagner (2012) take a similar approach of assessing whether so-called aid-for-trade works through the infrastructure channel in enhancing the export performance of recipient countries. However, to the best of our knowledge, we are the first to provide an empirical test of the hypothesis that aid specifically targeted at infrastructure helps developing countries attract higher FDI inflows through improving their endowment with infrastructure in transportation, communication, energy and finance.

Our focus on infrastructure is for two major reasons. First of all, it is widely believed that a sufficient endowment with infrastructure is critically important for the chances of various developing countries to attract more FDI. The few available studies, including Asiedu (2002) and Kumar (2006), tend to support this view – but they are typically based on limited information and selected indicators of infrastructure.[9] Second, data constraints that traditionally prevented a systematic assessment of the links between aid, infrastructure and FDI have been relaxed since the collection of comprehensive data on various aspects of economic infrastructure and the construction of aggregate indices by Donaubauer et al. (2014b). As discussed in more detail in the subsequent section, we make use of this new dataset to test our hypothesis on the effectiveness of aid targeted at infrastructure.

3. Method and data

The following FDI equation represents the starting point of our empirical analysis:

$$FDI_{it} = \alpha + \beta_1 aid_{it-1} + \beta_2 infrastructure_{it-1} + \beta_3 X_{it-1} + \eta_i + \varphi_t + \varepsilon_{it} \quad (1)$$

where the dependent FDI variable represents FDI inflows in percent of host country *i*'s GDP in year *t*.[10] The FDI data are from UNCTAD.[11] Two explanatory variables are of principal

[9] Cheng and Kwan (2000) find that better infrastructure stimulated FDI in Chinese regions.
[10] Using FDI flows for the dependent variable is standard in the relevant literature; see, e.g., Asiedu (2002), Harms and Lutz (2006), Asiedu et al. (2009), Kimura and Todo (2010), Selaya and Sunesen (2012), and

interest: aid_{it-1} and $infrastructure_{it-1}$. The aid variable represents (logged) annual flows of aid as reported by the OECD-DAC's Creditor Reporting System (CRS) under CRS code 200, i.e., economic infrastructure, to country *i* in year *t-1*; in additional estimations, we replace total aid in infrastructure by aid in specific sub-categories, i.e., CRS codes 210 (transport and storage), 220 (communications), 230 (energy), and 240 (banking and finance). To obtain sector-specific disbursements in these aid categories, we follow common practice in the literature by adjusting the aid commitment data reported in the CRS.[12] Note that we include (logged) aid in all other sectors among our control variables.[13] The aid variables and all other explanatory variables are lagged by one year.[14]

The construction of our index of infrastructure is explained in considerable detail in Donaubauer et al. (2014b). Importantly, the index is based on a broad annual dataset of 30 indicators of the quantity and quality of infrastructure in a large number of developing (and developed) countries, covering the 1990-2010 period. The index combines data from various sources to overcome serious data limitations in previous research related to infrastructure. Our aggregate indices of infrastructure are constructed by using an unobserved components model, where observed data in each area of infrastructure are a linear function of unobserved infrastructure and an error term. The variable $infrastructure_{it-1}$ relates to the index of overall infrastructure for country *i* in year *t-1*; it ranges from 0 to 100 with higher values indicating better infrastructure. In additional estimations, we alternatively use four sub-indices of

---

Donaubauer et al. (2014a). As discussed in more detail in Section 4.c below, we use inward FDI stocks as percentage of the host country's GDP in our robustness tests.

[11] Available at http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx?sCS_ChosenLang=en (accessed: August 2014).

[12] For a recent example, see Hühne et al. (2014) and the references given there. Specifically, we use the DAC's aggregate aid statistics to account for two potential biases. First, we multiply sector-specific CRS commitments with the ratio of total aid disbursements over total aid commitments (by donor *j* to recipient *i* in year *t*) since donors disburse typically less aid than they committed to do. Second, we multiply with the ratio of total DAC commitments over the accumulated project-based commitments from the CRS in order to adjust for under-reporting in the project-based CRS.

[13] All aid data are available at: http://stats.oecd.org/qwids.

[14] See Appendix A for summary statistics.

infrastructure that closely resemble the above noted sub-categories of aid in infrastructure, namely transportation, ICT, energy and finance.

X in equation (1) represents the vector of control variables, while η_i, $\varnothing_t$ and ε_{ti} are country fixed effects, year dummies, and the error term, respectively. In addition to aid in sectors other than infrastructure, we consider control variables that are commonly used in the literature on the determinants of FDI. In cross-country analyses, the host country's per-capita income (*GDP p.c.*; logged) typically accounts for the fact that FDI is concentrated in relatively advanced host countries. In panel estimations with country fixed effects included (as done here), however, *GDP p.c.* rather captures the variation of incomes and related production costs within host countries over time. We include the host country's (logged) GDP and its economic growth rate (*GDP* and *growth*) as proxies of the size and growth of local markets, which have often been shown to drive horizontal or market-seeking FDI. *Openness to trade* is defined as the sum of the host country's exports plus imports as a share of GDP and accounts for the fact that FDI and trade tend to complement each other. Finally, FDI may obviously be encouraged by a more favourable investment climate and lower country risk. The data on *GDP p.c.*, *GDP*, *growth*, and *openness to trade* are taken from the World Bank's World Development Indicators.[15] The data on *investment climate* are from the International Country Risk Guide (ICRG).[16]

We address the potential endogeneity of *aid* and *infrastructure* in equation (1) by taking their determinants explicitly into account in equations (2) and (3):

$$aid_{it} = \alpha_{aid} + \beta_1 infrastructure_{it-1} + \beta_2 X_{aid\,it-1} + \eta_{aid\,i} + \varphi_{aid\,t} + \varepsilon_{aid\,it}\,, \qquad (2)$$

$$infrastructure_{it} = \alpha_{infra} + \beta_1 aid_{it-1} + \beta_2 X_{infra\,it-1} + \varphi_{infra\,t} + \varepsilon_{infra\,it}\,, \qquad (3)$$

with *X* representing the respective vector of control variables.

[15] Available at: http://data.worldbank.org/data-catalog/world-development-indicators (accessed: August 2014).
[16] Available at: https://www.prsgroup.com/about-us/our-two-methodologies/icrg (accessed: August 2014).

The specification of equation (2) with (logged) aid flows in infrastructure as the dependent variable follows the standard literature on aid allocation by including indicators of the recipient countries' need for aid, their merit of aid and the donors' self-interest in the vector X_{aid}.[17] In addition to (logged) *GDP p.c.* as the commonly used indicator of need, we consider specific needs related to infrastructure that might be associated with higher aid in infrastructure from donors with a well-targeted aid allocation.[18] Meritorious recipient countries may receive more aid from donors honouring better local institutions, proxied by *law and order* taken from the ICRG, which may render aid more effective. On the other hand, self-interested donors have often been supposed to grant more aid to more important trading partners among recipient countries (proxied by *trade share*) and to countries serving as (temporary) members of the UN Security Council (*UNSC*).[19] We also include the recipient country's (logged) population (*population*) to take into account that more populated countries tend to receive more aid (in absolute terms), as well as (logged) aid received in sectors other than infrastructure to account for complementarities of different types of aid.[20]

In equation (3) with our index of infrastructure as the dependent variable, *aid* represents the explanatory variable of major interest to assess whether aid in infrastructure improves the recipient country's endowment with infrastructure. In addition, the vector X_{infra} includes aid in sectors other than infrastructure, *GDP p.c.*, *population*, and the country's geographic area (*area*) as control variables.[21] *Population* and *GDP p.c.* are standard in the related literature to "control for demand effects and the cost of supply" (Vijil and Wagner

[17] Recent contributions to this literature include Claessens et al. (2009), Hoeffler and Outram (2011) and Barthel et al. (2014).

[18] The baseline regressions include our index of infrastructure, $infrastructure_{it}$, to capture specific needs for aid in infrastructure. However, as explained in more detail in Section 4.b below, we subsequently prefer a refined measure of needs related to infrastructure.

[19] Alesina and Dollar (2000) is the seminal study on donors' self-interest. Barthel et al. (2014) review the recent evidence on export-related interests. Strategic and political interests of donors have typically been proxied by voting alignment in the UN General Assembly. As argued by Dreher et al. (2014), however, temporary membership in the UN Security Council is a potentially superior measure. We use the (logged) share of a recipient country in world exports to all recipient countries to proxy its importance as a trading partner; these data are taken from the WDI database. *UNSC* is a dummy variable set to one in years of UNSC membership (available at: http://www.un.org/en/sc/members/; accessed: August 2014).

[20] Considering that *other aid* is lagged by one year, this variable may also capture inertia in aid allocation.

[21] As the other variables, *area* is also logged; data are from the WDI.

2012: 857; see also Canning 1998). Likewise, *area* is widely used as efficient infrastructure is more difficult to provide in the remote areas of large countries.[22] As in equation (1), all explanatory variables in equation (2) and (3) are lagged by one year.

Equations (1) – (3) are estimated simultaneously by 3SLS, which explicitly allows us to account for dependencies between our three structural equations.[23] We cover the 1990-2010 period as earlier data on sector-specific aid are not reliable, and more recent data on the index of infrastructure are not yet available. Our sample includes all low and middle income countries that received aid during this period.[24]

4. Results

a. Baseline estimations

Table 1 reports our baseline results. We perform two variants of the 3SLS estimation of equations (1) – (3) introduced in Section 3 above. In columns (1)-(3) of Table 1, we omit aid granted in sectors other than infrastructure (*other aid*). By contrast, we include *other aid* in all three equations in columns (4)-(6).

Looking first at the results on the equation with infrastructure as the dependent variable, the treatment of *other aid* hardly affects the findings on the standard determinants of a country's endowment with economic infrastructure. In line with previous studies such as Canning (1998) and Vijil and Wagner (2012), we find a significantly better endowment with infrastructure when countries are richer (*GDP p.c.*), more populated (*population*) and smaller (*area*). Taking the coefficients in column (3) at face value, a one percent increase in *GDP p.c.* is associated with a considerable improvement of infrastructure by 4.7 points on the 0-100 scale of our index. A one percent increase in *population* and a one percent smaller *area* are

[22] Note that we do not include country fixed effects in Equation (3) since an *F*-test shows their joint insignificance at the one percent level. *Area* is included as time-invariant variable in Equation (3).
[23] *Trade share, UNSC* and *area* satisfy as exclusion restrictions for this sample such that each equation of the system is properly identified.
[24] A detailed country composition of our sample can be found in Appendix B.

associated with an improvement of the index of infrastructure by 1.4 and 0.9 points, respectively.

In the present context, the most interesting finding is that aid in infrastructure appears to be effective in improving the recipient countries' endowment with economic infrastructure. The coefficient on aid in infrastructure proves to be statistically significant at the one percent level. Furthermore, the quantitative impact of aid in infrastructure is remarkably strong, with an increase by one percent being associated with an improvement of the index of infrastructure by 0.9 points in column (3) of Table 1. The impact increases slightly in column (6) when accounting for *other aid*. Importantly, and in sharp contrast with aid in infrastructure, *other aid* has no significant effect on the recipient countries' endowment with infrastructure.

The positive effect of aid in infrastructure on the recipients' endowment with infrastructure may be surprising when considering the results on the aid equation in columns (2) and (5) of Table 1. In particular, the allocation of aid in infrastructure does not appear to be needs-based. Both indicators of need – the commonly used *GDP p.c.* to capture general need as well as the specific needs related to infrastructure, as reflected in our index of infrastructure – prove to be insignificant at conventional levels.[25] Taken together, the results for the equations with infrastructure and aid as dependent variables would then imply that aid in infrastructure is effective, but not necessarily where the need for such aid is most pressing. We return to this issue in the next sub-section where we use a refined indicator of need related to infrastructure.

In addition, we find no evidence in Table 1 that the allocation of aid in infrastructure is influenced by the donors' economic or strategic self-interest, as reflected in *trade share* and

[25] It should be recalled at this point that we control for recipient country fixed effects. As shown by Dreher et al. (2013) and Barthel et al. (2014), the evidence for a needs-based aid allocation weakens considerably once the variation of the indicators of need is restricted in this way.

UNSC.[26] However, our indicator on the recipients' merit of aid, *law and order*, proves to be highly significant. The significantly positive coefficient on *other aid* in column (5) points to complementarities between aid in different sectors and inertia, which are not particularly strong, however, with an elasticity of 0.13.

Turning to the FDI equation, it has to be stressed again that the 3SLS estimation accounts for the endogeneity of aid and infrastructure as the determinants of principal interest. The results on the control variables included in the FDI equation are mostly plausible. The significantly negative coefficient on *GDP p.c.*, at the one percent level in columns (1) and (4) of Table 1, suggests that rising incomes within host countries over time and the associated cost increases discourage FDI inflows. Surprisingly, higher economic growth in the host countries of FDI is not associated with higher FDI inflows at conventional levels of statistical significance. By contrast, it is in line with expectations that FDI inflows increase when the host country's investment climate improves. The negative and insignificant coefficient on *GDP* can be attributed to the fact that the dependent FDI variable is defined relative to the host country's GDP. The within variation of *openness to trade* tends to be relatively small, compared to the variation across host countries. Nevertheless, this variable enters positive and significant at the ten percent level.

More interestingly in the present context, our index of infrastructure proves to be significantly positive in both variants of the 3SLS estimations in Table 1. This finding suggests that aid in infrastructure promotes FDI inflows through its impact on the host country's endowment with economic infrastructure. The quantitative impact is considerable when taking the coefficient on the index of infrastructure in column (1) at face value. An improvement by ten points on the 0-100 scale of the index (corresponding to almost one standard deviation) is associated with an increase in FDI inflows, in percent of the host

[26] This does not necessarily imply that the self-interest of donors plays a minor role in the allocation of aid in infrastructure. Previous studies on the allocation of overall aid suggest that trade-related determinants matter primarily for the allocation of aid across recipient countries (see Barthel et al. 2014 for details).

country's GDP, by 4.6 percentage points (or 0.6 standard deviations). Recalling the coefficient on aid in infrastructure of almost 0.9 from column (3), a ten-percent increase in this type of aid would raise the FDI variable by almost 4.2 percentage points by working through the infrastructure channel.

We do not find evidence in Table 1 that aid in infrastructure has a direct effect on FDI inflows. The insignificant coefficient on aid in infrastructure in the FDI equations in columns (1) and (4) rather suggests that it is only through the infrastructure channel that this type of aid is effective in stimulating FDI inflows. Finally, the coefficient on *other aid* also proves to be insignificant at conventional levels in column (4), suggesting that it is only aid in infrastructure that is indirectly effective in promoting FDI inflows by improving the recipient country's endowment with economic infrastructure.

b. Refining need for infrastructure

In the following, we modify the measurement of the recipients' need for aid in infrastructure and re-estimate the system of equations (1) – (3) with the 3SLS estimator.[27] The modified measurement of need is motivated by the weak evidence for a needs-based allocation of aid in the baseline estimations. Specifically, we derive the need related to infrastructure from the 'normal pattern' of the endowment of countries with infrastructure. The normal pattern results from regressing our index of infrastructure on the countries' per-capita income (*GDP p.c.*), *population* and geographic *area*.[28] Appendix C reports these regressions for our overall index on infrastructure and the four sub-indices, based on pooled annual data covering the 1990-2010 period. The specific need for aid in infrastructure is then proxied by comparing the expected endowment with infrastructure – given the country's per-capita income, population and area in year *t* – and the actually observed index of infrastructure for the country in year *t*.

[27] Note that the R^2's of the individual equations are statistically not particularly meaningful when estimating the system of equations with 3SLS. For details see: http://www.stata.com/support/faqs/statistics/two-stage-least-squares (accessed: August 2014).
[28] All three variables are logged and lagged by one year.

The specific need for aid in infrastructure is assumed to be zero when the actually observed index value is higher than the value to be expected from the normal pattern. Whenever the actual index value is below the expected value, we consider the absolute deviation from the normal pattern (on a scale from 0 to 100) as our modified measure of specific need related to infrastructure. Note that this definition implies that higher values of our modified measure indicate greater need.

Table 2 reports the 3SLS results after modifying the measurement of need as just described. As can be seen, the equation with the index of infrastructure as the dependent variable is hardly affected, compared to Table 1. This is independent of whether *other aid* is excluded from the estimation (column 3) or included (column 6). Importantly, aid in infrastructure continues to be effective in improving the recipient countries' endowment with infrastructure. The quantitative impact is similarly strong when comparing the results in Tables 1 and 2. It also holds that *other aid* is not effective in improving infrastructure.

In contrast, the modified measurement of need changes the picture on aid allocation considerably. We now find evidence for a needs-based allocation of aid in infrastructure in columns (2) and (5) of Table 2. The coefficient on *infrastructure needs* in column (2) would imply that aid in infrastructure increases by about 2.1 percent when the gap between the expected and actual endowment with infrastructure widens by 10 index points – a modest, though not negligible effect. The effect appears to be weaker when including *other aid* among the control variables.[29]

More surprisingly, the modified measurement of need specifically related to infrastructure is also associated with stronger evidence on *GDP p.c.*, i.e., the traditional indicator on general need for aid. The coefficient on *GDP p.c.* now enters significantly negative, at the one percent level in columns (2) and (5). This finding is also quantitatively

[29] However, the coefficients on *infrastructure needs* in columns (2) and (5) are not fully comparable. As noted in Section 3, the lagged observations of *other aid* may also capture inertia in aid allocation. This would imply that the coefficient on *infrastructure needs* in column (5) mainly reflects the shorter-run effects on the allocation of aid in infrastructure.

relevant, indicating that a one-percent increase in the recipient country's per-capita income lowers the inflow of aid in infrastructure by 2.4 percent in column (2). The evidence for the remaining determinants of aid in infrastructure is largely as before in Table 1. The most notable exception is the coefficient on *trade share* which now suggests that donors grant more aid when recipient countries become more important trading partners.

The results shown in columns (1) and (4) of Table 2 indicate that the implications of the modified measurement of need extend beyond the allocation of aid. The FDI equation is also affected.[30] The positive impact of *infrastructure* on FDI appears to be slightly stronger than in the corresponding baseline estimations. Together with the evidence on the determinants of infrastructure and aid allocation, Table 2 thus suggests that aid in infrastructure promotes FDI inflows through improving infrastructure in recipient countries falling below the normal pattern of endowments with infrastructure. More precisely, a ten-percent increase of aid in infrastructure would raise the FDI variable by 4.7 percentage points (about 0.6 standard deviations) in column (1) through improving the index of infrastructure by almost 9.3 points in column (3).

At the same time, we now find an additional direct effect of aid in infrastructure on FDI. The direct effect proves to be statistically significant at the one percent level in columns (1) and (4). Taking the coefficients at face value, a ten-percent increase of aid in infrastructure would lead to an increase in FDI inflows, in percent of GDP, by 14-15 percentage points (i.e., about two standard deviations). This is in sharp contrast with *other aid* – which continues to be ineffective in promoting FDI, both directly and indirectly through the infrastructure channel.

The surprisingly strong direct effect of aid in infrastructure on FDI in Table 2 suggests that foreign investors anticipate longer-term effects on the country's endowment with infrastructure which are not yet reflected by the index of infrastructure. Donaubauer et al.

[30] The evidence on the control variables is largely as before in Table 1. The only exception is that *openness to trade* is no longer significant at conventional levels.

(2014a) find similar anticipation effects of aid in education on FDI flows to Latin America. Mayer (2006: 45) argues more generally that aid commitments "can have a large signaling role for foreign investors." Foreign investors may also be confident that aid-financed infrastructure serves them particularly well, compared to locally financed infrastructure. Aid-financed infrastructure may focus more strongly on FDI-related needs, it may be of superior quality, or it may be better maintained due to external control and oversight.[31] Such differences between aid-financed and locally financed infrastructure would largely escape our measurement of infrastructure and could be captured directly by the aid variable.

c. Robustness and disaggregation

In all robustness tests and extensions reported in the following we maintain the modified measurement of needs specifically related to infrastructure. In contrast to columns (1) and (4) of Table 2, however, we consider inward FDI stocks, in percent of the host country's GDP, as the dependent variable in the FDI equations reported in columns (1) and (4) of Table 3. While the preferred definition with FDI flows should fit well with aid flows as our explanatory variable of principal interest, FDI stocks may provide a better fit with the persistent endowment of countries with infrastructure. FDI inflows as well as aid flows are often quite volatile, especially in small and less developed host countries.

As can be seen in columns (3) and (6) of Table 3, the evidence on the determinants of the countries' endowment with economic infrastructure is qualitatively as before. The quantitative impact of aid in infrastructure is considerably smaller than in Table 2, but the coefficient on this type of aid continues to be significantly positive (in contrast to *other aid* in column 6). The allocation of aid in infrastructure does not appear to be needs-based when

[31] For instance, FDI-related needs may be particularly pressing with respect to sea and air transport, while local authorities may be mainly concerned about roads. Or foreign investors care mainly about transport and communication networks in the host country's economic centers, whereas the host country's government builds such networks not least to better connect remote areas.

considering FDI stocks instead of FDI flows as the ultimate outcome variable in our system of equations. The insignificance of our indicators on general and specific need for aid resembles the baseline estimations in Table 1, while being in conflict with the related evidence in Table 2.

Considering our variables of major interest as determinants of FDI stocks, the coefficient on *infrastructure* is strongly significant and positive as before with FDI flows.[32] Moreover, the quantitative impact of *infrastructure* is similar to that in Table 2 when taking into account that the mean and the standard deviation of the dependent FDI stock variable are about 9-10 times as large as the mean and the standard deviation of the dependent FDI flow variable in Table 2. Consequently, an improvement in infrastructure by 10 points in column (1) is again associated with an increase in the FDI variable by about 0.6 standard deviations.

All the same, the indirect effect of aid in infrastructure on the FDI variable weakens because of aid's smaller impact on *infrastructure* (as noted above). The direct impact of aid in infrastructure on the FDI variable also weakens in Table 3 (to 0.65 standard deviations of the FDI variable in column 1, when aid increases by 10 percent), compared to Table 2. Yet the direct effect remains surprisingly strong, relative to the indirect effect through the infrastructure channel, when replacing FDI inflows by FDI stocks in the FDI equation. Finally, the contrast between aid in infrastructure and *other aid* sharpens in column (4) of Table 3. The coefficient on *other aid* proves to be significantly negative with FDI stocks as the dependent variable, which appears to be in line with the widespread perception of FDI and aid as alternative means of external financing in many lower income countries (see the Introduction).

In Table 4, we return to the standard definition of *FDI* with FDI inflows as the dependent variable in the FDI equation. We replicate the estimation shown in columns (1)-(3)

[32] The evidence on most of the control variables in columns (1) and (4) is very similar to Table 2, in terms of the significance and signs of the coefficients. GDP now proves to be significantly negative, whereas the significantly positive coefficient on *openness to trade* points to stronger complementarities between trade and FDI when replacing the more volatile FDI flows by the more persistent FDI stocks.

of Table 2 for reduced samples.[33] Specifically, we exclude the top and bottom deciles of all observations on (i) aid in infrastructure in columns (1)-(3) of Table 4, (ii) FDI flows in percent of GDP in columns (4)-(6), and (iii) the overall index of infrastructure in columns (7)-(9) to test whether our major results depend on sample selection. Previous findings on aid and infrastructure as determinants of FDI prove to be robust in Table 4. While the size of the coefficients on the index of infrastructure and aid in infrastructure varies, the coefficients enter significantly positive at the one percent level with just one exception.[34] Furthermore, there is again strong evidence for indirect effects of aid in infrastructure working through the infrastructure channel when excluding the top and bottom deciles in terms of aid in infrastructure, the dependent FDI variable, or the index of infrastructure (columns 3, 6 and 9). Note also that we again find the allocation of aid in infrastructure to be needs-based. In particular countries which fall further behind the normal pattern in terms of endowment with infrastructure typically receive more aid in infrastructure (except when excluding the top and bottom deciles for the dependent FDI variable; column 5).

In Table 5, we take a more specific view on both the recipient countries' endowment with infrastructure and the donors' aid in infrastructure. We replace our overall index of infrastructure by the sub-indices of the four components of infrastructure related to transport, ICT, energy and finance. Correspondingly, we replace total aid in infrastructure (CRS code 200) by its sub-categories related to transport and storage (210), communications (220), energy (230), and banking and finance (240).[35]

The evidence on most of the control variables in Table 5 does not offer additional insights so that we focus on aid and infrastructure as our variables of major interest. As can be seen, the findings on infrastructure as a determinant of *FDI* prove to be fairly robust. The sub-

[33] We also replicated the estimation shown in columns (4)-(6) of Table 2. These results are available on request.
[34] The coefficient on infrastructure is significant at the five percent level only in column (4) when excluding the top and bottom deciles of the dependent FDI variable.
[35] For the sake of brevity, the estimations for the sub-indices of infrastructure and the sub-categories of aid in infrastructure are again restricted to the specification without *other aid*.

indices of infrastructure enter significantly positive in all four FDI equations (columns 1, 4, 7 and 10). However, the sub-index of transport infrastructure has by far the strongest impact on *FDI*.[36] The evidence is weakest for the sub-index of energy-related infrastructure, in terms of both statistical significance and quantitative impact. The comparatively weak evidence for this sub-index may be attributed to measurement problems, notably with regard to capturing the reliability of energy supply. One may also suspect that FDI reacts less to improved infrastructure in energy-rich host countries where FDI restrictions continue to be relatively strict.

While infrastructure generally matters, three out of four sub-categories of aid in infrastructure promote FDI through the corresponding infrastructure channel for transport, energy, and finance. The exception relates to aid in communication infrastructure and the corresponding ICT channel. The significantly negative coefficient on aid in column (6) of Table 5 is counterintuitive. It should be noted, however, that aid in communication infrastructure contributed less than eight percent to overall aid in infrastructure throughout our period of observation. Consequently, the volatility of annual aid flows tends to be particularly large for this sub-category of aid. In quantitative terms, aid in transport infrastructure and aid in financial infrastructure appear to be similarly effective in promoting FDI indirectly though improving the host countries' endowment with infrastructure in transportation and finance, respectively.[37] In contrast to finance, however, the indirect effect working through transport infrastructure would not benefit needier recipient countries. Column (2) rather suggests that the allocation of aid in transport infrastructure is biased against recipients with greater need.[38]

Finally, Table 5 indicates that the direct effects of aid in infrastructure on the dependent FDI variable are restricted to the two large sub-categories. The coefficients on aid

[36] An increase by 10 index points would be associated with an increase in *FDI* by 5.7 percentage points.
[37] A ten-percent increase in aid would raise *FDI* by 2.6 (4.56 * 0.565) and 3.0 (14.67 * 0.207) percentage points, respectively. The indirect effect appears to be marginal for a ten-percent increase in aid in energy-related infrastructure (1.36 * 0.0815 = 0.11).
[38] The same applies to aid in energy-related infrastructure in column (8).

are significantly positive, at the one percent level, as well as quantitatively important for transportation in column (1) and energy in column (7). These sub-categories of aid contributed 48.4 and 34.8 percent, respectively, to overall aid in infrastructure during the 1990-2010 period. By contrast, the coefficients on aid are insignificant at conventional levels for the two small sub-categories, communication (column 4) and finance (column 10). This result is plausible considering that the aid signal has to be sufficiently strong to trigger anticipation effects.

5. Summary and conclusion

According to the small existing literature, it has proven elusive to improve the attractiveness of low and middle income countries to FDI by stronger overall aid efforts by the donors of official development assistance. Instead of considering aggregate aid flows, we focus on sector-specific aid to assess possible complementarities between aid and FDI and identify the transmission mechanisms through which aid may promote FDI. Specifically, we raise the hypothesis that aid specifically targeted at economic infrastructure helps developing countries attract higher FDI inflows through improving their endowment with infrastructure in transportation, communication, energy, and finance.

We make use of a new and comprehensive index of economic infrastructure for a large number of aid-recipient countries, covering the 1990-2010 period. By performing 3SLS estimations we explicitly account for dependencies between three structural equations on the allocation of sector-specific aid, the determinants of infrastructure, and the determinants of FDI. This approach allows us to simultaneously assess three critical junctures in the transmission from aid to FDI: (i) whether the allocation of aid is needs-based by targeting recipient countries with less developed infrastructure, (ii) whether aid is effective in improving the recipient country's infrastructure, and (iii) whether aid impacts on FDI via infrastructure.

We find strong and robust evidence that aid in infrastructure is effective in improving the recipient countries' endowment with infrastructure. In sharp contrast, *other aid* is not effective in improving infrastructure. Considering that infrastructure consistently proves to be an important determinant of developing countries' attractiveness to FDI, our findings imply that only targeted aid promotes FDI indirectly through the infrastructure channel. In addition, aid in infrastructure appears to have surprisingly strong direct effects on FDI. It seems that foreign investors anticipate longer-term effects of aid on the country's endowment with infrastructure and expect aid-financed infrastructure to serve them particularly well. While the evidence for a needs-based allocation of aid in infrastructure is sensitive to the measurement of need, our preferred specification suggests that recipients whose endowment with infrastructure is relatively poor tend to benefit more from aid in infrastructure.

Clearly, the hypothesis that specific categories of aid can promote FDI by removing critical impediments to higher FDI flows to developing countries calls for more empirical research. In particular, the OECD's (2002: 33) claim that "carefully targeted development assistance may assist in leveraging FDI flows and creating a virtuous circle of increasing savings and investment" could relate as much to aid in social infrastructure (including education, health and governance issues) as to aid in economic infrastructure. Consequently, extended efforts at data collection and index construction could prove useful to identify country-specific bottlenecks to higher FDI flows in social infrastructure, and to assess whether the corresponding aid categories are effective in overcoming such bottlenecks. On the basis of a fuller account of country-specific bottlenecks, it might become feasible to compare FDI-related needs for sector-specific aid with actual aid patterns. Correcting for mismatches could render aid more effective in promoting FDI, to the extent that re-directing aid to the most relevant sectors would activate further transmission mechanisms in addition to improving the host countries' endowment with economic infrastructure.

References

Alesina, A. and D. Dollar (2000). Who gives foreign aid to whom and why? *Journal of Economic Growth* 5(1): 33–63.

Asiedu, E. (2002). On the determinants of foreign direct investment to developing countries: Is Africa different? *World Development* 30(1): 107–119.

Asiedu, E., Y. Jin and B. Nandwa (2009). Does foreign aid mitigate the adverse effect of expropriation risk on foreign direct investment? *Journal of International Economics* 78(2): 268–275.

Barthel, F., E. Neumayer, P. Nunnenkamp and P. Selaya (2014). Competition for export markets and the allocation of foreign aid: The role of spatial dependence among donor countries. *World Development,* forthcoming.

Beladi, H. and R. Oladi (2007). Does foreign aid impede foreign investment? In: S. Lahiri (Ed.), *Theory and Practice of Foreign Aid.* Amsterdam: Elsevier (pp. 55–63).

Canning, D. (1998). A database of world stocks of infrastructure, 1950-95. *World Bank Economic Review* 12(3): 529–547.

Chen, L.K. and Y.K. Kwan (2000). What are the determinants of the location of foreign direct investment? The Chinese experience. *Journal of International Economics* 51(2): 379–400.

Claessens, S., D. Cassimon and B. van Campenhout (2009). Evidence on changes in aid allocation criteria. *World Bank Economic Review* 23(2): 185–208.

D'Aiglepierre, R. and L. Wagner (2013). Aid and universal primary education. *Economics of Education Review* 37(Dec): 95–112.

Donaubauer, J., D. Herzer and P. Nunnenkamp (2014a). Does aid for education attract foreign investors? An empirical analysis for Latin America. *European Journal of Development Research,* forthcoming.

Donaubauer, J., B. Meyer and P. Nunnenkamp (2014b). A new global index of infrastructure: Construction, rankings and applications. Kiel Working Paper 1929. Kiel Institute for the World Economy.

Dreher, A., P. Nunnenkamp and R. Thiele (2008). Does aid for education educate children? Evidence from panel data. *World Bank Economic Review* 22(2): 291–314.

Dreher, A., P. Nunnenkamp and M. Schmaljohann (2013). The allocation of German aid: Self-interest and government ideology. Kiel Working Paper 1817. Kiel Institute for the World Economy.

Dreher, A., M. Gould, M. Rablen and J.R. Vreeland (2014). The determinants of election to the United Nations Security Council. *Public Choice* 158(1-2): 51–83.

Easterly, W. (2007). Was development assistance a mistake? *American Economic Review* 97(2): 328–332.

Economides, G., S. Kalyvitis and A. Philippopoulos (2008). Does foreign aid distort incentives and hurt growth? Theory and evidence from 75 aid-recipient countries. *Public Choice* 134(3-4): 463–488.

Harms, P. and M. Lutz (2006). Aid, governance and private foreign investment: Some puzzling findings for the 1990s. *Economic Journal* 116(513): 773–790.

Hoeffler, A. and V. Outram (2011). Need, merit, or self-interest – What determines the allocation of aid? *Review of Development Economics* 15(2): 237–250.

Hühne, P., B. Meyer and P. Nunnenkamp (2014). Who benefits from aid for trade? Comparing the effects on recipient versus donor exports. *Journal of Development Studies 50(9)*: 1275-1288.

Kimura, H. and Y. Todo (2010). Is foreign aid a vanguard of foreign direct investment? A gravity-equation approach. *World Development* 38(4): 482–497.

Kumar, N. (2006). Infrastructure availability, foreign direct investment flows and their export-orientation: A cross-country exploration. *Indian Economic Journal* 54(1): 125–144.

Mayer, T. (2006). Policy coherence for development: A background paper on foreign direct investment. Working Paper 253. OECD Development Centre. Paris.

Mishra, P. and D. Newhouse (2009). Does health aid matter? *Journal of Health Economics* 28(4): 855–872.

OECD (2002). *Foreign Direct Investment for Development: Maximising Benefits, Minimising Costs.* Paris: OECD.

OECD (2014). *Development Co-operation Report 2014: Mobilising Resources for Sustainable Development.* Paris: OECD.

Selaya, P. and E.R. Sunesen (2012). Does foreign aid increase foreign direct investment? *World Development* 40(11): 2155–2176.

Stiglitz, J.E. (2000). Capital market liberalization, economic growth, and instability. *World Development* 28(6): 1075–1086.

Straub, S. (2011). Infrastructure and development: A critical appraisal of the macro-level literature. *Journal of Development Studies* 47(5): 683–708.

UNCTAD (2005). *Economic Development in Africa: Rethinking the Role of Foreign Direct Investment.* New York and Geneva: United Nations.

UNCTAD (2011). *Foreign Direct Investment in LDCs: Lessons Learned from the Decade 2001-2010 and the Way Forward.* New York and Geneva: United Nations.

United Nations (2003). Financing for development. Monterrey consensus of the international conference on financing for development. http://www.un.org/esa/ffd/monterrey/MonterreyConsensus.pdf (accessed: August 2014).

Vijil, M. and L. Wagner (2012). Does aid for trade enhance export performance? Investigating the infrastructure channel. *World Economy* 35(7): 838–868.

Williamson, C.R. (2008). Foreign aid and human development: The impact of foreign aid to the health sector. *Southern Economic Journal* 75(1): 188–207.

Yasin, M. (2005). Official development assistance and foreign direct investment flows to Sub-Saharan Africa. *African Development Review* 17(1): 23–40.

Table 1 – Baseline regression results

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	FDI	Aid	Infra	FDI	Aid	Infra
Aid in Infrastructure	0.890		0.898***	0.802		0.968***
	(0.552)		(0.190)	(0.522)		(0.229)
Other Aid				0.132	0.130***	-0.0718
				(0.211)	(0.0308)	(0.199)
Infrastructure	0.463***	-0.0790		0.429***	0.00346	
	(0.166)	(0.0661)		(0.165)	(0.0638)	
GDP p.c.	-9.845***	-0.102	4.665***	-9.442***	-0.488	4.680***
	(1.899)	(0.484)	(0.242)	(1.908)	(0.466)	(0.248)
Growth	0.0355			0.0263		
	(0.0294)			(0.0297)		
GDP	-0.149			-0.322		
	(0.735)			(0.711)		
Openness to Trade	0.0189*			0.0177*		
	(0.0101)			(0.0101)		
Investment Climate	0.422***			0.432***		
	(0.127)			(0.126)		
Population		-1.177	1.377***		-0.104	1.386***
		(1.419)	(0.217)		(1.368)	(0.216)
Trade Share		0.463			0.304	
		(0.326)			(0.313)	
UN Security Council		0.0765			0.117	
		(0.116)			(0.111)	
Law and Order		0.351***			0.352***	
		(0.0514)			(0.0483)	
Area			-0.880***			-0.881***
			(0.180)			(0.180)
Constant	56.44***	38.30*	-38.04***	57.30***	19.62	-38.22***
	(16.28)	(22.98)	(4.086)	(15.88)	(21.95)	(4.384)
Observations	1,237	1,237	1,237	1,229	1,229	1,229
R-squared	0.253	0.673	0.263	0.277	0.704	0.264

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All equations include year FE; the equations for FDI and aid also include country FE. All explanatory variables are lagged by one year.

Table 2 – Regression results with refined need related to infrastructure

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	FDI	Aid	Infra	FDI	Aid	Infra
Aid in Infrastructure	1.477***		0.927***	1.390***		0.985***
	(0.566)		(0.191)	(0.527)		(0.228)
Other Aid				0.0836	0.158***	-0.0979
				(0.211)	(0.0322)	(0.195)
Infrastructure	0.510***			0.481***		
	(0.169)			(0.168)		
GDP p.c.	-10.01***	-2.388***	4.811***	-9.822***	-1.614***	4.811***
	(1.914)	(0.557)	(0.246)	(1.917)	(0.527)	(0.252)
Growth	0.0466			0.0389		
	(0.0298)			(0.0297)		
GDP	-0.947			-0.963		
	(0.726)			(0.700)		
Openness to Trade	0.0144			0.0135		
	(0.0103)			(0.0103)		
Investment Climate	0.228*			0.275**		
	(0.130)			(0.129)		
Population		-2.365**	1.455***		-1.613*	1.484***
		(1.003)	(0.222)		(0.975)	(0.220)
Infrastructure Needs		0.213***			0.129***	
		(0.0254)			(0.0240)	
Trade Share		0.876***			0.628**	
		(0.325)			(0.315)	
UN Security Council		0.0162			0.0750	
		(0.114)			(0.111)	
Law and Order		0.484***			0.429***	
		(0.0635)			(0.0612)	
Area			-0.913***			-0.918***
			(0.183)			(0.184)
Constant	66.47***	69.63***	-40.84***	65.97***	50.04***	-40.48***
	(16.47)	(19.00)	(4.170)	(15.86)	(18.23)	(4.455)
Observations	1,213	1,213	1,213	1,205	1,205	1,205
R-squared	0.165	-0.316	0.269	0.195	0.335	0.270

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All equations include year FE; the equations for FDI and aid also include country FE. All explanatory variables are lagged by one year.

Table 3 – Regression results with FDI stocks

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	FDI	Aid	Infra	FDI	Aid	Infra
Aid in Infrastructure	5.128***		0.409***	5.486***		0.349**
	(0.827)		(0.135)	(0.883)		(0.149)
Other Aid				-1.462**	0.129***	0.166
				(0.642)	(0.0329)	(0.174)
Infrastructure	4.760***			4.521***		
	(0.639)			(0.625)		
GDP p.c.	-50.00***	-0.733	4.638***	-48.25***	-0.531	4.726***
	(6.985)	(0.546)	(0.243)	(6.966)	(0.526)	(0.252)
Growth	0.176			0.173		
	(0.117)			(0.116)		
GDP	-16.59***			-16.23***		
	(2.582)			(2.560)		
Openness to Trade	0.150***			0.151***		
	(0.0400)			(0.0396)		
Investment Climate	2.074***			2.031***		
	(0.428)			(0.425)		
Population		-0.179	1.895***		-0.0582	1.876***
		(0.993)	(0.207)		(0.977)	(0.211)
Infrastructure Needs		0.00817			-0.0128	
		(0.0247)			(0.0240)	
Trade Share		0.364			0.302	
		(0.327)			(0.321)	
UN Security Council		0.105			0.138	
		(0.117)			(0.114)	
Law and Order		0.359***			0.350***	
		(0.0623)			(0.0609)	
Area			-1.044***			-1.039***
			(0.183)			(0.184)
Constant	585.3***	24.89	-35.73***	589.8***	19.39	-38.23***
	(58.72)	(18.77)	(3.848)	(58.14)	(18.27)	(4.400)
Observations	1,199	1,199	1,199	1,191	1,191	1,191
R-squared	0.282	0.692	0.275	0.320	0.700	0.278

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All equations include year FE; the equations for FDI and aid also include country FE. All explanatory variables are lagged by one year.

Table 4 – Regression results excluding top and bottom deciles for aid in infrastructure, FDI and endowment with infrastructure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Excluding top and bottom deciles of Aid			Excluding top and bottom deciles of FDI			Excluding top and bottom deciles of Infrastructure		
VARIABLES	FDI	Aid	Infra	FDI	Aid	Infra	FDI	Aid	Infra
Aid in Infrastructure	2.567***		0.625*	1.511***		1.379***	1.643**		0.478***
	(0.988)		(0.328)	(0.399)		(0.210)	(0.710)		(0.136)
Infrastructure	0.872***			0.220**			1.194***		
	(0.199)			(0.0971)			(0.161)		
GDP p.c.	-11.14***	-2.257**	4.747***	-2.567**	-1.493**	5.176***	-8.903***	-2.739***	2.667***
	(2.139)	(0.949)	(0.287)	(1.135)	(0.741)	(0.286)	(2.290)	(0.867)	(0.185)
Growth	-0.0357			-8.52e-06			-0.0585*		
	(0.0366)			(0.0162)			(0.0340)		
GDP	0.374			-0.785			-0.200		
	(0.958)			(0.607)			(0.963)		
Openness to Trade	0.0498***			0.0114**			0.0403***		
	(0.0155)			(0.00565)			(0.0144)		
Investment Climate	0.177			0.139**			0.162		
	(0.137)			(0.0599)			(0.137)		
Population		-1.055	1.183***		0.994	1.537***		-1.364	0.550***
		(1.053)	(0.262)		(0.997)	(0.259)		(1.062)	(0.166)
Infrastructure Needs		0.978***			-0.666			1.331***	
		(0.346)			(0.442)			(0.423)	
Trade Share		0.184***			0.159***			0.162***	
		(0.0473)			(0.0356)			(0.0361)	
UN Security Council		-0.223*			0.114			-0.0217	
		(0.114)			(0.111)			(0.115)	
Law and Order		0.267***			0.226***			0.409***	
		(0.0504)			(0.0615)			(0.0747)	
Area			-0.915***			-0.577**			-0.384***
			(0.207)			(0.225)			(0.134)
Constant	26.84	48.21**	-31.27***	8.032	-8.237	-58.07***	41.81**	56.91***	-6.459**
	(20.44)	(22.23)	(6.781)	(9.943)	(18.11)	(4.739)	(18.44)	(20.53)	(3.245)
Observations	820	820	820	842	842	842	812	812	812
R-squared	0.299	-0.831	0.282	0.149	0.403	0.336	0.314	0.361	0.206

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All equations include year FE; the equations for FDI and aid also include country FE. All equations are lagged by one year. The upper/lower deciles are calculated based on the observations included in the baseline regression (table 2, column 1-3).

Table 5 – Regression results with sub-categories of aid in infrastructure and sub-indices of infrastructure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		Transport			ICT			Energy			Banking and Finance	
VARIABLES	FDI	Aid	Infra	FDI	Aid	Infra	FDI	Aid	Infra	FDI	Aid	Infra
Aid in Infrastructure	0.518***		0.456***	0.781		-0.272***	0.413***		0.136***	-0.398		1.467***
	(0.115)		(0.130)	(0.507)		(0.0997)	(0.126)		(0.0468)	(0.402)		(0.308)
Infrastructure	0.565**			0.131***			0.0815*			0.207***		
	(0.223)			(0.0502)			(0.0448)			(0.0649)		
GDP p.c.	-5.623***	3.170***	2.903***	-2.385	-1.313**	3.767***	-7.201***	0.881*	2.691***	-5.839***	0.153	6.496***
	(1.276)	(1.129)	(0.264)	(1.463)	(0.516)	(0.124)	(1.299)	(0.519)	(0.213)	(1.396)	(0.662)	(0.504)
Growth	0.0383			0.0570*			0.00166			-0.0945***		
	(0.0234)			(0.0317)			(0.0289)			(0.0323)		
GDP	-0.585			-1.688**			0.00399			-2.003**		
	(0.670)			(0.738)			(0.684)			(0.827)		
Openness to Trade	0.0152			0.00733			0.00972			0.0133		
	(0.00932)			(0.0118)			(0.0107)			(0.0115)		
Investment Climate	0.297***			0.229**			0.273***			0.226**		
	(0.0916)			(0.110)			(0.0910)			(0.0991)		
Population		2.571	2.623***		-0.801	-0.0969		-0.486	0.275		3.115	3.978***
		(1.734)	(0.216)		(1.240)	(0.114)		(1.339)	(0.168)		(1.953)	(0.427)
Infrastructure Needs		-0.232***			0.0198***			-0.0269***			0.0950***	
		(0.0680)			(0.00660)			(0.00852)			(0.0254)	
Trade Share		0.240			0.199			-0.126			2.349***	
		(0.640)			(0.483)			(0.486)			(0.623)	
UN Security Council		0.0719			0.219			-0.288			0.164	
		(0.182)			(0.178)			(0.190)			(0.189)	
Law and Order		0.238***			0.429***			0.177**			0.723***	
		(0.0782)			(0.0794)			(0.0792)			(0.148)	
Area			-1.424***			-0.00217			0.395***			-1.947***
			(0.206)			(0.102)			(0.152)			(0.383)
Constant	50.84***	-50.86**	-21.90***	45.81***	38.68*	6.630***	51.75***	17.76	-2.955	96.31***	-42.03	-87.78***
	(11.67)	(24.82)	(3.895)	(17.54)	(21.90)	(2.042)	(12.35)	(23.60)	(3.058)	(17.42)	(33.03)	(8.066)
Observations	1,280	1,280	1,280	1,194	1,194	1,194	1,043	1,043	1,043	929	929	929
R-squared	0.344	0.079	0.182	0.417	0.512	0.455	0.347	0.629	0.154	0.446	0.382	0.234

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All equations include year FE; the equations for FDI and aid also include country FE. All equations are lagged by one year. Each sub-sample is constructed conditional on a positive value for aid in the specific infrastructure sector.

Appendix A – Summary statistics

	Observations	Mean	Std. dev.	Min	Max
FDI flow (% of GDP)	3065	3.969	7.737	-65.411	170.774
FDI stock (% of GDP)	2951	34.749	78.638	0	1607.406
Aid in Infrastructure ($ million)	3120	56.308	140.598	-29.132	1886.943
Aid in Transport Infrastructure ($ million)	3120	25.284	69.783	-26.21	1067.358
Aid in Communication Infrastructure ($ million)	3120	4.07	16.463	-7.879	283.245
Aid in Energy Infrastructure ($ million)	3120	18.315	66.761	-11.598	1499.351
Aid in Financial Infrastructure ($ million)	3120	4.759	20.312	-15.569	443.104
Other Aid ($ million)	3120	211.952	513.001	-223.949	14996.993
Infrastructure	2103	31.017	10.776	0	96.278
Transport Infrastructure	2512	22.156	11.837	0	94.954
ICT Infrastructure	2450	31.756	7.608	0	72.588
Banking and Finance-related Infrastructure	1706	33.194	14.668	0	100
Energy-related Infrastructure	1881	33.137	7.587	0	61.506
Need related to Infrastructure (deviation from normal pattern):					
Total Infrastructure	2012	17.929	20.768	0	100
Transport Infrastructure	2363	20.165	22.443	0	100
ICT Infrastructure	2331	13.232	14.684	0	100
Banking and Finance-related Infrastructure	1669	15.337	20.13	0	100
Energy-related Infrastructure	1774	9.073	12.368	0	100
GDP p.c.	2855	5749.71	6415.93	100.886	52169.961
Growth	2944	3.874	6.842	-51.031	106.280
GDP ($ million)	2987	54283.89	237000	8.825	5930000
Openness to Trade (% of GDP)	2812	84.504	47.577	0.309	460.471
Trade Share (%)	2545	0.805	2.260	0.002	30.532
Population (million)	3121	32.941	135.552	0.009	1337.825
Investment Climate	1986	6.926	2.313	0	12
Law and Order	1997	3.235	1.217	0	6
UN Security Council	2835	0.055	0.227	0	1
Area (1000 square km)	3111	562.994	1191.532	0.030	9600

Note: All variables before taking logs. Logs are taken from actual values plus one.

Appendix B – List of Countries

Sub-Saharan Africa	Latin America & Caribbean	East Asia & Pacific	South Asia	Europe & Central Asia	Middle East & North Africa
Angola	Argentina	China	Bangladesh	Albania	Algeria
Burkina Faso	Bolivia	Indonesia	India	Armenia	Egypt
Botswana	Brazil	Mongolia	Sri Lanka	Azerbaijan	Iran
Côte d'Ivoire	Colombia	Malaysia	Pakistan	Belarus	Jordan
Cameroon	Costa Rica	Philippines		Kazakhstan	Lebanon
Congo	Dominican Republic	Papua New Guinea		Serbia	Libya
DR Congo	Ecuador	Thailand		Turkey	Morocco
Ethiopia	Guatemala	Vietnam		Ukraine	Syria
Gabon	Guyana			Montenegro	Tunisia
Ghana	Honduras				Yemen
Guinea	Haiti				
Gambia	Jamaica				
Kenya	Mexico				
Madagascar	Nicaragua				
Mali	Panama				
Mozambique	Peru				
Malawi	Paraguay				
Namibia	El Salvador				
Niger	Suriname				
Nigeria	Venezuela				
Sudan	Chile				
Senegal	Uruguay				
Sierra Leone					
Togo					
Tanzania					
Uganda					
South Africa					
Zambia					

Appendix C – Normal pattern of endowment with infrastructure (pooled OLS)

VARIABLES	(1) Transport	(2) ICT	(3) Finance	(4) Energy	(5) Total
GDP p.c.	0.497***	0.590***	0.498***	0.628***	0.630***
	(0.0108)	(0.0116)	(0.0119)	(0.0147)	(0.0114)
Area	-0.180***	-0.0523***	-0.149***	0.0591***	-0.109***
	(0.00950)	(0.00882)	(0.0129)	(0.0113)	(0.00960)
Population	0.203***	0.0763***	0.270***	-0.0143	0.171***
	(0.0133)	(0.0101)	(0.0143)	(0.0136)	(0.0108)
Constant	-5.285***	-5.593***	-6.969***	-6.005***	-6.912***
	(0.205)	(0.152)	(0.206)	(0.194)	(0.177)
Observations	3,127	3,100	2,387	2,543	2,776
R-squared	0.530	0.607	0.454	0.545	0.641

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