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Does Foreign Aid increase Foreign Direct Investment?

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**Summary.** – We examine the idea that aid and FDI are complementary sources of foreign capital. We argue that the relationship between aid and FDI is theoretically ambiguous: aid raises the marginal productivity of capital when used to finance complementary inputs (like public infrastructure and human capital investments), but aid may crowd out private investments when it comes in the shape of pure physical capital transfers. Empirically, we find that aid invested in complementary inputs draws in FDI, while aid invested in physical capital crowds it out. The paper shows that *the composition of aid matters* for its overall level of efficiency.

**Key words** – Development aid, foreign direct investment (FDI), foreign capital for development, aid effectiveness.

**JEL classifications:** F21; F35; O19.

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1. INTRODUCTION

The notion that foreign aid and foreign direct investment (FDI) are complementary sources of capital is conventional among governments and international cooperation agencies. For instance, the UN's 2002 Monterrey Consensus on International Financing for Development affirms that "ODA [Official Development Aid] plays an essential role as a complement to other sources of financing for development, especially in those countries with the least capacity to attract private direct investment. A central challenge, therefore, is to create the necessary domestic and international conditions to facilitate direct investment flows, conducive to achieving national development priorities, to developing countries, particularly Africa, least developed countries, small island developing States, and landlocked developing countries, and also to countries with economies in transition.” (UN, 2002, p. 9).

However, the implicit presumption in the consensus that ODA has a "catalyzing" effect on FDI, or that aid and FDI are complements, is by no means evident. For example, Kosack and Tobin (2006) argue that aid and FDI are essentially unrelated, because aid is basically oriented to support the government budget and finance investments in human capital, while FDI is a private sector decision relatively more connected to physical capital. In a more general study, Caselli and Feyrer (2007) estimate the marginal product of capital (\( MPK \)) across countries and find that, accounting for the contribution of land and other natural resources to income generation, "[...] the return from investing in capital is no higher in poor countries than in rich countries." (Caselli and Feyrer, 2007, p. 537). One of the implications of their study is that increasing aid inflows to developing countries will lower the \( MPK \) in these economies and will tend to be fully offset by outflows of other types of capital investments (Caselli and Feyrer, 2007, p. 540). If this is the case, aid and FDI are clearly closer to being substitutes rather than being complements.

This paper presents a unified framework for assessing the relative merit of these different claims. We analyze the relationship between aid and FDI in a theoretical framework that

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1 See the 2007 Paris Declaration Aid Effectiveness, or the 2011 UNCTAD Policy Focus, available at www.unctad.org/en/docs/aldcafricapf2011d1_en.pdf, for more recent examples.
distinguishes between aid directed towards complementary factors of production and aid invested in physical capital. This distinction serves to illustrate, on the one hand, that aid invested in complementary factors increases $MPK$ in the recipient country, which tends to draw in additional foreign resources and helps to sustain a higher level of capital over time. For example, aid can ease important bottlenecks in poor countries by financing public infrastructure and human capital investments that would not have been undertaken by private actors (due to the free-riding problem in financing public goods for instance), nor by public agents (for example because of the budgetary constraints that prevent aid-recipient governments from undertaking this type of investments). On the other hand, the distinction also helps to illustrate that foreign aid invested in physical capital competes directly with other types of capital, and thus replaces investments that private actors would have undertaken anyway. In this case, capital mobility and rate-of-return equalization across countries will give rise to a flight of other types of capital after an aid flow has been received.

This framework provides a number of testable predictions. First, for a given level of domestic saving, aid invested in physical capital crowds out other types of foreign investments in physical capital, one for one. Second, aid invested in complementary factors of production has an ambiguous net effect on FDI. The logic of the ambiguity is that, while an increase in complementary factors increases $MPK$ and attracts additional foreign investments, the productivity increase also raises income, domestic savings and domestic investments, which tends to lower $MPK$ and thus crowd out foreign investments. These two findings suggest that the overall impact of aid on FDI is in theory indeterminate, and that the composition of aid matters.

We take the implications of our theoretical analysis to the data utilizing a panel of 99 countries over the period 1970-2001 for which we have disaggregated data. We find a large and positive effect of aid invested in complementary factors, while aid invested in physical capital has a negative impact on FDI. The combined impact of these two types of aid on FDI remains positive, so our results imply that more aid should be directed towards inputs complementary to physical capital to optimize the return on aid. The results are robust to (1) a broader definition of complementary aid than that adopted in the benchmark estimations, (2) allowing for imperfect capital mobility, and (3) controlling for traditional FDI correlates and regional fixed effects.
The paper is structured as follows. Section 2 reviews the scarce theoretical and empirical literature on aid and FDI. Section 3 describes our theoretical framework. Section 4 presents our empirical strategy, describes the data and discusses relevant econometric. Section 5 shows the results, and Section 6 tests their robustness. Section 7 sums up and discusses policy implications.

2. THE LITERATURE ON AID AND FDI

The relationship between aid and FDI is controversial and research results on it remain inconclusive. To our knowledge, only six papers analyze the question empirically. Harms and Lutz (2006) and Karakaplan et al. (2005) analyze the relationship between aid and FDI for a broad sample of developing countries. Karakaplan et al. (2005) find that aid has a negative direct effect on FDI and that both good governance and financial market development significantly improve the impact of aid on subsequent flows of FDI. Harms and Lutz (2006), on the other hand, find that once they control for the regulatory burden in the host country, aid works as a complement to FDI and, surprisingly, that the catalyzing effect of foreign aid is stronger in countries that are characterized by an unfavorable institutional environment.

Kimura and Todo (2010) and Blaise (2005) present case studies on Japanese FDI and aid flows, and report incongruent results. While Blaise (2005) finds positive effects from aid to infrastructure projects, Kimura and Todo (2010) find no positive infrastructure effect, no negative rent-seeking effect but a positive vanguard effect (arising when foreign aid from a particular donor country promotes FDI from the same country but not from other countries). Two other case studies, Bhavan, Xu and Zhong (2011) and Carro and Larrú (2011), find that aid attracts FDI in Bangladesh, Sri Lanka, Pakistan and India; and that the evidence is inconclusive in the cases of Argentina and Brazil, respectively.

We believe that this type of mixed results can be explained to a large extent by the high level of aggregation used for the aid variable. Karakaplan et al. (2005) and Bhavan, Xu and Zhong (2011) include only overall ODA. Harms and Lutz (2006) distinguish between grants, technical cooperation grants, as well as bilateral and multilateral aid, but it remains unclear why one would expect foreign investors to react differently to these types of aid. Kimura and Todo (2010) apply the idea of different types of aid but do not implement an effective disaggregation: they rely on a proxy for aid for infrastructure that takes the bulk of total aid.
(namely aid for economic and social infrastructure, production and multisector activities), and a proxy for aid for non-infrastructure that contains the most volatile part of aid (food and humanitarian aid, and aid related to debt).

A general shortcoming in this literature is also the lack of consensus on the specification of the FDI relation (Bloningen and Piger, 2011). None of the cited empirical papers are supported by a theoretical model. One reason might be that the only paper analyzing theoretically the relationship between aid and FDI is Beladi and Oladi (2007) – who set up a general equilibrium model where all foreign aid is used to finance public goods, but where they unfortunately do not consider any further disaggregation for the aid flows nor make an empirical analysis.

This paper closes this gap by proposing a simple theoretical model for the relationship between different types of aid and FDI in a small open economy, which constitutes the base for our empirical analysis. We describe the main elements and mechanisms in the next section (a formal presentation is given in the appendix).

3. A THEORETICAL ANALYSIS OF AID AND FDI

Assume a Solow setup for a small open economy, where output per capita, \( y \), grows with (a) the accumulation of physical capital per capita, \( k \) (financed by domestic and foreign investments), and (b) improvements in total factor productivity, \( A \) (which includes any factor complementary to the accumulation of physical capital per capita, like new technologies and better institutions); such that \( y = Ak \).

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2 More generally, analyzing why development economics needs theory, Acemoglu (2010) argues that development economics essentially "investigates the causes of poverty and low incomes around the world and seeks to make progress in designing policies that could help individuals, regions, and countries to achieve greater economic prosperity", and that "[…] Economic theory plays a crucial role in this endeavor, not only because it helps us focus on the most important economic mechanisms, but also because it provides guidance on the external validity of econometric estimates, meaning that it clarifies how we can learn from specific empirical exercises about the effects of similar shocks and policies in different circumstances and when implemented on different scales." (Acemoglu, 2010, p. 17).
Assume that foreign aid is composed by two types of flows, which contribute to the described process of growth in two different ways: one part of aid helps to increase the amount of physical capital $k$, and the other helps to increase the amount of complementary factors or total factor productivity $A$. (As an example of two types of aid imagine, for instance, aid projects to modernize agriculture or other specific productive sector, and aid projects to improve the quality of public institutions.)

If international mobility of capital is unrestricted, the return to investments in physical capital (the $MPK$) should be the same across countries. If this is the case, as Caselli and Feyrer (2007) estimate in their paper, any inflow of foreign capital should tend to reduce the $MPK$ in the recipient country and will tend to crowd out other sources of capital. Assuming that one part of foreign aid is effectively used to finance projects that could have been financed by private (foreign or domestic) investors, a direct implication is that, controlling for domestic sources of capital (domestic savings), an increase in the flow of aid used to make investments in physical capital will tend to crowd out FDI.

In turn, the effect of aid directed to increase complementary factors is in principle positive: foreign aid that is used to finance reforms, better institutions or better producing technologies, will increase the $MPK$ and will tend to attract additional FDI. But interestingly, given that an increase in complementary factors also increases the aggregate level of income, in the context

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3 Aid has typically been thought to finance only public type of goods, but there is compelling evidence that aid also finances projects that could have been financed by foreign (or domestic) private investors, in areas with or without initial private investors' initiative or interest. One example of this is the Danish Development Agency's Business Development programs ("Private Sector Development", "Business to Business for Development", "Innovative Partnerships for Development"), which since 1993 have supported the establishment of commercial establishments and partnerships between Danish companies and companies in many developing countries in areas like organic farming and agriculture, IT and programming, clothing, and tourism, among others. A second, larger and more recent example is USAID's Private Sector Development program for Iraq, "Izdihar" ("prosperity" in Arabic), which encourages private sector institutions and reforms, the establishment of a stock exchange, and the support of a number of private banks and microfinance institutions. Visit for example www.danidadevforum.um.dk/en/menu/Topics/GrowthAndEmployment/BusinessDevelopment, and www.usaid.gov/iraq/accomplishments/privsec.html.

4 An interesting corollary is that the relationship between domestic savings and FDI has the same features as the one between this type of aid and FDI: controlling for other sources of capital, a larger amount of domestic savings tends to reduce the marginal returns to capital accumulation, and thereby
of a Solow economy (where domestic savings are determined by the country's level of income), we should also observe an increase in the level of domestic savings and domestic investments, which will tend to lower the $MPK$ in the country and thereby reduce the amount of additional FDI attracted to the country. Therefore, the net effect of aid to complementary factors on FDI is in theory ambiguous: it will be the result of combining the positive effects via higher total factor productivity, with the negative effects via larger availability of domestic sources of capital.

The two counterbalancing effects from aid to complementary factors are both of first order, so the final effect of this type of aid will depend on its existing level. In contrast, the effect of aid for physical capital investments will not operate with this type of scale effects, because its relationship with FDI is pinned down by the assumption of unrestricted capital mobility, through equalization of the level of $MPK$ across countries. (We relax the assumption of unrestricted capital mobility as a robustness check later, and consider the case where the $MPK$ differs across countries in a measure that reflects each country's idiosyncratic risks.)

A key implication of the analysis is that the effect of total aid on FDI is in theory ambiguous, because it is the combined effect of aid for physical capital investments and aid to complementary factors. This is an important result because it offers a simple explanation for why empirical studies that do not disaggregate aid flows tend to find insignificant or ambiguous effects, and provides a clear theoretical basis for the idea that the composition of aid matters for its overall level of efficiency.

A simple model formalizing this analysis and showing in more detail the mechanisms at work is presented in the appendix.

Based on these implications and the basic mechanisms described, we present in the next section our empirical examination of the relationship between aid and FDI.

4. EMPIRICAL STRATEGY

the need of additional FDI flows. Our empirical results support this idea, and shows that the conditional correlation between savings and FDI is indeed negative.
Within the framework described in the Section 3, the relationship between aid and FDI should have the following reduced form structure:

\[ f_{di} = f(aid_K, aid_A, X), \]

(1)

to reflect that the basic correlates of the level of FDI per capita in a country, \( f_{di} \), are the amount of aid invested in physical capital per capita, \( aid_K \); the amount of aid to complementary factors, \( aid_A \); determinants of the level of physical capital in the country and other correlates of \( f_{di} \) (all collected in \( X \)), like the level of domestic savings per capita, \( S \), the depreciation rate of the existing stock of \( k \) (given by the physical rate of capital depreciation and the rate of population growth, \( n \)), the rate of return to physical capital investments in a world with unrestricted capital mobility (which will be a given level for a small country), and some measure of initial economic conditions (like the initial overall productivity level in the economy, \( A_{0i} \)).

In a panel setting, the econometric interpretation of this aid-FDI relationship is

\[ f_{di_{it}} = \beta_0 + \beta_1 A_{0i,t} + \beta_2 n_{it} + \beta_3 S_{it} + \beta_4 aid_{K_{it}}^{it} + \beta_5 aid_{A_{it}}^{it} + \beta_6 (aid_{A_{it}}^{it})^2 + u_{it}, \]

(2)

where \( f_{di_{it}} \) is the net flow of FDI per capita to country \( i \) during period \( t \), \( A_{0i,t} \) is the overall productivity level at the beginning of period \( t \), \( n_{it} \) is population growth, \( S_{it} \) is domestic savings per capita, \( aid_{K_{it}}^{it} \) is aid invested in physical capital, \( aid_{A_{it}}^{it} \) is aid invested in complementary factors, and \( \beta_0 \) is a constant term capturing all time-invariant factors. The square of \( aid_{A_{it}}^{it} \) is included in the regression to reflect that total effect of \( aid_A \) is conditional on its own level –feature that arises from the two counterbalancing first-order effects of complementary aid on FDI, namely that \( aid_A \) increases the marginal productivity of capital and attracts additional foreign investments; but it also raises income, domestic savings and domestic investments, which lowers the \( MPK \) and tends to crowd out foreign investments. The square of \( aid_{K_{it}}^{it} \) is not included in the regression because, as explained in Section 3,

\[^5\] Equation (1) is basically a simplified representation of the reduced form derived for the steady state equilibrium in the theoretical model presented in the appendix (equation A.6).
without restrictions to capital mobility, aid directed to investments in physical capital substitutes \( fdi \) independently of its own level, due to cross-country equalization of \( MPK \).

We expect \( \beta_1 \) to be positive in this specification since higher productivity raises the steady state level of capital and the demand for FDI. We also expect \( \beta_2 \) to be positive since a fast growing population dilutes the stock of \( k \) and thus allows for an increase in FDI per capita. \( \beta_3 \) should be negative since a high level of domestic savings lowers the need for foreign capital. From the theoretical analysis, \( aid_k \) is expected to crowd out foreign investments, and therefore the sign of \( \beta_4 \) should be negative. If capital mobility is unrestricted (an assumption that we relax in Section 6), aid to physical capital should crowd out FDI one by one, and we should in fact expect \( \beta_4 = -1 \). Finally, as explained in Section 3, the net effect of \( aid_A \) is theoretically indeterminate, so we do not have prior expectations for the signs of \( \beta_5 \) and \( \beta_6 \).

Interesting hypotheses that we can test with linear combinations of the estimated parameters are whether the effect of \( aid_k \) is negative (and equal to \(-1\)), whether the effect of \( aid_A \) is positive, and if the combined effect (or the effect of total aid) is significantly larger than zero.

(a) Regression specification

Precise data for the initial level of productivity \( (A_{0,0}) \) are unavailable, so we need to find valid proxies for it before running regressions. We start by assuming that the initial level of productivity is the same for all countries, \( \beta_0 \) and that it grows at a constant rate per period, so that \( A_{0,0} = \beta_0 + \alpha_t \). If we make this assumption and pool the data, we can estimate

\[
fdi_{it} = \beta_0 + \alpha_t + \beta_2 n_{it} + \beta_3 S_{it} + \beta_4 aid^k_{it} + \beta_5 aid^A_{it} + \beta_6 \left( aid^A_{it} \right)^2 + u_{it},
\]

(3)

where \( \alpha_t \) is a time-specific constant (that captures common productivity shocks at time \( t \)).

However, not all countries start out with the same initial conditions, and therefore we allow also for cross sectional differences in productivity by including time-invariant country-specific fixed effects, \( \alpha_i \):
\[ fdi_\mu = \beta_0 + \alpha_i + \alpha_i + \beta_2 n_\mu + \beta_3 S_\mu + \beta_4 aid^K_\mu + \beta_5 aid^A_\mu + \beta_6 \left( aid^A_\mu \right)^2 + u_\mu. \] (4)

This equation can be consistently estimated with a fixed effects model (FE). But then again, if productivity evolves unequally across countries over time, regression (4) leaves out important information. We thus extend the list of regressors to include a lagged dependent variable, which captures time-moving country-specific factors and agglomeration effects, and basically reflects the persistent nature of FDI:

\[ fdi_\mu = \beta_0 + \alpha_i + \alpha_i + \beta_2 n_\mu + \beta_3 S_\mu + \beta_4 aid^K_\mu + \beta_5 aid^A_\mu + \beta_6 \left( aid^A_\mu \right)^2 + u_\mu. \] (5)

Equation (5) is a dynamic specification for panel data, which can be estimated consistently and efficiently using the Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) Generalized Method of Moments (GMM) estimators, and therefore constitutes our preferred econometric specification. To keep the empirical analysis as close as possible to our theoretical setup, the only additional control we add to this regression is the initial level of GDP per capita, \( y_{i0} \), which is a strong proxy for time-varying initial conditions in each country.

Summing up, in our empirical analysis we run regressions of the type

\[ fdi_\mu = \beta_0 + \beta_2 n_\mu + \beta_3 S_\mu + \beta_4 aid^K_\mu + \beta_5 aid^A_\mu + \beta_6 \left( aid^A_\mu \right)^2 + \gamma X + u_\mu, \] (6)

where \( X = \{ \alpha_i, \alpha_i, \ fdi_{\mu-1}, \ y_{i0} \} \). We do not add further controls here because we believe that the omitted variables bias is substantially reduced by including a full set of time dummies, individual country effects, the initial level of GDP per capita, and the lagged level of the dependent variable.\(^6\)

\(^6\) We can extend the set of controls \( X \) by including a measure of human capital (for example the level of primary schooling), and a measure of climate and geographical characteristics (for example the amount of tropical land in the country), but these factors do not add significant value to the benchmark regression we want to establish at this stage, and do not affect our results either, so we maintain our basic specification without including them. Regressions showing the results including these variables...
(b) Data

The dependent variable in all our regressions, $fdi_{it}$, is net FDI inflows in constant US dollars divided by population to control for country size. The FDI data is taken from UNCTAD's Foreign Direct Investment database.\footnote{The data can be accessed at www.unctad.org/Templates/Page.asp?intItemID=4979.}

The main control variables are the income per capita level, population growth rate and savings per capita, which are taken from the World Bank's World Development Indicators.\footnote{Our data was extracted from the 2005 CD version. The data can also be accessed now at data.worldbank.org/data-catalog/world-development-indicators.}

The aid variables are total net flows of official aid disbursements reported in the OECD aid statistics database. Since data on sectoral disbursements are available only after 1990, our measure of aid to a given sector is constructed using sectoral commitments as a proxy for sectoral disbursements.\footnote{Approximating sectoral disbursements with sectoral commitments may cause some concerns due to differences in definitions and statistical record (see Clemens \textit{et al.}, 2011, for more are available in the supplementary material for this paper, available at www.econ.ku.dk/pabloselaya/aidfdiWD2012/webappendix_april2012.pdf.} More precisely, we follow the approach in Clemens \textit{et al.} (2011) and Thiele \textit{et al.} (2006) and assume that the proportion of aid actually disbursed to sector $x$ during a given period, $aid_{x}$, is equal to the proportion of aid committed to sector $x$ during this period, and hence that

\begin{equation}
aid_{x} \approx \frac{\sum x commit}{\sum x commit} \sum x aid_{x},
\end{equation}

where $commit_{x}$ is the amount of ODA commitments to sector $x$, and $\sum x commit_{x}$ and $\sum x aid_{x}$ are the total amounts of aid commitments and disbursements received during each period, respectively.
details). However, according to Odedokun (2003) and Clemens et al. (2011) this problem is likely to be small since disbursements and commitments (both on the aggregate and sectoral levels) are highly correlated.

Aid is decomposed into two broad categories, relying on the sectoral disaggregation from OECD's Aid Activity database: 10

- **Aid invested in complementary inputs, \( a_\text{aid} \)**: aid oriented to social infrastructure (such as education, health, and water supply projects) and economic infrastructure (such as energy, transportation and communications projects).
- **Aid invested in physical capital, \( k_\text{aid} \)**: contributions to directly productive sectors (such as agriculture, manufacturing, trade, banking and tourism projects).

These two aid categories capture the main characteristics of \( a_\text{aid} \) and \( k_\text{aid} \): aid invested in complementary factors is intended to generate positive spillover effects (public goods, inputs complementary to physical capital) whereas aid invested in physical capital has a more narrow purpose and could more easily have been undertaken by private investors (projects of agriculture, forestry, fishing, industry, mining, construction, trade, banking and tourism). Other sectoral aid categories (like multisector support, program assistance, debt reorganization, emergency assistance and unallocated types of aid) are excluded from the analysis since they are primarily oriented to provide fiscal budget support in the recipient country. 11

Tables A.2 and A.3 in the appendix show statistics of \( a_\text{aid} \) and \( k_\text{aid} \) across time and countries. The statistics show that \( k_\text{aid} \) has been on average 22\% of total aid during the period 1970-2001, and \( a_\text{aid} \) has been on average 50\%.

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9 Data on total disbursements comes from OECD’s DAC database, and data on sectoral aid commitments from OECD’s Credit Reporting System database. Both datasets can be accessed at www.oecd.org/dataoecd/50/17/5037721.htm.

10 OECD’s sectoral classification for the purpose of aid is developed to facilitate tracking of aid flows and to permit measuring the share of each sector or other purpose category in total aid. For details on OECD’s aid "purpose codes", and aid’s disaggregation according to its purpose of investment, see www.oecd.org/dac/stats/crsguide.

11 In Section 6 we present a number of robustness checks for our results, and address specifically their sensitivity to our definition of different types of aid.
All the data used in the estimations are averaged over five-year intervals to reduce the noise caused by sudden annual changes and possible discrepancies.

(c) Endogeneity

We need to consider the possible endogeneity of the aid variables (and all other variables in the right hand side) in our regressions, since the estimated coefficients are consistent only if all explanatory variables are exogenous. Aid would be endogenous if, for example, donors systematically disburse more resources to those countries that are neglected by private foreign investors (Harms and Lutz, 2006).

We start by estimating regressions (3) and (4) with an instrumentation strategy that follows cross-country studies on aid effectiveness (e.g., Hansen and Tarp, 2001; Dalgaard et al., 2004), and use lags of the own aid variables, \( \log \) GDP per capita levels and squared levels, \( \log \) population levels, and a dummy for countries in the CFA franc zone.

As shown in the tables below, these instruments are strong for the model estimated in levels (equation 3), but not for the model estimated including country fixed effects (equation 4), and they unfortunately do not pass standard tests of validity. We therefore opt for an identification strategy based on predetermined instruments, and take Arellano and Bond's (1991) first-difference GMM (GMM-DIFF) estimator, which relies on lagged levels as instruments for regressions in first differences, and later on Arellano and Bover(1995) and Blundell and Bond's (1998) system GMM (GMM-SYS) estimator, which supplements the GMM-DIFF set with a system of regressions in levels, with lagged first differences used as instruments. Validity of this instrumentation strategy can be assessed with tests of overidentification and autocorrelation of the residuals, which are described in the tables in the next section.

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12 More precisely, column 1 in Table 1 shows that the first-stage F test for joint significance of the excluded instruments (Kleibergen-Paap statistic) is high and supports the hypothesis that the instruments are strong, but the Hansen test of overidentification rejects the hypothesis that the instruments are valid (uncorrelated with the error term and exogenous as a group). In column 2 we add country fixed effects, and the instruments gain marginally more validity, but lose completely their strength. In general, Roodman (2007) shows that the different instrumentation strategies in the traditional aid effectiveness literature are all fragile.
5. EMPIRICAL RESULTS

Table 1 reports the results of estimating equations (3) to (6) for a (non balanced) sample of 99 countries for which we have disaggregated data, using data averaged over five-year intervals between 1970 and 2001. The standard errors reported are robust to arbitrary heteroskedasticity and intra-group correlation (clustering) within countries, and in columns 3 to 5 they also include the two-step correction for small samples suggested by Windmeijer (2005).

– Table 1 here –

Independently of the chosen estimator, our results strongly support the notions that aid to complementary factors has a positive effect on FDI, that aid invested in physical capital tends in turn to crowd out FDI, and that the net effect is small but always positive.

In terms of specification, a Hausman test between columns 1 and 2 confirms the relevance of including fixed effects (p-value = 0.81). The lagged dependent variable is highly significant, which suggests that a dynamic model is a correct specification, and that we should then rely on consistent and efficient methods for estimating it, like Arellano and Bond's (1991) GMM-DIFF. Results in column 3 report the results of estimating our preferred specification (equation 6) with this method. The coefficients have the same signs as in previous regressions, and the linear parameter tests show that we cannot reject the hypotheses that (a) \( \text{aid}_A \) operates with scale effects, (b) \( \text{aid}_A = -1 \), (c) \( \text{aid}_A > 0 \) and (d) total \( \text{aid} > 0 \), all of them supporting the main predictions of our theoretical analysis.

The Hansen test of overidentification does not reject the null hypothesis that the instruments as a group appear as exogenous. The tests of autocorrelation cannot reject the absence of autocorrelation in the second, third and fourth differences (they cannot reject absence of AR(1) in column 3 either, but only marginally). This indicates that second and higher-order lags of the endogenous variables are valid instruments. Based on this, we limit the number of included lags to only the second, which helps us to conform to the "rule of thumb" of keeping the number of instruments below the number of cross sections (Roodman, 2006), and control
the problem of overfitting the Hansen test of instruments joint validity that appears when the number of instruments approaches the number of observations (Roodman, 2009).

Based on the indication that there might be AR(1) and that persistence in the FDI variable is important, we turn to GMM-SYS estimators. Column 4 presents the result of estimating equation (5), and column 5 presents the results of estimating equation (6), which is the richest (and our preferred) econometric specification.

Column 5 in Table 1 shows that one dollar of aid invested on physical capital crowds out on average 0.84 dollars of FDI in per capita terms. The table also shows that one aid dollar invested in complementary factors attracts on average 1.09 dollars of additional FDI. This type of aid works with scale effects, so, evaluated at the median (21.6 dollars per capita), our results indicate that one dollar of aid invested in complementary factors draws in total 1.03 (1.09 – 2×0.0013×21.6) dollars of FDI in per capita terms. The corresponding Wald test confirms this marginal effect to be significantly positive at the 1% level.

Having specified a dynamic model we can calculate long-run effects of \( aid_K \) and \( aid_A \), by assuming that the level of FDI per capita is the same in every period. Evaluated at the median, we find that one additional aid dollar per capita invested in complementary factors draws in 1.98 dollars of FDI per capita in the long run \( \left( \frac{1.03}{1-0.48} \right) \) – which indicates that \( aid_A \) generates important benefits for foreign investors both in the short and the long run.

The results also confirm the crowding out effect of aid invested in physical capital, which in the short run costs about 0.84 dollars of FDI per capita for each dollar of aid invested in physical capital, and that accumulates to a level of 1.61 dollars in the long run. Interestingly, the Wald tests reported at the bottom of the table show that the negative effect of \( aid_K \) on \( fdi \) is statistically not different from −1, which supports Caselli and Feyrer’s (2007) estimate that the MPK tends to be equalized across countries.

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13 This choice helps us to observe the minimally arbitrary "rule of thumb" proposed by Roodman (2006) of keeping the number of instruments below the number of cross sections to make the regressions less susceptible to the problem of "too many instruments" (Roodman, 2009).
The effect of other controls is either insignificant or goes according to the theoretical predictions: population growth enters insignificantly, domestic savings negatively (1 additional dollar of domestic savings per capita is associated with 17 dollars less of FDI per capita on average), and initial GDP per capita enters positively (1 additional dollar of GDP per capita at the beginning of each period tends to attract 8.72 dollars of FDI per capita on average).

A Wald test also show that the combined effect of $aid_A$ and $aid_K$ is significantly positive and equal to 0.19 dollars (evaluated at the median), which implies that the substitution effect of $aid_K$ is more than outweighed by the positive effects of $aid_A$ on $fdi$ in a typical case.\textsuperscript{14}

6. ROBUSTNESS CHECKS

In light of the policy implications arising from the analysis, it is necessary to ensure that the results are robust to correcting for possible misspecifications. We carry out three basic checks for robustness of our empirical findings.

(a) Technical assistance

The grouping of our sectoral aid variables could be questioned. In particular, aid to complementary factors in this paper does not include Technical Cooperation Grants (TCGs), which aim to contribute to development primarily through education and training. Since TCGs consist of activities involving the supply of human resources or actions targeted on human resources (education, training, and advice) one could easily argue that TCGs would have the same impact as aid invested in complementary factors.\textsuperscript{15} In Table 2 below we therefore replicate the specifications from Table 1 using an extended definition of $aid_A$ that includes also TCGs from the OECD database.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
\textbf{Column 1} & \textbf{Column 2} & \textbf{Column 3} \\
\hline
\textbf{Row 1} & \textbf{Row 2} & \textbf{Row 3} \\
\hline
\end{tabular}
\end{table}

\textsuperscript{14} If the marginal effects are evaluated at the mean instead of the median, our conclusions remain the same.
Although there is a slight drop in the size of the main coefficients, the results from Table 1 carry completely over.

(b) Imperfect capital mobility

In our theoretical analysis we assume unrestricted capital mobility and, therefore, $MPK$ equalization across countries. If this is assumption unrealistic, we should allow in our theoretical analysis the return to capital investments to reflect idiosyncratic risk characteristics in each country.

Assuming each country has a given level of idiosyncratic risk, $\rho$, the capital stock in each country will conform then to a different risk-adjusted level of $MPK$. From there, the relationship between $aid_K$ and FDI will essentially continue as before: for given levels of initial domestic savings and idiosyncratic risks, an increase in $aid_K$ will tend to decrease the overall $MPK$ and thereby crowd out $fdi$. This means that in our preferred econometric specification (6) we will have to add some measure of $\rho$ to still be able to identify the effect of $aid_K$.

Including a measure of $\rho$ in our regressions is necessary then to account for the effect of imperfect capital mobility on $aid_K$, but not sufficient, since it affects also $aid_A$: $\rho$ determines basically a new level for the stock of capital in the economy ($k^*$), but this capital stock is also determined by the level of complementary factors in the economy ($A$), which is directly affected by $aid_A$. The interplay between $\rho$ and $aid_A$ has first order effects, and we therefore need to reflect this explicitly in the regression. (The model in the appendix shows formally the effects of allowing for imperfect capital mobility across countries and introducing country specific risks into consideration).

Based on this, our regression specification should now look like

---

15 TCGs were not initially included in the definition of $aid_A$, since they can in theory also contribute to an aid project in some productive sector of the economy.
\[ fdi_i = \beta_0 + \beta_1 n_{it} + \beta_2 S_{it} + \beta_3 aid_i^k + \beta_4 aid_i^A + \beta_5 (aid_i^A)^2 + \beta_6 \rho_{it} + \beta_7 (aid_i^A \times \rho_{it}) + \gamma X + u_i, \]  

(8)

where \( \rho_{it} \) is a measure of idiosyncratic risk that might affect investment decisions. The signs of \( \beta_6 \) and \( \beta_7 \) are expected to be negative or positive, depending on \( \rho_{it} \) increasing or reducing country \( i \)'s attractiveness as an investment location.

We use the overall International Country Risk Guide rating and its 12 specific political risk components as different measures of \( \rho_{it} \).\(^{16}\)

In general, lower political risk is associated with higher levels of overall accountability, stability and institutional quality in the political process. In particular, from the specific ICRG rankings, political risk is lower the higher the government stability, the better the socioeconomic conditions and the investment profile, the lower the number of internal conflicts, external conflicts and political corruption, the lower the military is involved in politics, the lower the religious and the ethnic tensions, the higher the prevalence of law and order, and the larger the degrees of democratic accountability and bureaucratic quality.

– Table 3 here –

Results from estimating regression (8) including these political risk measures are reported in Table 3.\(^{17}\) We treat all risk variables as endogenous, and find that none of the political risk indices enter the regression significantly by themselves, but that some of them affect significantly through \( aid_A \): a better ranking in the overall ICRG country risk indicator, government stability, better socioeconomic conditions, better investment profile, and higher bureaucratic quality. Although the results also show that the conditional effect of some of the indexes reduce significance of the effects of \( aid_k \) and \( aid_A \), the marginal effect of aid on FDI remains positive and significant in practically all cases considered, and our most important

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\(^{16}\) In order to detect significant effects of aid on FDI, Karakaplan et al. (2005) and Harms and Lutz (2006) use aid interacted with the Kaufmann et al. (2005) governance indicators to capture differences in government effectiveness.

\(^{17}\) For results in Table 3, a high value of the different political-risk measures is associated with a low overall political risk, and hence, a high value of the different risk measures should have a positive effect on \( fdi \).
findings appear more robustly: \( aid_k \) affects negatively \( fdi \) and we cannot reject that the effect is statistically equal to \(-1\), \( aid_A \) affects positively and the impact is positive, and the marginal net effect is typically small but statistically positive and significant.\(^{18}\) These results are reassuring, since we are now controlling for the facts that mobility across countries is probably neither perfect nor unrestricted, and that political risks are likely to be an important direct determinant of FDI allocation.

(c) **Omitted variables**

In general, our specification should also be guided by the extensive literature on FDI determinants. Blonigen and Piger (2011) present the most updated and comprehensive survey on this topic. They use statistical techniques to identify from a large set of candidates those variables that are most likely to be determinants of FDI. They find that traditional gravity variables (real GDP levels and distance between countries), cultural factors, relative labor endowments, and regional trade agreements are the variables with higher inclusion probabilities in an empirical FDI regression. Blonigen and Piger (2011) also report variables thought to be important determinants, but which according to their calculations have low inclusion probabilities and appear as non-robust in more comprehensive tests: multilateral trade openness, business costs, infrastructure (including credit markets), and institutions.

We estimated equation (8) including proxies for all these categories, using growth rates of real GDP per capita; variables for socioeconomic, religious and ethnic conditions, geographic and climate characteristics, and a number of variables that proxy for the quality of political institutions. Our results remain remarkably stable and are similar to the ones reported in Table 3. (These results are reported in the supplementary material for this paper, available in a web appendix.)\(^{19}\)

We believe that the omitted variables bias is substantially reduced by controlling for country fixed effects, time dummies, a lagged dependent variable and other controls, and that we do a

\(^{18}\) The only exception occurs with the number of external conflicts, where the positive effect of \( aid_A \) and the negative effect of \( aid_k \) are strongly significant and very close in magnitude, so that the combined effect remains positive but significant only at the 21% level.

fair assessment of misspecification by checking the effect of other potential determinants of FDI and confounders in Table 3. However, one final check we could present is for the existence of regional effects – to control, for example, for the possibility that aid is more effective in attracting FDI in some continents and not in others.

In Table 4 we add a full set of continent dummies to our basic specification (regression 6), and test our results with the benchmark definition of $\text{aid}_A$, and the alternative definition of it including TCGs. 20

\[ \text{Table 4 here} \]

Columns 1 and 3 in Table 4 reproduce our benchmark regressions (shown in column 5 in Tables 1 and 2 respectively), to facilitate comparison. Columns 2 and 4 in Table 4 show that inclusion of regional effects in our main regressions does not change the results. These columns also show that we cannot reject the hypothesis that the set of continent dummies are jointly statistically insignificant, which is an indication that aid is not more effective in attracting FDI in certain continents and not in others.

7. CONCLUSION

Due to its potential to transfer knowledge and technology, create jobs, boost overall productivity, and enhance competitiveness and entrepreneurship, attracting FDI to developing countries is essential to contribute to economic growth, development and poverty reduction. 21

Given the emphasis on using ODA as a vehicle for creating a private sector enabling environment, the question of whether or not aid flows induce significantly more FDI inflows becomes an important and relevant question not only on its own right but also as an essential element in the aid effectiveness debate.

---

20 The inclusion of regional dummies makes a difference in a dynamic panel regression, because we estimate our main regressions with GMM-SYS, where country-specific and time-invariant regressors affect the part of the system estimated in levels.

21 An effective contribution of FDI to growth and development also depends on other factors, among them its contribution to environmental and social development in the host countries, and its support to their national development priorities. See Te Welde (2006) for a historical perspective on FDI and development, and Alfaro et al. (2010) for an assessment of FDI's impact on growth.
Our results strongly support the hypotheses that aid invested in inputs complementary to physical capital draws in foreign capital, while aid directly invested in physical capital crowds out private foreign investments. While the impact of the two types of aid together is positive, an important policy implication is that *the composition of foreign aid matters* for its overall level of efficiency. This is particularly important for debates where the discussion tends to center on the amount of aid to be donated to poorest countries.

Our analysis supports the recommendation of investing aid in complementary inputs. Such investments improve absorption capacity and increase $MPK$ in the host countries, which allows them to accumulate more foreign capital without experiencing a drop in domestic private investments or a flight of foreign capital.
REFERENCES


## Table 1. Foreign aid and FDI

<table>
<thead>
<tr>
<th></th>
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<td>8.72***</td>
<td>8.72***</td>
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</table>

Observations: 325, 307, 239, 325, 325
N countries (clusters): 99, 81, 85, 99, 99
N excluded instruments: 6, 5, 24, 54, 64
1st stage F, Kleibergen-Paap: 21.1, 0.49
Hansen overid., p-value: 0.021, 0.15, 0.5, 0.14, 0.21
AR(1), p-value: 0.12, 0.012, 0.013
AR(2), p-value: 0.30, 0.33, 0.25
AR(3), p-value: 0.52, 0.26, 0.24
AR(4), p-value: 0.39, 0.27, 0.25

H\_0: aidK = -1
0.15 | -0.36 | 0.38 | 0.16 | 0.16

H\_0: aid > 0
0.77 | 0.25 | 0.65 | 0.22 | 0.19

H\_0: aid\_A > 0
1.62 | 1.61 | 1.26 | 1.07 | 1.03

Notes. The dependent variable is FDI per capita (fdi). All regressions include time dummies and a constant term. Aid variables are instrumented with own lags, (log) levels and square levels of GDP per capita, (log) population, and a FRZ dummy in columns 1 and 2. We use predetermined instruments in columns 3–5 (second lags in column 3; and second lags and lagged differences in columns 4 and 5). Robust standard errors in brackets, clustered at the country level, and including Windmeijer’s (2005) small sample correction in columns 3–5. ***, **, and * denote significance at 1, 5, and 10% levels.
Table 2. Foreign aid and FDI — Alternative definition of aid_A

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Notes. The dependent variable is FDI per capita (fdi). aid_A* is defined as aid_A + technical cooperation grants. All regressions include time dummies and a constant term. Aid variables are instrumented with own lags, (log) levels and square levels of GDP per capita, (log) population, and a FRZ dummy in columns 1 and 2. We use predetermined instruments in columns 3–5 (second lags in column 3; and second lags and lagged differences in columns 4 and 5). Robust standard errors in brackets, clustered at the country level, and including Windmeijer’s (2005) small sample correction in columns 3–5. ***, **, and * denote significance at 1, 5, and 10% levels.
Table 3. Foreign aid and FDI — Political risks

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<tr>
<th>Risk measure:</th>
<th>ICRG index</th>
<th>Govt. stability</th>
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<th>Investm. profile</th>
<th>Internal conflict</th>
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Observations: 264
N countries (clusters): 82
N excluded instruments: 71
AR(1), p-value: 0.018
AR(2), p-value: 0.17
AR(3), p-value: 0.22
Hansen overid., p-value: 0.5

$H_0: aid_K = -1$
| 0.45 | 0.48 | 0.27 | 0.41 | 0.13 | 0.10 | 0.22 |
| [0.36] | [0.43] | [0.25] | [0.29] | [0.27] | [0.30] | [0.3] |

$H_0: aid > 0$
| 0.32 | 0.45 | 0.14 | 0.21 | 0.16 | 0.12 | 0.28 |
| [0.071]*** | [0.12]*** | [0.068]*** | [0.046]*** | [0.076]*** | [0.098] | [0.09]*** |

$H_0: aid_A > 0$
| 0.87 | 0.97 | 0.87 | 0.80 | 1.03 | 1.02 | 1.07 |
| [0.34]*** | [0.33]*** | [0.3]*** | [0.31]*** | [0.31]*** | [0.32]*** | [0.3]*** |
Table 3 (continued). *Foreign aid and FDI — Political risks*

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<th>Law and order</th>
<th>Ethnic tensions</th>
<th>Democratic accountab.</th>
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<td>-0.0013***</td>
<td>-0.0013***</td>
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<td>-24.4***</td>
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<td>0.44***</td>
<td>0.45***</td>
<td>0.44***</td>
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<td>11.6***</td>
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<td>[4.24]</td>
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</table>

| Observations | 262                  | 262                | 262           | 262            | 262                   | 262              |
| N countries  | 82                   | 82                 | 82            | 82             | 82                    | 82               |
| N excluded   | 71                   | 71                 | 71            | 71             | 71                    | 71               |
| AR(1), p-value | 0.012               | 0.012              | 0.013         | 0.013          | 0.014                 | 0.015            |
| AR(2), p-value | 0.092               | 0.064              | 0.08          | 0.082          | 0.10                  | 0.10             |
| AR(3), p-value | 0.13                | 0.13               | 0.13          | 0.14           | 0.12                  | 0.15             |
| Hansen overid., p-value | 0.35             | 0.24               | 0.43          | 0.36           | 0.37                  | 0.39             |

$H_0$: aid$_K$ = -1  
0.59  
[0.47]  
$H_0$: aid > 0  
0.37  
[0.079]**  
$H_0$: aid$_A$ > 0  
0.78  
[0.44]**  

Notes. The dependent variable is FDI per capita ($fdi$). Risk measures taken from the International Country Risk Guide (ICRG). All regressions are estimated by GMM-SYS, and include a full set of time dummies and a constant term. Aid variables are instrumented with their second lags and lagged differences. Robust standard errors in brackets, clustered at the country level, and including
Windmeijer’s (2005) small sample correction. ***, **, and * denote significance at 1, 5, and 10% levels.
Table 4. Foreign aid and FDI — Regional effects

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<th>alternative def. of $aid_A (\text{aid}_A^*)$</th>
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<td>GMM-SYS 2</td>
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<td>$aid_K$</td>
<td>-0.84*** ([0.29])</td>
<td>-0.89*** ([0.28])</td>
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<tr>
<td>$aid_A (\text{aid}_A^*)$</td>
<td>1.09*** ([0.32])</td>
<td>1.10*** ([0.28])</td>
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<td>$aid_A (\text{aid}_A^*)$, squared</td>
<td>-0.0013*** ([0.00031])</td>
<td>-0.0013*** ([0.00026])</td>
</tr>
<tr>
<td>savings per cap., $S$</td>
<td>-17.0*** ([7.30])</td>
<td>-2.53 ([12.0])</td>
</tr>
<tr>
<td>pop. growth, $n$</td>
<td>-2.39 ([5.93])</td>
<td>5.1 ([7.61])</td>
</tr>
<tr>
<td>$fdi$, lagged</td>
<td>0.48*** ([0.11])</td>
<td>0.46*** ([0.094])</td>
</tr>
<tr>
<td>GDP per capita, $y$</td>
<td>8.72*** ([2.99])</td>
<td>1.21 ([6.43])</td>
</tr>
<tr>
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</tr>
<tr>
<td>N countries (clusters)</td>
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<td>98</td>
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<td>N instruments</td>
<td>64</td>
<td>59</td>
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<td>Hansen overid., $p$-value</td>
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<td>0.29</td>
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<tr>
<td>AR(1), $p$-value</td>
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<td>0.011</td>
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<td>AR(3), $p$-value</td>
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<td>0.25</td>
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<tr>
<td>AR(4), $p$-value</td>
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</tr>
<tr>
<td>Continent dummies</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>$H_0$: cont. dumm. = 0 ($p$-value)</td>
<td>-</td>
<td>0.59</td>
</tr>
<tr>
<td>$H_0$: $aid_K = -1$</td>
<td>0.16</td>
<td>0.11</td>
</tr>
<tr>
<td>$H_0$: $aid &gt; 0$</td>
<td>0.19</td>
<td>0.15</td>
</tr>
<tr>
<td>$H_0$: $aid_A &gt; 0$</td>
<td>1.03</td>
<td>1.04</td>
</tr>
</tbody>
</table>

Notes. The dependent variable is FDI per capita ($fdi$). $aid_A^*$ is defined as $aid_A +$ technical cooperation grants. All regressions are estimated by GMM-SYS, and include a full set of time dummies and a constant term. Aid variables are instrumented with their second lags and lagged differences. Robust standard errors in brackets, clustered at the country level, and including Windmeijer’s (2005) small sample correction.***, **, and * denote significance at 1, 5, and 10% levels.
APPENDIX A

A theoretical model of aid and FDI

This section presents a Solow model for a small open economy, adapted to studying the relationship between different types of aid flows and FDI.

Assume a Cobb-Douglas production function where GDP per capita, \( y \), is given by

\[
y = A k^\alpha,
\]

where \( k \) is the stock of physical capital per capita \( (\frac{K}{L}) \), \( A \) denotes total factor productivity, and \( \alpha \) is a constant.

Assume that the total flow of foreign aid, \( AID \), can be split into aid invested in complementary factors, \( AID_A \), and aid invested in physical capital, \( AID_K \), so that \( AID = AID_A + AID_K \). The part invested in complementary factors, \( AID_A \), raises the marginal productivity of all production factors that are complementary to physical capital.\(^{22}\) Aid to complementary factors helps for example to finance infrastructure investments that lead to the interconnection of markets (Easterly and Levine, 1999), or investments in human capital improve technology adoption. On the other hand, aid invested in physical capital, \( AID_K \), enters the production function only through its effect on physical capital accumulation and has no (augmenting) effect on total factor productivity.

To model the augmenting effect of complementary aid on all production factors that are complementary to physical capital, we allow the flow of \( AID_A \) to increase the existing stock of \( A (A_0) \) in the economy:

\[
A = A_0 + AID_A.
\]

Allowing complementary aid to have a direct impact on \( A \) is a shorthand for the idea that \( AID_A \) has an augmenting effect on any production factor other than \( k \) (e.g. human capital, public investments, new technology, etc.) and, thus, it is ultimately able to increase the \( MPK \).\(^{23}\)

\(^{22}\) The argument of complementarity between public and private investment is generalized by Clarida (1993) and Chatterjee et al. (2003). Reinikka and Svensson (2002) find empirical support for the importance of complementary public capital for foreign investors.

\(^{23}\) We could assume that FDI (and domestic savings) also contributes to the accumulation of TFP in the economy. Our assumption that only one part of aid contributes to increasing TFP highlights the fact that there is one part of aid that explicitly aims to transfer technology, improve institutions, etc.,
We assume an open economy. Accordingly, capital equipment (in per capita terms) is financed by (i) domestic savings \( S = sy \), where \( s \) is a given savings rate, and also by (ii) foreign direct investments \( fdi \) and (iii) the part of aid invested in physical capital \( aid_k \). Then, capital accumulation in per capita terms is given by

\[
\dot{k} = sy + fdi + aid_k - (n + \delta)k ,
\]

where \( n \) is the population growth rate and \( \delta \) is a fixed depreciation rate.

With perfect capital mobility (following Caselli and Feyrer, 2007), the world real rate of return, \( r^w \), pins down at any point in time the net return to capital \( MPK - \delta \), and thus

\[
r^w = MPK - \delta = A \alpha k^{\alpha-1} - \delta .
\]

According to (A.4), the steady state level of \( k \) at any point in time is given by

\[
k^* = \left[ \frac{A\alpha}{r} \right]^{\frac{1}{1-\alpha}} ,
\]

where \( r \) is defined as a gross world real rate of return, \( r^w + \delta \).

Rewriting (A.3) taking (A.5) as given, the flow of FDI per capita is determined as the residual

\[
fdi = -aid_k - sy^* + (n + \delta)k^* ,
\]

where \( y^* = Ak^{\alpha-1} \).

At a first glance, (A.6) seems to support the Caselli and Feyrer (2007) conjecture that aid and FDI are substitutes: for a given level of domestic savings, equalization between \( MPK \) and \( r \) requires an increase in foreign aid to be accommodated by a proportional reduction in FDI:

\[
\frac{\partial fdi}{\partial aid_k} = -1 .
\]

However, this type of relationship only holds for aid invested in physical capital. The effect of complementary aid has two components:

---

whereas the effects that FDI (and domestic savings) have on TFP might be important as well but in practice are only indirect.

24 In line with Sørensen and Witta-Jacobsen (2005, Ch. 4) and Turnovsky (2000).
\[
\frac{\partial \text{fdi}}{\partial \text{aid}_A} = -s \frac{\partial y^*}{\partial \text{aid}_A} + (n + \delta) \frac{\partial k^*}{\partial \text{aid}_A}.
\] (A.8)

First, since

\[
\frac{\partial k^*}{\partial \text{aid}_A} = \frac{\partial}{\partial \text{aid}_A} \left( \frac{A \alpha}{r} \right) = \frac{\alpha}{1-\alpha} \left[ \frac{A \alpha}{r} \right]^{\frac{\alpha}{r}} L > 0,
\] (A.9)

we see that complementary aid has a positive effect on the steady state capital stock. This finding is based on the augmenting effect of \( \text{aid}_A \) on TFP \( (A) \), which rises the MPK and allows the recipient country to increase its capital stock without experiencing a counterbalancing capital flight. More precisely, for a given level of \( s \), aid-financed investments in complementary factors allow a sustainable increase in FDI equal to \((n + \delta) \frac{\partial k^*}{\partial \text{aid}_A}\).

Second, since

\[
s \frac{\partial y^*}{\partial \text{aid}_A} = s \frac{\partial (A k^*)}{\partial \text{aid}_A} = s \left[ L k^2 + A k \right] \frac{\partial k^*}{\partial \text{aid}_A} > 0,
\] (A.10)

complementary aid has a positive effect on domestic savings and thus on domestically financed capital investments. This comes from the fact that \( \text{aid}_A \) shifts the production function and thereby raises the steady state levels of income and domestic savings. Given the assumption of MPK equalization in \((A.4)\), the corresponding increase in domestically financed investments causes a proportional reduction of size \(-s \frac{\partial y^*}{\partial \text{aid}_A}\) in the need for FDI.

This model holds several implications that should be taken into account when assessing the empirical relationship between aid and FDI. First, the effect of total aid on FDI is ambiguous:

\[
\frac{\partial \text{fdi}}{\partial \text{aid}} = \frac{\partial \text{fdi}}{\partial \text{aid}_K} + \frac{\partial \text{fdi}}{\partial \text{aid}_A} = -1 - s \frac{\partial y^*}{\partial \text{aid}_A} + (n + \delta) \frac{\partial k^*}{\partial \text{aid}_A} \geq 0,
\] (A.11)

because we expect aid to production sectors to have a negative effect on FDI, but the effect of complementary aid is indeterminate. Second, from equations (second component) and (savings effect), since the marginal effect of complementary aid on FDI includes the level of complementary aid itself, the relationship between complementary aid and FDI is not linear, and there are scale effects from complementary aid that should be taken into account.\(^{25}\) Since

\(^{25}\) The main reason for expecting significant scale effects only for \( \text{aid}_A \) is that it has two first-order effects on the level of FDI: it increases the marginal productivity and attracts additional foreign
and the capital stock in (A.5) should be redefined accordingly:

\[ k^* = \left( \frac{A\alpha}{r + \rho} \right)^{\frac{1}{r}}. \]  

(A.13)

While this renders the effect of aid invested in physical capital unchanged, the effect of complementary aid becomes somewhat more complicated. The risk premium impacts FDI directly through (A.13) but, given that

\[ \frac{\partial k^*}{\partial \text{aid}_A} = \frac{\partial}{\partial \text{aid}_A} \left( \left[ A\alpha \right]^{\frac{1}{r}} \right) = \frac{1}{1 - \alpha} \left[ A\alpha \right]^{\frac{1}{r}} \frac{L\alpha}{r + \rho}, \]  

(A.14)

the marginal effect of \( \text{aid}_A \) will also depend on the risk premium and thus on country-specific characteristics.

---

investments, but also raises income, domestic savings and domestic investments, which lowers MPK and tends to crowd out foreign investments. The total effect of complementary aid is then conditional on the existing amount of \( \text{aid}_A \). \( \text{aid}_k \) does not operate with scale effects, because it has only one direct effect on the level of FDI: both are sources for investments in physical capital (along with domestic savings), and in a world where the MPK is pinned down by \( r^\omega \) (Caselli and Feyrer, 2007), the relationship between \( \text{aid}_k \) and FDI (and savings) is linear (they are substitutes to each other, independently of the size of \( \text{aid}_k \) in the economy).
## APPENDIX B

### Additional tables

**Table A.1. Summary statistics**

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<th></th>
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<th>Mean</th>
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<th>Max</th>
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<td>-384.9</td>
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<td>0</td>
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Table A.2. $aid_A$ and $aid_K$ across time (as % of total aid), and total aid receipts (in USD per capita)

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<th>Year</th>
<th>Social infras</th>
<th>Econ. infras</th>
<th>$aid_A$</th>
<th>Agric., forestry, fishing</th>
<th>Industry, mining, construction</th>
<th>Trade, banking, tourism</th>
<th>$aid_K$</th>
<th>Total aid per capita</th>
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</thead>
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<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(1) + (2)</td>
<td>(a)</td>
<td>(b)</td>
<td>(c)</td>
<td>(a) + (b) + (c)</td>
<td>(USD)</td>
</tr>
<tr>
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<td>29.9</td>
<td>32.7</td>
<td>50.4</td>
<td>16.2</td>
<td>17.8</td>
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<td>22.8</td>
<td>372.1</td>
</tr>
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All countries (186 countries, 1970-2001):

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Average 31.9 24.9 50.4 15.3 11.3 3.5 22.0 323.4
Std. dev. 9.4 8.6 6.8 5.0 6.7 2.6 7.4 99.6
Minimum 22.3 13.0 41.6 9.2 3.0 0.8 12.2 112.6
Maximun 46.5 36.4 59.4 21.2 18.8 7.4 29.1 388.9

Main sample (99 countries, 1975-2001):

Median 22.3 22.5 45.1 13.6 6.3 1.1 19.9 88.1
Average 25.7 22.7 47.6 12.9 6.9 1.7 18.8 91.7
Std. dev. 12.8 6.2 7.8 3.9 3.8 1.3 5.6 27.3
Minimum 12.8 14.5 40.1 8.1 3.2 0.6 12.3 51.6
Maximun 43.5 30.5 58.0 17.5 13.2 3.8 24.7 130.3

Notes. Estimated amount of $aid_A$ and $aid_K$, as percentages of total aid commitments. $aid_A$ is aid financing complementary inputs (projects in social infrastructure, such as education, health, and water supply projects; and economic infrastructure, such as energy, transportation and communications projects). $aid_K$ are aid contributions to directly productive sectors (such as agriculture, manufacturing, trade, banking and tourism projects). Total aid disbursements per capita expressed in constant 2000 US dollars. Estimates based on data from the OECD’s Credit Reporting System and Aid Activity database. Data available for 186 developing countries, of which 99 are included in the main sample, due to limitations in the availability of other variables.
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Main sample (99 countries, 1975-2001):

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Notes. × = included in the final sample. Estimated amount of $aid_A$ and $aid_K$, as percentages of total aid commitments. $aid_A$ is aid financing complementary inputs (projects in social infrastructure, such as education, health, and water supply projects; and economic infrastructure, such as energy, transportation and communications projects). $aid_K$ are aid contributions to directly productive sectors (such as agriculture, manufacturing, trade, banking and tourism projects). Total aid disbursements per capita expressed in constant 2000 US dollars. Estimates based on data from the OECD’s Credit
Reporting System and Aid Activity database. Data available for 186 developing countries, of which 99 are included in the main sample, due to limitations in the availability of other variables.
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**Notes.** Aid data available for 186 developing countries from the OECD Credit Reporting System and Aid Activity databases, of which 99 are included in the main sample, due to limitations in the availability of other variables.