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Aid and Growth Accelerations

Vulnerability Matters

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Abstract

This paper confronts three conundrums. First, does the relationship between aid and growth fade over time when aid is successful? Second, why are aid inflows neglected in the literature on growth acceleration (or episodes). Third, why is country vulnerability overlooked in the same literature? Our purpose is to address these puzzles, and in doing so two hypotheses are formulated and tested. First, we assume that aid can have a positive (catalytic) effect on the launching of growth episodes, as well as on their duration. Second, we assume that this effect is all the more significant with the intensity of the exogeneous shocks the country faces. Econometric tests do not reject these hypotheses.

The paper first considers the origin of the puzzles and explains the hypotheses presented as the answer, and then introduces the models used to test these. Finally, it assesses the results and their implications. Once again, it appears that vulnerability does matter with regard to the impact of aid on both the probability of an occurrence of growth spells and on their duration.

Keywords: official development assistance, growth acceleration, economic vulnerability, probit estimations

JEL classification: F35, O40, O47

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1 Aid, vulnerability and growth accelerations: a discussion of hypotheses

1.1 The aid–growth relationship: a dynamic perspective

Important progress has been made in the estimation of the aid–growth relationship, as evidenced by Arndt, Jones and Tarp (2010). However, most econometric estimations of the impact of aid on economic growth do not capture the dynamic nature of this relationship: if aid is successful in promoting self-sustained growth, it progressively should become redundant. Thus, in a successful country, the positive correlation between aid and growth should revert into a negative one. The fact that fast growing emerging countries do not receive aid, at times considered to suggest the ineffectiveness of aid, can be analysed from the opposite direction … whether these countries previously received aid and whether this aid contributed to launching growth. Consider, for instance, the history of countries such as Korea, Thailand, Tunisia, where large aid inflows helped to launch long spells of growth, followed by a decline in aid levels. A panel estimation of aid effects that relies on observations related to countries at very different stages of development is weakened by this dynamics.

Thus, as a preliminary issue, we examine whether aid has contributed to launching growth. It is striking to note that well before the extensive use of aid–growth econometric estimations, the main approach of aid contribution was to design 'pump priming models' (Mikesell 1968). But it is also interesting to observe that the investigation of the factors determining the launch of growth or growth episodes, as initiated by Hausmann, Pritchett and Rodrik (2005)[1] does not take development assistance into account. A notable exception is offered by Dovern and Nunnenkamp (2007), to whom we come back later,[2] but their results are significant with only one definition of growth acceleration, and in their case, pretty weak.

The reason for this absence of aid in the 'growth acceleration' literature may have been that a risk of endogeneity exists when an aid variable is introduced into the relationship. Hausmann, Pritchett, and Rodrik (2005) raise this issue for (private) capital inflows as likely to be forward-looking: indeed, they are endogenous if investors are able to predict the timing of accelerations. But the argument cannot be applied to official development assistance (ODA). As with ODA, Dovern and Nunnenkamp (2007) consider the risk of endogeneity to be low, arguing that evidence does not support the idea of a reverse causation problem. Consequently, they do not instrument aid, referring in particular to the meta-analysis by Doucouliagos and Paldam (2005) who find that results are not affected in most aid–growth econometric estimations when the endogeneity of aid is accounted for.[3] In order to verify this assertion, we propose a two-step empirical test

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1 And also followed noticeably by Pattillo, Gupta and Carey (2005), Berthélémy (2006), Arbache and Page (2007), and Carrère and de Melo (2007).

2 A preliminary CERDI study by Guillaumont and Kouak Tiyab (2007), available on request, also offers some tentative results.

3 They also recall, quoting Nunnenkamp and Thiele (2006), that according to the literature on aid, the data are far from displaying straightforward adjustments of the donors' allocation to variations of the economic conditions in recipient countries.

based on an instrumentation 'à la Tavares'. The impact of aid on growth acceleration is a relevant issue, whatever the endogeneity.

Of course, for aid to truly contribute to development, it should contribute not only to a temporary acceleration of growth, but also lead to sustained growth. A complementary issue to be examined, then, is the impact of aid on the duration of the growth episode.

Finally, if we expect aid to decrease once growth appears to be self-sustained, another and more complex issue would be to estimate how long a given (high) level of aid needs to be supplied so that it can eventually be reduced without a decrease in growth.

Three issues are involved: the first concerns estimation of the impact (of aid) on the probability of a growth episode. The second issue is estimating the impact (of aid) on the duration of the episode. The third is determining the duration of a given aid inflow needed which would enable aid to be reduced without a loss of growth. Here, we investigate mainly the first issue, offer some preliminary results on the second issue, and provisionally keep the third (and most complex) issue aside.

Now to introduce nonlinearities in the aid–growth relationship: these nonlinearities, which are linked to a time sequence, differ from those usually considered in the cross-country estimations linked to total aid amounts. The latter often presumes that the marginal impact of aid on growth decreases (to become null when absorptive capacity is reached). At times, it is also assumed that the marginal impact could be increased in poor countries when the level of aid is low (fitting the big push theory).[4] Nevertheless, the assumption that aid can contribute to launching growth is also consistent with the notion of the big push.

1.2 Vulnerability as an obstacle to growth accelerations: how it can be reduced with aid

Although considerable evidence exists to indicate that vulnerability is an obstacle to growth (e.g., Ramey and Ramey 1995), this issue has not been addressed in depth in the growth acceleration literature. For instance, the seminal paper by Hausmann, Pritchett, and Rodrik includes only a terms of trade variable that changes over time, but no index of instability of export prices or/and terms of trade is included. However, the growth episode can be interrupted not only by a one-time shortfall, but also by a succession of shortfalls and booms, which makes it difficult to forecast and invest optimally.

At the same time it has been argued in the aid–growth literature that marginal aid effectiveness is higher in vulnerable economies, or in economies faced with exogenous shocks, as evidenced, for instance, by the significant positive coefficient of a multiplicative variable of aid and a measure of exogenous vulnerability. This positive effect is due to aid's stabilizing impact that leads to a lower negative impact of vulnerability on growth (Guillaumont and Chauvet 2001; Chauvet and Guillaumont 2004, 2009; Guillaumont 2006; Guillaumont Jeanneney and Tapsoba 2012). When decreasing returns are estimated, vulnerability (or more precisely, export instability)

4 On the opposition between the big push and the absorptive capacity approaches, see Guillaumont and Guillaumont Jeanneney (2010).

slows down or postpones this decrease (Wagner 2008). Other methods lead to similar conclusions (Collier and Goderis 2008).

To support this hypothesis it has been said that aid, through this dampening effect, is likely to have a role in avoiding macroeconomic collapses or the vicious circles that may follow negative shocks in low-income economies with weak resilience. In other words, aid is a factor of higher resilience. If aid has such an effect on long-term growth, it could even be expected to have a similar effect on the probability of growth accelerations. Thus we should test the hypothesis that aid's effect on growth accelerations is all the more greater in recipient countries that are facing exogenous shocks, simply because these shocks are likely to prevent growth acceleration. The argument is at least as valid with respect to the duration of the growth episodes.

While structural economic vulnerability seems a highly relevant factor conditioning the impact of aid on the occurrence of growth episodes, there may be other elements as well. Dovern and Nunnenkamp (2007) consider the quality of local institutional conditions, not through a multiplicative variable, but by dividing their sample into two groups (the 'good' and the 'bad' states). Curiously they find a significant (still limited) impact of aid on the probability of growth episodes only in the 'bad' states.[5] This paradoxical finding may be due precisely because of the negative impact of structural vulnerability on policy and institutional variables (analysed in Guillaumont, McGillivray and Wagner 2011).

2 Aid introduced in the probit model of growth acceleration

2.1 Identification of the episodes

For identifying growth acceleration, we follow the methodology proposed by Hausmann, Pritchett, and Rodrik (2005). Although their definition of the parameters has been debated, the filter they propose has been widely used in literature.

Basically, for a spell to be considered as 'growth acceleration', it must meet four criteria:

1) growth of GDP per capita to have been sustained for at least n years;
2) acceleration to have been fast, with the difference between the growth rates for two consecutive periods at least g percentage points;
3) growth rate from the acceleration period to have been sufficiently high, at least g^* per cent;
4) GDP per capita observed at the end of the acceleration period to have been higher than the maximum level registered over the entire period before acceleration.

The yearly growth rate of GDP per capita (y) over the period [t; $t+n$], called $g_{t,\ t+n,}$ is obtained by estimating by OLS the following equation:

[5] They use the Polity IV index.

$$\ln(y_{t+i}) = a + g_{t,\,t+n} \qquad t\,;\ i = 0, \ldots, n$$

Conditions (2) to (4) that must be met are the following:[6]

$$(2) \qquad \Delta g_{t,\,n} = g_{t,\,t+n} - g_{t-n,\,t} \geq g$$

$$(3) \qquad g_{t,\,t+n} \geq g^*$$

$$(4) \qquad y_{t+n} \geq \max\{y_i\}\,, \qquad i \leq t$$

For the identification of acceleration episodes, set values should be chosen for the three parameters (n, g and g^*). Originally Hausmann, Pritchett, and Rodrik chose to work with eight-year periods (N=7) during which growth was to accelerate by 2 percentage points (g=2), with a minimum growth rate during the acceleration period on average higher than 3.5 per cent (g^*=3.5). Nevertheless, Pattillo, Gupta and Carey (2005) in their focus on African growth, note that the continent rarely experiences such growth acceleration, and they subsequently use less demanding criteria. They consider five-year periods (N=5), and minimum growth during acceleration on average higher than 2 per cent (g^*=2%), while keeping the second criterion (g) at its original 2 per cent level. Finally, Dovern and Nunnenkamp (2007) alternatively use eight- and five-year periods, with g set at either 2 or 1 per cent, but without imposing the third condition (g^*), as they are more interested in the ability of aid to foster even moderate growth than in its ability to generate high absolute growth rates (which may lead to misinterpreting a period of stagnation following long-term decline as growth acceleration).

Here we first apply the filter parameters used by Pattillo, Gupta and Carey (N=5*;* g=2; g^*=2%). Moreover we compare the main results thus obtained with those drawn from the filter used by Dovern and Nunnenkamp (with N=5; g=2 or g=1).

2.1 The growth episodes

The previous filters applied to the GDP per capita series are drawn from Heston, Summers and Aten's (2009) Penn World Tables version 6.3. This produces several sets of growth episodes covering the years 1970 to 2007, a period more recent than those applied in earlier growth acceleration studies. These are summarized in Table 1.

As expected, the number of episodes is lower with N=5*;* g=2; g^*=2% (the Pattillo, Gupta and Carey parameters) than with only N=5; g=2 and still lower than with only N=5; g=1 (the Dovern and Nunnenkamp parameters). The differences are mainly due to the number of episodes in sub-Saharan Africa, and in Middle East and North Africa.

6 Arbache and Page (2007) propose a slightly different methodology that will be discussed further.

Table 1
Number of growth accelerations detected using three alternative filters
by regions and decades in developing countries only, 1970-2007

Filtering parameters	Region	1970s	1980s	1990s	2000s	Total
N=5, *g*=2, *g**=2	East Asia and Pacific	2	7	4	1	14
	Europe and Central Asia	0	1	1	3	5
	Middle East and North Africa	3	3	2	1	9
	South Asia	2	1	3	2	8
	Sub-Saharan Africa	3	7	4	2	16
	Latin America and the Caribbean	7	9	7	5	28
	Total	17	28	21	14	80
N=5, *g*=2	East Asia and Pacific	2	7	4	1	14
	Europe and Central Asia	0	1	1	4	6
	Middle East and North Africa	3	5	5	1	14
	South Asia	3	1	3	2	9
	Sub-Saharan Africa	3	10	4	3	20
	Latin America and the Caribbean	9	8	8	5	30
	Total	20	32	25	16	93
N=5, *g*=1	East Asia and Pacific	2	6	4	3	15
	Europe and Central Asia	0	1	2	4	7
	Middle East and North Africa	5	5	7	5	22
	South Asia	3	2	2	3	10
	Sub-Saharan Africa	5	12	7	7	31
	Latin America and the Caribbean	10	12	9	8	39
	Total	25	38	31	30	124

Source: Authors' calculations, based on data from Heston, Summers and Aten (2009).

2.2 Data measurement

Three kinds of data are used:

- *Standard data from growth episodes literature*, extended here to the year 2007. These include an openness indicator (exports+imports over GDP), a geographical variable to take into account the share of tropical areas in total landmass, the 'civil liberties' variable from the Freedom House Index as the institutional quality indicator, the indicator of education has been replaced by the Human Assets Index (HAI), a composite index of health and education used by the UN in the identification of least developed countries (LDCs) and made available at Ferdi on a retrospective basis for a large set of countries. Also included are two variables constructed from Marshall and Jaggers' (2002) Polity IV database reflecting institutional shocks: *poschange* (equal to one in the five years following a change towards democracy according to the Polity IV data) and *negchance* (equal to one in the five years following a change towards autocracy). Finally we include three variables reflecting economic policies: inflation rate, M2 over GDP and government spending over GDP, all from the World Bank's world development indicators.

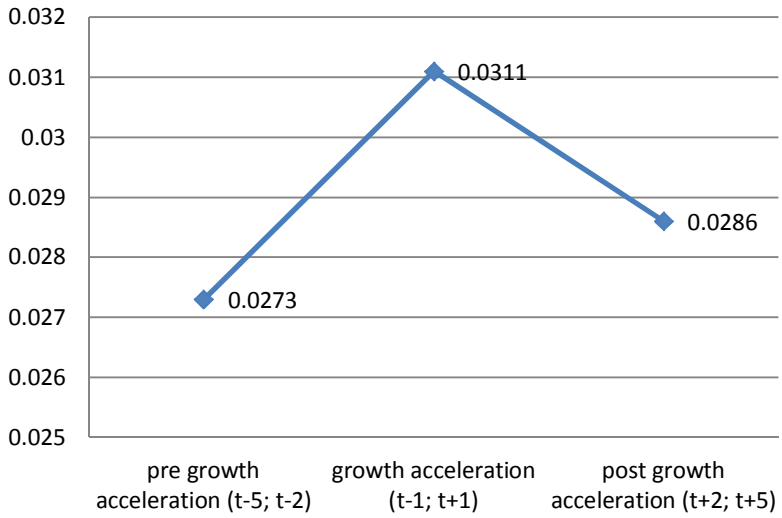
- *ODA data* from the DAC database are used for net disbursements, while acknowledging the limitations of this information in the assessment of the aid impact; more relevant data with the necessary time coverage are not available.

– An index of structural economic vulnerability, *the Economic Vulnerability Index*, also used (as HAI) by the UN for the identification of the LDCs and calculated at Ferdi on a retrospective basis. It is a simple average of an index of the intensity of exogenous shocks (shock index), relying on three components, and of the exposure to these shocks (exposure index) based on four components. In other words, it is a weighted average of seven components: instability of exports, instability of agricultural production, homeless population due to natural disasters (for the shocks), low population size, distance from world's markets, exports concentration and the share of agricultural value added to GDP (for the exposure) (details on this index in Guillaumont 2010).

2.3 Stylized facts

The simple graph given in Figure 1 summarizes the story behind this paper. It compares the average level of the ODA-to-GDP ratio before, during and after growth acceleration periods (defined according to the first filter parameters). Although the differences are not very large, Figure 1 clearly indicates the impulse given by aid to growth acceleration without the level of aid being sustained after acceleration. However, the same figure for various other regions presents a diverging picture with the peak being sharper for East Asia and Pacific, but reversed for Middle East and North Africa (probably due to oil exports).

Figure 1
ODA over GDP, before, during and after a growth acceleration, 1970-2007, filter parameters (N=5, g=2, g*=2)



Source: Authors' calculations, based on data from Heston, Summers and Aten (2009).

2.4 The probit model

The empirical literature on the determinant of growth accelerations relies extensively on a binary choice model. Hence, in the regressions presented in Tables 2 and 3, the dependent variable is a dummy variable that takes the value of one at time *t*, i.e., the starting point of a growth acceleration, and in the two adjacent years, *t*-1 and *t*+1. This

window of three years is used to deal with the uncertainty concerning the exact timing of growth accelerations. Equations are estimated by probit.

Recent research by Ai and Norton (2003) emphasizes the difficulty of interpreting interactions in nonlinear models. They show that the interaction effect cannot be evaluated by looking at the sign, magnitude, or statistical significance of the coefficient on the interaction term. The interaction effect is conditional on the independent variable, and therefore both the magnitude and statistical significance of the interaction term can vary across observations. To ensure that our inferences are correct, we use the methodology developed by Ai and Norton to compute the real (or corrected) marginal effect of a change in the interaction variable. We report both the corrected marginal effects and their standard errors in the following tables.

3 Main results on the probability of occurrence

3.1 Aid increases the probability all the more that the EVI is higher

Table 2 relies on the three main sets of parameters presented above, beginning with our preferred set: N=5; g=2; g^*=2% (the Pattillo, Gupta and Carey parameters). The first columns show the results with the aid variable only additively introduced, with and without economic policy variables. The marginal impact of aid appears significant. In the third column, we control for a possible endogeneity problem using instrumental variables inspired by Tavares (2003). Our coefficient of interest remains broadly the same with regard to both significance and size. As Dovern and Nunnenkamp note, the endogeneity issue does not seem to be severe in this particular framework. When a multiplicative variable (aid x EVI) is added (column 4), the explanatory power is increased, with highly significant coefficients for both the additive and the multiplicative aid variables, as well as for the coefficient of the additive EVI variable. The signs are as expected (minus for EVI, plus for aid x EVI). The negative coefficient obtained for the additive aid variable should be interpreted with caution with respect to the distribution of EVI, and to the results obtained with only the aid variable (without the multiplicative one).

Table 2
Impact of ODA on growth accelerations, conditional on vulnerability (EVI)
probit estimations, 1970-2007, various filter parameters

Filtering parameters	N=5, g=2, g^*=2				N=5, g=2	N=5, g=1
	(1)	(2)	(3)	(4)	(5)	(6)
LGDP per capita	0.038 (0.007)***	0.026 (0.007)***	0.040 (0.010)***	0.024 (0.007)***	0.039 (0.008)***	0.047 (0.010)***
Openness	0.042 (0.021)**	0.040 (0.021)*	0.061 (0.030)**	0.052 (0.019)***	0.039 (0.022)*	0.024 (0.029)
Tropical	-0.044 (0.014)***	-0.037 (0.013)***	-0.045 (0.012)***	-0.032 (0.012)***	-0.041 (0.015)***	-0.082 (0.019)***
HAI	-0.031 (0.035)	-0.008 (0.035)	-0.013 (0.052)	-0.056 (0.029)*	-0.053 (0.037)	-0.045 (0.050)
Civil liberties	-0.000 (0.003)	-0.001 (0.002)	-0.001 (0.003)	-0.001 (0.002)	0.001 (0.003)	0.001 (0.003)
EVI	-0.000 (0.000)	-0.001 (0.000)*	-0.001 (0.000)*	-0.001 (0.000)***	-0.001 (0.000)**	-0.000 (0.000)

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Impact of ODA on growth accelerations, conditional on vulnerability (EVI)
probit estimations, 1970-2007, various filter parameters

Filtering parameters	*N*=5, *g*=2, *g**=2				*N*=5, *g*=2	*N*=5, *g*=1
	(1)	(2)	(3)	(4)	(5)	(6)
Positive change (Polity IV)	-0.008 (0.009)	-0.013 (0.008)*	-0.022 (0.014)	-0.012 (0.006)*	-0.020 (0.008)**	-0.031 (0.011)***
Negative change (Polity IV)	0.040 (0.020)**	0.041 (0.022)*	0.043 (0.018)**	0.028 (0.019)	0.028 (0.022)	0.005 (0.020)
M2/GDP		-0.023 (0.016)	-0.034 (0.024)	-0.030 (0.013)**	-0.017 (0.016)	-0.019 (0.020)
Government spending over GDP		0.063 (0.054)	0.094 (0.083)	0.071 (0.044)	0.049 (0.057)	0.025 (0.077)
Inflation		-0.025 (0.010)**	-0.037 (0.019)*	-0.026 (0.008)***	-0.021 (0.012)*	-0.036 (0.016)**
ODA (over GDP)	0.181 (0.070)***	0.140 (0.080)*	0.226 (0.135)*	-1.981 (0.472)***	-1.179 (0.573)**	-0.778 (0.753)
ODA x EVI				0.096 (0.033)***	0.028 (0.011)**	0.024 (0.022)
Observations	2722	2256	2254	2256	2256	2256
Pseudo R^2	0.10	0.10	0.10	0.13	0.12	0.09

Notes: This table displays marginal effects. Regional and decennial dummies are included (but not reported). Coefficients and standard errors for the interactive terms are corrected following Ai and Norton (2003). Robust standard errors in parentheses. Column (3) displays results obtained by instrumenting ODA over GDP using the strategy proposed by Tavares (2003).

* significant at 10%; ** significant at 5%; *** significant at 1%.

Source: See text.

The last two columns give the results with the same sets of variables as in column 4, but with two other less demanding criteria for growth acceleration. They are still significant for *N*=5; *g*=2, although indicating a lower impact of aid, but not for *N*=5; *g*=1, the least demanding set. In other words, the sharper pattern of growth acceleration clearly highlights aid's contribution to the probability of a growth episode occurring.

3.2 The marginal impact of aid on the probability of occurrence is conditional on both the exposure to the shocks and on the size of the shocks

Here we consider the exposure and shock components of EVI separately. The size of a shock has a very significant negative impact on the probability, whereas exposure does not. The first two columns of Table 3 give the results obtained with the preferred filter (*N*=5, *g*=2, *g**=2): probability of an occurrence of growth acceleration as a function of ODA appears to be conditional for both the exposure index and the shock index. When a less demanding filter is used, the impact is smaller and conditional only for the exposure index. When various subcomponents of EVI are considered (results not reported), it seems that export concentration has a major role.

Table 3
Impact of ODA on growth accelerations, conditional on the shock and exposure components of EVI
probit estimations, 1970-2007, various filter parameters

Filtering parameters	*N*=5, *g*=2, *g**=2		*N*=5, *g*=2	
	(1)	(2)	(3)	(4)
LGDP per capita	0.026 (0.007)***	0.018 (0.006)***	0.038 (0.008)***	0.034 (0.008)***
Openness	0.011 (0.019)	0.029 (0.019)	-0.006 (0.023)	0.014 (0.023)
Tropical	-0.042 (0.014)***	-0.026 (0.010)**	-0.047 (0.015)***	-0.038 (0.014)***
HAI	-0.021 (0.029)	-0.045 (0.029)	-0.020 (0.036)	-0.052 (0.038)
Civil liberties	0.002 (0.002)	-0.000 (0.002)	0.004 (0.003)	0.002 (0.003)
Choc	-0.160 (0.038)***	-0.083 (0.027)***	-0.140 (0.041)***	-0.094 (0.036)***
Exposure	0.039 (0.025)	-0.019 (0.024)	0.056 (0.031)*	0.003 (0.032)
Positive change (Polity IV)	-0.007 (0.007)	-0.005 (0.007)	-0.016 (0.009)*	-0.013 (0.008)
Negative change (Polity IV)	0.045 (0.022)**	0.029 (0.018)	0.038 (0.024)	0.029 (0.022)
M2 over GDP	-0.017 (0.015)	-0.020 (0.013)	-0.003 (0.018)	-0.008 (0.016)
Government spending over GDP	0.024 (0.049)	0.003 (0.048)	-0.010 (0.062)	-0.024 (0.063)
Inflation	-0.023 (0.010)**	-0.020 (0.009)**	-0.016 (0.012)	-0.015 (0.011)
ODA (over GDP)	-0.845 (0.279)***	-2.499 (0.557)***	-0.388 (0.340)	-1.856 (0.700)***
ODA x Shock	4.596 (1.981)***		1.938 (1.544)	
ODA x Exposure		6.839 (3.021)***		4.433 (2.188)**
Observations	2256	2256	2256	2256
Pseudo R^2	0.13	0.14	0.12	0.13

Notes: This table displays marginal effects. Regional and decennial dummies are included (but not reported). Coefficients and standard errors for the interactive terms are corrected following Ai and Norton (2003).

Robust standard errors in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%.

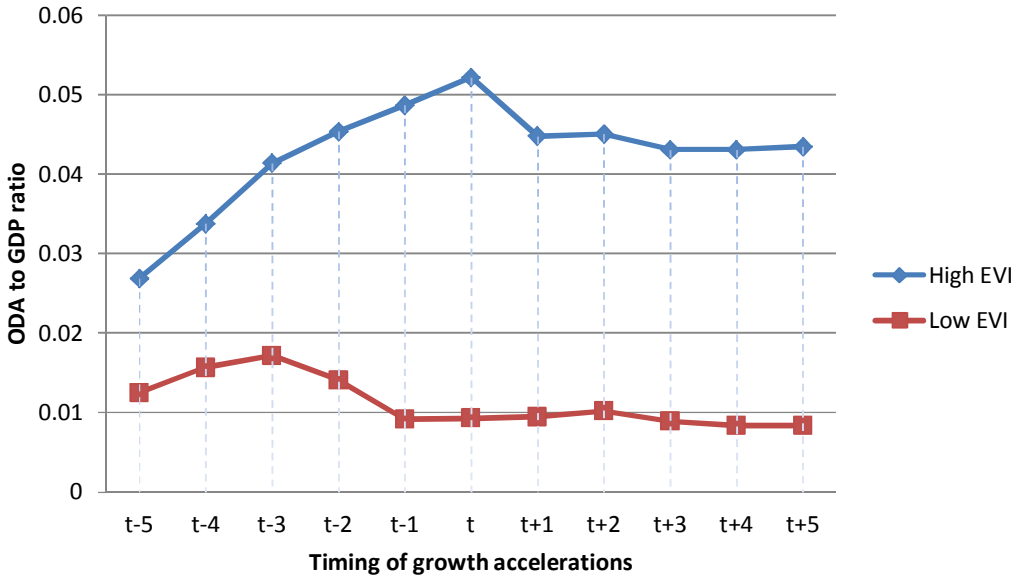
Source: See text.

3.3 Both level and growth rate of ODA matter: towards an indicator of aid acceleration

In the previous section, we saw that the current level of ODA has a positive impact on the probability of an occurrence of growth acceleration and that this effect is stronger in countries that are relatively more vulnerable. As shown in Figure 2, this might be only part of the story. Focusing on countries for which EVI is higher than the median, we saw that ODA has steadily increased during the five years prior to acceleration (that

occurs in *t*). Indeed, this may mean that the level of ODA is a factor that can trigger growth acceleration. However, the interpretation of this finding is different if one considers the dynamics of ODA disbursements. Does the probability of growth acceleration rise when a country experiences a high and stable *level* of ODA for a few years or sharp a*cceleration* of ODA?

Figure 2
ODA to GDP ratio, before, during and after a growth acceleration, with respect to EVI levels relative to the sample median, 1970-2007, filter parameters (*N*=5, *g*=2,*g**=2)



Source: Authors' calculations, based on data from Heston, Summers and Aten (2009).

The results displayed in Table 4 shed some light on these questions. We choose to base the analysis of this section on the equation used in Table 2 (column 2) for all four specifications.

In the first specification, we include the lagged value of ODA over GDP ranging from *t*-1 to *t*-5 instead of its contemporaneous value. As can be seen, only the first lag of ODA over GDP turns out to be significant. Furthermore, coefficients, while insignificant, seem to be decreasing with the lag. This pattern is not consistent with the notion that the probability of growth acceleration is increased in a country that receives relatively larger, stable flows of aid over a few years.

Alternatively, in the second specification we examine whether the growth rate of aid between *t*-*i* (*i* ranging from two to five) and *t* is positively and significantly correlated with the probability of growth acceleration. In essence, we are trying to see if the pattern displayed in Figures 1 and 2 can be formally replicated using an econometric approach. As evidenced in the Table 4,[7] we find the expected relationship, that is, a significant coefficient for the growth rate of aid between *t*-*i* and *t*, except for *i*=5. Thus

[7] Table 4 does not display the coefficients related to the included control variables (available upon request from the authors).

an acceleration of ODA disbursements sustained for at least four years appears to be a factor that explains the probability of growth acceleration.

Next, we try to create an *indicator of aid impulse* or of accelerated disbursements prior to growth by multiplying the lagged value of the ODA-to-GDP ratio with the growth rate of aid over the corresponding period. This gives us the variation of ODA between *t-i* and *t* over initial GDP.[8] The results obtained with this new variable are presented in specification 3. The rationale for this indicator, which captures both ODA's high level and fast growth rate, is that both variables matter. As can be seen in the third specification, the coefficients related to our indicator are always significant. This clearly shows that a period of accelerated disbursements that translates into a high level of ODA increase over GDP is an important factor in explaining the probability of growth acceleration occurring.

Finally, in the last specification, we check whether the impact of our new indicator is higher for vulnerable countries as suggested by Figure 2. While the significance levels are slightly weaker than before (Table 3), we find again, with *i*=4, confirmation of the same pattern, i.e., that economically vulnerable countries would benefit more from a strong acceleration of aid disbursements.

Table 4
ODA over GDP, ODA growth rate and an indicator of accelerated disbursements, probit estimations, 1970-2007, filter parameters (*N*=5, *g*=2, *g**=2)

	i=1	*i*=2	*i*=3	*i*=4	*i*=5
			Specification 1		
ODA (over GDP) *t-i*	**0.141**	0.075	0.034	-0.061	-0.007
	(0.083)*	(0.078)	(0.081)	(0.077)	(0.067)
			Specification 2		
Delta ODA (*t-i* ; *t*) (over ODA)		**0.002**	**0.002**	**0.002**	0.000
		(0.001)*	**(0.001)***	**(0.001)***	(0.000)
			Specification 3		
Delta ODA (*t-i* ; *t*) (over initial GDP)		**0.199**	**0.245**	**0.228**	**0.158**
		(0.129)*	**(0.123)****	**(0.115)****	**(0.087)***
			Specification 4		
EVI		-0.001	-0.001	-0.001	-0.001
		(0.000)***	(0.000)**	(0.000)**	(0.000)*
Delta ODA (*t-i* ; *t*) (over GDP)		-1.075	-0.802	-1.116	-0.588
		(0.842)	(0.663)	(0.560)**	(0.507)
Delta ODA (*t-i* ;) (over GDP) x EVI		**0.042**	0.033	**0.049**	0.027
		(0.028)+	(0.028)	**(0.028)***	(0.025)

Notes: This table displays marginal effects. All the control variables used in Table 2 column 2 are included (but not reported) in all four specifications. Coefficients and standard errors for the interactive terms are corrected following Ai and Norton (2003).

Robust standard errors in parentheses.

significant at 15%, * significant at 10%; ** significant at 5%; *** significant at 1%.

Source: See text.

8 Our indicator is then built as follows : $\frac{\Delta ODA_{t-i:t}}{GDP_{t-i}} = \frac{\Delta ODA_{t-i:t}}{ODA_{t-i}} * \frac{ODA_{t-i}}{GDP_{t-i}}$.

4 A second step: aid and the duration of growth spells

4.1 Once launched, but lasting how long?

Up to now, we have considered only the impact of aid on the starting point of growth spells. A complementary issue is aid's impact on the duration of these spells. The duration of ongoing spells of accelerated growth may be cut short by exogenous shocks, particularly in highly vulnerable countries. As Berthélémy (2006) shows, there are only a few countries that have experienced consistently high growth rates over long periods, while growth surges of short duration are quite common. The evidence on what makes growth sustained is even more limited than that on the determinants of growth acceleration. And, to our knowledge, there are no analyses of the role of aid with respect to the duration of growth spells.

According to our hypothesis, aid has an impact not only on the probability of the occurrence of a growth spell (acceleration), as was shown in the previous section, but also on the duration of the spell, and that the more vulnerable the recipient country is to exogenous shocks, the greater the impact. This hypothesis is strongly linked to the findings that aid has a stabilizing effect on the income level and growth, even if aid volatility under certain conditions can reduce this impact (see the discussion of these issues in Chauvet and Guillaumont (2009) and Guillaumont Jeanneney and Tapsoba (2012)).[9] Briefly stated, aid is likely to protect the growth process of developing countries that are vulnerable to external shocks.

4.2 Methodological issues

Altering the scope of interest leads to a change in the filtering method. The choice of an adequate filter to assess the duration of growth spells may appear to be more complex than selecting the filters for identifying growth accelerations. In fact, we rely on a modified version of the less strict filter proposed for growth accelerations by Arbache and Page (2007). Although initially designed to detect the starting point of growth acceleration, it can be adapted to the duration issue. Arbache and Page, using four-year moving averages (N=3), state that the average growth rate of the spell should simply exceed the average growth rate over the entire period ($g^*=\bar{g}$) in order to qualify as acceleration. Moreover, the difference in the growth rates of two successive observations needs merely to be positive (g=0). As for the fourth criterion, while, other authors pose that the post-growth output should exceed pre-episode peaks, Arbache and Page in a less restrictive fashion simply state that the four-year GDP per capita forward moving average should exceed the four-year backward moving average. Finally, Arbache and Page also add another criterion: they choose to discard all the spells that do not fulfil all the criteria for at least three consecutive years.[10]

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9 If aid is volatile and procyclical, it might contribute to macroeconomic instability in countries with high dependence ratios. But aid is not procyclical more frequently than it is contracyclical, or even procyclical, it can still be stabilizing. From a panel regression, it appears that the average aid level reduces income growth volatility.

10 Two other papers have been considered for the purpose of methodology: the papers by Hausmann, Rodriguez and Wagner (2006) on the duration of economic stagnation episodes and by Berg, Ostry

Thus we choose to apply the following conditions to our data:

1) per capital GDP growth sustained for at least ***N=5*** years;

2) acceleration need not be fast. If the mean growth rate over the period is sufficiently high, we consider the difference between the growth rates of two consecutive observations to be at least of ***g=0*** percentage points;

3) growth rate induced by the acceleration has been sufficiently adequate, ***g*=2*** %;

4) the forward four-year moving average GDP per capita exceeds the backward moving four-year average;

5) growth acceleration episode requires at least three consecutive years of adherence to conditions 1) to 4). A growth episode also includes the five subsequent years after the last year that satisfied conditions 1) to 4); i.e., we attach the moving average window to the years identifying the growth acceleration.

Utilizing this filtering method, we identify high growth spells of at least eight years. The subsequent econometric analysis will try to assess the impact of aid in helping developing countries extend the duration of these observed spells. This combination of conditions is the baseline of an extended forthcoming study (Wagner 2012). We show that the results presented here are very robust to numerous alternative conditions.

4.3 Data and results

As was already shown with respect to growth accelerations, the number of spells does not appear to be correlated with income per capita. This is not the case for the duration of growth spells. As can be seen in Table 5, the higher the income per capita, the longer the duration of the growth spell when it does occur. Consistent with this finding at the regional level, sub-Saharan Africa displays the shortest average duration of growth spells. Again in Wagner (2012), it is shown that this finding is robust to numerous changes in the filter.

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and Zettelmeyer (2008), which is the only one devoted specifically to estimating the determinants of the length of growth episodes. Berg, Ostry and Zettelmeyer use a statistical filter rather than economic criteria to study the duration of growth spells. They apply a variant of the procedure proposed by Bai and Perron (1998, 2003) for testing multiple structural breaks in timeseries when both the total number and the location breaks are unknown. Following their definition, a growth episode starts with a statistical breakup followed by a period of at least 2 per cent of average growth and ends with a statistical downbreak followed by a period of less than 2 per cent growth or the end of the sample, the minimum duration of a growth spell being set to eight years. In this analysis we use only the 'classical' approach as, in our opinion, it provides better control over the filter as well as the additional hypothesis which appears to be important. First, using the Berg methodology does not allow to control for the fast recovery processes observed at the end of a crisis and second, it does not prevent the yearly growth rate from fluctuating heavily during the episode. Finally, we believe that the filter is dependent on the statistical power of the test. A false rejection would lead to either a loss or an abnormally large duration of a spell.

Table 5
Number and duration of growth spells, over the period 1970-2007

	No. of spells	No. of interrupted spells	Maximum duration (yrs)	Average duration (yrs)
Total	137	107	20	10.70
Low income	29	19	14	9.82
Lower middle income	35	25	20	10.57
Upper middle income	29	22	16	10.72
High income	44	40	20	11.37
LDC	35	27	16	10.28
SIDS	25	22	16	10.61
East Asia and Pacific	25	20	14	10.64
Europe and Central Asia	6	3	14	11.66
Latin America and the Caribbean	21	15	16	10.23
Middle East and North Africa	15	10	20	11.06
North America	2	2	12	10.00
South Asia	13	9	16	11.07
Sub-Saharan Africa	29	23	12	9.82
Western Europe	25	24	20	11.64

Note: The difference between the total number of spells and the number as interrupted spells gives the number of spells that were still ongoing at the end of the sample in 2007.

Source: Authors' calculations, based on data from Heston, Summers and Aten (2009).

The results presented in Table 6 are obtained by performing maximum likelihood estimation of parametric regression survival-time models, using a Weibull survival distribution (see Wooldridge 2010 for further details). As is standard in survival analysis, the table shows the exponentiated regression coefficients. These can be interpreted as 'hazard ratios': the factor by which a hazard rate increases when the covariate increases by one unit. For example, a hazard ratio of 1.5 means that a unit change in the regressor increases the risk of a growth downbreak in the next period by 50 per cent. A hazard ratio of 1 means there is no effect, and a hazard ratio of less than one denotes a 'growth protective effect'.

We keep the econometric specification similar to that in the first part of the paper. Nevertheless, we include three new variables to take into account major shocks, both external (net barter terms of trade shocks) and societal (severity of civil conflict), which could happen during the spell, inducing very strong disturbing effects. These results allow us to observe the impact of the three variables of interest on the duration of growth spells: the economic vulnerability, or more precisely the exposure to exogenous shocks), the level of aid, and the multiplicative variable ('aid x vulnerability' or 'aid x shock exposure'), the coefficient of which reflects to what extent the impact of aid is conditional on vulnerability (or to shock exposure). We find that the exposure to shocks appears to be an important factor among structural characteristics of recipient countries in explaining the duration of growth episodes. Aid per capita, considered alone (i.e., as only an additive variable) is not a significant factor. But once the multiplicative variable is added, it appears to have a significant impact. This means that the more exposed a country is to exogenous shocks, the greater the positive impact of aid is on the sustainability of growth.

Table 6
Impact of ODA and vulnerability on the duration of growth spells, unconditional, 1970-2007, parametric survival model using a Weibull survival distribution

	(1)	(2)	(3)	(4)	(5)	(6)
LGDP per capita	0.793	0.907	1.171	1.237	1.263	1.291
	(0.076)**	(0.127)	(0.185)	(0.209)	(0.198)	(0.245)
Openness	0.613	1.280	0.153	0.109	0.161	0.313
	(0.546)	(1.339)	(0.395)	(0.296)	(0.342)	(0.790)
Tropical	0.851	0.874	1.036	1.338	2.118	1.264
	(0.341)	(0.381)	(0.560)	(0.757)	(1.180)	(0.817)
HAI	0.984	0.979	0.971	0.982	0.999	0.979
	(0.009)*	(0.011)*	(0.015)*	(0.017)	(0.016)	(0.017)
Civil liberties	0.943	0.984	1.195	1.225	1.086	1.156
	(0.082)	(0.133)	(0.251)	(0.270)	(0.271)	(0.291)
Exposure	1.026	1.033	1.062	1.080	1.063	1.074
	(0.011)**	(0.017)**	(0.029)**	(0.033)**	(0.032)**	(0.033)**
Shock	0.990	0.983	0.973	0.969	0.982	0.969
	(0.009)	(0.010)*	(0.015)*	(0.015)**	(0.018)	(0.017)*
Shock NBTT (negative)		6.269	1.221	2.759	14.192	4.756
		(7.534)	(2.088)	(5.141)	(21.712)*	(9.639)
Shock NBTT (positive)		0.000	0.000	0.000	0.000	0.000
		(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
MEPV Civtot		1.145	1.112	1.204	1.260	1.220
		(0.084)*	(0.108)	(0.137)	(0.153)*	(0.131)*
Positive change (Polity IV)		1.488	0.901	1.232	1.600	1.388
		(0.725)	(0.688)	(1.012)	(1.234)	(1.132)
Negative change (Polity IV)		0.746	0.975	0.933	0.670	0.687
		(0.220)	(0.474)	(0.481)	(0.381)	(0.562)
M2/GDP			1.020	1.019	1.015	1.010
			(0.020)	(0.021)	(0.015)	(0.020)
Government spending			1.013	1.012	1.037	1.032
			(0.046)	(0.047)	(0.043)	(0.061)
Inflation			1.012	1.001	0.992	1.005
			(0.026)	(0.027)	(0.022)	(0.029)
ODA (per capita)	1.001	0.999	1.004	1.037	1.057	1.037
	(0.001)	(0.004)	(0.007)	(0.021)*	(0.020)***	(0.024)
ODA x Exposure				0.999	0.999	0.999
				(0.000)*	(0.000)***	(0.000)*
Observations	279	235	180	180	189	180
Number of subjects	84	69	59	59	61	59
Number of failures	59	46	38	38	40	38

Notes: This table displays hazard ratios. Robust standard errors in parentheses;

* significant at 10%; ** significant at 5%; *** significant at 1%

In columns (1), (2), (3), (4) and (6) we use initial values rather than current values for the first group of control variables.

In column (6) we also use the initial level of ODA rather than current values.

Source: See text.

5 Concluding remarks

The foregoing econometric tests of the role of aid in launching and sustaining growth spells should be considered only as indications of the possible impact of aid on growth examined in a dynamic perspective. The usual limitation to this kind of exercise is, of course, generated by the debated relevance of the ODA concept used and by its use in a non-disaggregated manner. Some clear conclusions, however, do emerge.

Aid has an impact both on the probability of occurrence of growth spells and the durations of these spells. This double impact is higher in countries that are structurally vulnerable, as indicated by the level of their Economic Vulnerability Index (EVI). While the impact of aid on the probability of a growth spell occurrence depends both on the exposure and shocks components of EVI, the impact on the duration of spells seems to depend only on exposure to shocks. On the whole, this is an additional argument to use EVI or any similar index as criterion for aid allocation: structural vulnerability reflects not only the need for assistance—a handicap to be compensated—but it is also a factor of aid effectiveness (see Guillaumont 2009; Guillaumont, Guillaumont Jeanneney and Wagner 2010).

This work calls for further research in two directions. The first refers mostly to technical refinements to the definition of aid. The second, and most important, direction would be to look more thoroughly at the dynamics of the aid–growth relationship, focusing on the channels through which aid can help to launch and sustain growth to the point where growth is sustained without aid.

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Appendix Table
Summary of alternative filtering methods

Dovern and Nunnenkamp (2007)	Hausmann, Pritchett and Rodrik (2005)	Pattillo, Gupta and Carey (2005)	Arbache and Page (2007)
	METHODS		
Condition 1	*Condition 1*	*Condition 1*	*Condition 1*
None	The forward 8-yr moving average growth > 3.5% for a given year.	The forward 6-yr moving average growth > 2% for a given year.	The forward 4-yr moving average growth exceeds the country's average growth.
Condition 2	*Condition 2*	*Condition 2*	*Condition 2*
The forward 6 (or 9)-yr moving average growth minus the backward 6 (or 9)-yr moving average growth > 2% (or 1%) for a given year.	The forward 8-yr moving average growth minus the backward 8-yr moving average growth > 2.5% for a given year.	The forward 6-yr moving average growth minus the backward 6-yr moving average growth > 2% for a given year.	The forward 4-yr moving average growth minus the backward 4-yr moving average growth > 0 for a given year.
Condition 3	*Condition 3*	*Condition 3*	*Condition 3*
Post-growth output exceeds pre-episode peak.	Post-growth output exceeds pre-episode peak .	Post growth output exceeds pre-episode peak.	The forward 4-yr moving average GDP per capita exceeds the backward 4-yr moving average.
			Condition 4
			A growth acceleration episode requires at least 3 yrs in a row satisfying conditions 1-3 An episode includes the 3 subsequent yrs after the last year that satisfies conditions 1-3; i.e., we attach the moving average window to the years identifying the growth acceleration.
	KEY ORIGINAL PARAMETERS		
Δg^*=2% or 1%	g^*=3.5%	g^*=2%	$g^*=\bar{g}$%
N=5 or 8	Δg^*=2.5%	Δg^*=2%	Δg^*=0%
	N=7	N=5	N=3

Source: Compiled by the authors from above mentioned papers.