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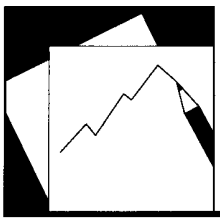

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The Macroeconomic Impact of Scaled-Up Aid: The Case of Niger

Abdikarim Farah, Emilio Sacerdoti, and Gonzalo Salinas

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The Macroeconomic Impact of Scaled-up Aid: The Case of Niger

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Abstract

We develop a simple macroeconomic model that assesses the effects of higher foreign aid on output growth and other macroeconomic variables, including the real exchange rate. The model is easily tractable and requires estimation of only a few basic parameters. It takes into account the impact of aid on physical and human capital accumulation, while recognizing that the impact of the latter is more protracted. Application of the model to Niger—one of the poorest countries in the world—suggests that if foreign aid as a share of GDP were to be permanently increased from the equivalent of 10 percent of GDP in 2007 to 15 percent in 2008, annual economic growth would accelerate by more than 1 percentage point, without generating significant risks for macroeconomic stability. As a result, by 2020 Niger's income per capita would be 12.5 percent higher than it would be without increased foreign aid. Moreover, the higher growth would help Niger to cut the incidence of poverty by 25 percent by 2015, although the country will still be unable to reach the Millennium Development Goal of poverty reduction (MDG 1).

JEL Classification Numbers: E22, E23, E27, O11, O47

Keywords: aid, growth, capital accumulation, low income countries

Author's E-Mail Address: afarah@imf.org; esacerdoti@imf.org; gsalinas@imf.org

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I. INTRODUCTION

1. The need to scale up aid for low-income countries (LICs) has been embraced by the international community since the 2005 Gleneagles G8 summit. The belief is that increased aid should help LICs develop faster and make progress toward the Millennium Development Goals (MDGs) established for 2015.[1] In particular, it is presumed that stepped up public physical investment would address, among other things, the infrastructure gap of LICs and crowd in private investment, which ultimately should support broad-based growth. Further, large public spending on education and health would foster productivity by tackling low educational attainment, high child and maternal mortality, and HIV/AIDS and malaria.

2. Despite broad political consensus, the impact of aid on economic growth has not been settled empirically. Regression-based studies on the impact of aid on economic growth (e.g., Griffin and Enos, 1970; Papanek, 1973; Dowling and Hiemenz. 1982; Gupta and Islam, 1983; Boone, 1994; Burnside and Dollar, 2000; and Easterly, Levine, and Roodman, 2003) reach widely differing conclusions. More recently, Rajan and Subramanian (2005b) provide evidence that any positive impact of aid on growth would be offset by the adverse effects of aid-induced real exchange rate appreciation on exports. On the other side, Clemens et al. (2004) distinguish the use by recipients of aid flows on physical and human capital. They find that aid used to accumulate physical capital has a significant positive impact on growth over the short to medium run, and that used for human capital has a long-term growth payoff that is econometrically difficult to discern. And Minoiu and Reddy (2007) find that non-geopolitically-motivated aid has a positive effect on economic growth.

3. Notwithstanding the lack of empirical consensus of the impact of aid on growth, policy makers need some kind of framework to help them assess the potential economic impact of increased aid flows. To this end, we develop a simple macroeconomic model that requires a small set of parameters to calibrate, and assesses effects of higher foreign aid on output growth and other macroeconomic variables, including the real exchange rate. In line with the findings of Clemens et al. (2004), the model distinguishes the short- to medium-term growth payoff of aid-financed physical investment and the long-term payoff of aid-financed human capital formation. It also considers the use of part of the aid for non-growth-generating activities. Our approach is similar to those of Agénor et al. (2005), Lofgren and Diaz-Bonilla, (2006), and Berg et al. (2008). Those studies use dynamic stochastic general equilibrium (DSGE) models to simulate the potential impact of aid

[1] The MDGs range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015. They form a blueprint agreed to by all the world's countries and its leading development institutions. For a list of the MDGs and more information about them, see http://www.un.org/millenniumgoals/.

flows on such macroeconomic indicators as GDP growth, inflation, and the real exchange rate. However, calibrating these models requires a large number of parameters, most of which may not be readily available for most LICs.

4. Application of the model to Niger—one of the poorest countries in the world—suggests that scaled-up aid would raise economic growth and help reduce poverty without unduly jeopardizing macroeconomic stability. In particular, we consider a 50 percent increase in foreign aid (up from about 10 percent of GDP in 2007) and keeping it constant thereafter as a share of GDP. This is projected to raise economic growth by more than 1 percentage point sustained over a long period, without generating significant risks to macroeconomic stability. Although new large aid flows would cause the real exchange rate to appreciate, adverse effects on exports would be limited. However, for Niger to achieve the income-based poverty reduction MDGs, aid flows would need to triple relative to their 2007 level, and an increase of that magnitude is likely to threaten macro stability.

5. In what follows, Section II reviews the literature; Section III presents the macroeconomic model; Section IV contains a simulation of the model with application to Niger; and Section V draws conclusions.

II. Aid and Growth—Literature Review

6. The neoclassical production function provides a good benchmark for the possible impact of aid on growth. This is illustrated by considering an augmented Solow growth model with constant returns to scale:

$$Y_t = A_t K_t^{\alpha} (L_t H_t)^{1-\alpha} \tag{1}$$

where Y_t is output, A is total factor productivity (TFP), K_t is physical capital, L_t is labor, H_t is human capital, and α is the capital share in income. In this set up, higher aid could be assumed to raise physical capital one-for-one (Rajan and Subramanian, 2005a). With this assumption, the marginal impact of aid on growth is:

$$\frac{\delta \gamma_{y,t}}{\delta(\frac{Aid_t}{Y_t})} = \alpha\beta\frac{Y_t}{K_t} \tag{2}$$

where γ_y is the rate of output growth per worker, β is the fraction of aid invested, and Y/K is the output-to-capital ratio. Assuming a capital share in income of 0.35 (Bosworth and Collins, 2003), β=1, and a capital-output ratio of 0.45, an increase in aid of 1 percent of GDP will raise output growth by about 0.2 percentage points. Because of the law of diminishing returns inherent in the neoclassical framework, the growth rate would eventually revert to the rate prevailing before the increase of aid. However, the growth impact could be sustained in the presence of "increasing returns to scale" or when aid fosters TFP.

7. Despite the straightforward implications of the neoclassical model, early studies (e.g. Griffin and Enos, 1970; Papanek, 1973, Dowling and Hiemenz, 1982; Gupta and Islam,

1983; and Boone, 1994) failed to agree on the observed effect of aid on output growth. Although several later studies (e.g., Burnside and Dollar, 2000; and Chauvet and Guillamont, 2002) found a positive growth impact when aid interacts with other growth determinants, Roodman (2003) and Easterly et al. (2003) show that the significance of this relationship is not robust to an expansion of the sample size, elimination of outliers, and a correction for serially correlated errors. Rajan and Subramanian (2005b) find aid has negative effects on economic growth because of the adverse effects of aid-induced appreciation of the real exchange rate on exports, though the methodology used to derive these conclusions has been contested (e.g., Kraay, 2006; and Minoiu and Reddy, 2007).[2]

8. Recent studies that look at more disaggregated aid data seem to find a positive relationship between aid and growth. Clemens et al. (2004) find that aid allocated to physical investment (e.g., infrastructure and program assistance) has a discernible impact on growth while that allocated to human capital (e.g., health and education) has a long term growth payoff that is econometrically harder to identify.[3] Minoiu and Reddy (2007) differentiate *geopolitical aid* (e.g., general budgetary support, roads for military bases) from *development aid* (e.g., irrigation, infrastructure, health, and education). They find that a 1 percent of GDP increase in development aid boosts average growth by about 0.5 percentage points over the following 10 years and between 0.6 and 2.1 percentage points after 25 years; but they also find that geopolitical aid has either a zero or a negative growth impact, depending on the specification. Heady (2005 and 2007) and Bobba and Powell (2007) find a positive impact of non-geopolitical aid.

9. In view of the mixed results from cross-country growth regressions, development practitioners are relying more on general equilibrium models and their simulations to assess the economic impact of increased foreign aid. In this context, Agénor et al, (2005) develop a model that captures the links between foreign aid, the level and composition of public investment, and their effects on economic growth and poverty. A similar framework underpins the Maquette for Millennium Development Goals Simulations (Lofgren and Diaz-Bonilla, 2006), which explicitly links socioeconomic performance and public expenditure. Berg et al. (2008) provide a DSGE model that focuses on the interaction of fiscal, monetary, and exchange rate policies as aid flows increase. However, these models require a large number of parameters to calibrate that are not readily available for most LICs.

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[2] Minoiu and Reddy (2006) notice that the Instrumental Variable used in Rajan and Subramanian (2005b) approximates only geopolitically motivated aid, which a priori is not clearly expected to have a positive effect on growth. Kraay (2006) also questions Rajan and Subramanian (2005b) due to the lack of robustness to increases in sample size and changes in the definition of exchange rate overvaluation, while noting that it is at odds with the vast majority of studies that find only a weak relation between aid and real exchange rate appreciation.

[3] In their most conservative estimates, a one percentage point increase in the share of Aid to GDP raises GDP growth rate by about 0.4 percentage points.

III. THE MODEL

10. Our approach is to model the growth impact of aid through its effect on physical and human capital accumulation while taking into account its effects on domestic demand and the real exchange rate. On the supply side, we distinguish the economic growth impact of increased physical capital from that of human capital. In particular, we assume that while higher physical capital induced by more aid raises growth quickly, human capital affects growth with a long time lag. The latter assumption is premised, for instance, on the fact that an individual remains in school for a number of years before joining the labor force. The demand side of the model captures the crowding-in effect of public investment on private investment and the effects of aid-induced real exchange appreciation on exports. All variables in the model are expressed in real terms.

A. Supply Side

11. Output is determined by the human-capital augmented Solow production function, with constant returns to scale:[4]

$$Y_t^S = A_t K_t^{\alpha} H_t^{\beta} L_t^{1-\alpha-\beta} \tag{3}$$

K_t is the sum of private (K_p) and government physical capital (K_G). α and β are, respectively, the shares of output attributed to physical and to human capital. Taking logs of Equation (3) and differentiating it with respect to time, gives:

$$\dot{y}_t = \dot{a}_t + \alpha \dot{k}_{t-1} + \beta \dot{h}_t + (1-\alpha-\beta)\dot{l}_t \tag{4}$$

The upper dot represents the time derivative of the log of each factor of production, which is approximately equal to the percentage change in the factor of production. Note that we have assumed that private capital becomes productive with a one-year lag.[5] Physical capital is determined by the following accumulation equation:

$$K_t = (1-\delta_K)K_{t-1} + I_{PK,t} + I_{GK,t}, \tag{5}$$

where I_{PK} and I_{PG} represent investments in private and government capital, respectively, while δ_K is the depreciation rate of all physical capital. Human capital formation is defined as

[4] We refrain from making assumptions that would significantly increase the impact of aid on growth. Gottschalk (2008) provides a comprehensive review of the growth effects of public investment assuming increasing returns to scale and the existence of poverty traps.

[5] This implies that the supply function is contemporaneously independent from the demand side of the economy.

$$H_t = \frac{(1-\delta_H)}{(1+\bar{g})} H_{t-1} + I_{H,t} \ , \tag{6}$$

where I_H and δ_H are investment and depreciation of human capital, respectively, and g is the rate of population growth (assumed constant). Equation (6) captures the fact that population growth reduces per capita human capital over time. We assume that investment in human capital is determined by government spending on health and education (G_H) as follows[6]:

$$I_{H,t} = \bar{w} * (\sum_{i=t-6}^{i=t-1} G_{H,i}) = \frac{1}{20} * (\sum_{i=t-6}^{i=t-1} G_{H,i}) \ , \tag{7}$$

where and w is the share of each school-graduating cohort in the labor force. Appendix 1 provides the derivation of equation 7.

B. Aid Flows

12. In line with Clemens et al. (2004), we classify foreign aid into early impact (ΔAID_{EI}**),** late impact **(** AID_{LI} **)**, and no impact (AID_{NI}) aid on output growth.

$$AID_t = AID_{EI,t} + AID_{LI,t} + AID_{NI,t} \tag{8}$$

Early impact aid finances mainly physical capital and is assumed to have an effect on output with a one-year lag. Late impact aid finances expenditures in human capital formation (G_H) as follows:

$$G_{H,t} = \gamma_{H,0} T_t + AID_{LI,t} \tag{9}$$

The first term on the right-hand side is public expenditure on human capital, assuming it remains constant as a share of government revenue (T) with respect to its level before the aid increase. The second term incorporates increased expenditures funded by additional late impact aid.

We further distinguish late impact aid that finances capital goods (AID_{LIK}) from late impact aid that finances consumption goods (AID_{LIC}):

$$AID_{LI,t} = AID_{LIC,t} + AID_{LIK,t} \tag{10}$$

Although we consider AID_{LIK} as part of government investment in demand equations (Equation 18 below), its effect on the supply side is captured through human capital (Equation 7) rather than physical capital.

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[6] Baldacci et al (2004) present panel data evidence of a significant and direct impact of education and health spending on the accumulation of human capital in developing countries.

C. Demand Side

13. The demand side of the economy comprises a set of behavioral equations for private consumption (C_t), investment (I_t), government revenue (T_t) and expenditures (G_t), exports (X_t), and imports (M_t).

$$C_t = c_1(Y_t - T_t) \tag{11}$$

$$T_t = \tau Y_t \tag{12}$$

$$I_{P,t} = \rho_p Y_t \tag{13}$$

$$I_{GK,t} = \rho_{GK} T_t + AID_{EI,t} \tag{14}$$

$$I_{GH,t} = \rho_{GH} T_t + AID_{LIK,t} \tag{15}$$

$$X_t = Y_t^{\psi_X} RER_t^{\sigma_X} \tag{16}$$

$$M_t = Y_t^{\psi_M} RER_t^{\sigma_M} + \theta * AID_t \tag{17}$$

$$G_t = \gamma T_t + AID_{EIC,t} + AID_{LIC,t} + AID_{NI,t} \tag{18}$$

Private consumption (equation 11) is a function of disposable income $(Y_t - T_t)$, while government revenue (equation 12) is in turn a function of income. We link private investment directly to output (equation 13), whereas government investment is determined by government revenue and foreign aid (equations 14 and 15). Notice that we divide public investment into capital that affects output through physical capital accumulation (I_{GK}), and capital that affects it through human capital formation (I_{GH}). A similar simplification allows us to express government consumption (equation 18) as a function of domestic revenue, late impact and no-impact aid. Import and export volumes (equations 16 and 17) are assumed functions of income and the real exchange rate. The positive link between exports and output is premised on the assumption that the expansion of exports is determined by the production capacity of the country while the world demand for its exports is unlimited. Furthermore, imports are partly determined by foreign aid, as we assume that a share (θ) of aid is used directly for imports.

D. Closing of the Model

14. We close the model by setting aggregate demand equal to aggregate supply:

$$Y^s{}_t = Y^D{}_t = C_t + I_t + G_t + (X_t - M_t) \quad (19)$$

and the current account deficit is equal to:

$$(X_t - M_t) = AID_t + KF_t \quad (20)$$

where KF_t represents non-aid capital flows and is assumed proportional to GDP ($KF_t = kY_t$). The structure of the model is as follows. Output is determined by physical capital (lagged one year) and human capital, as well as TFP. Output and exogenously determined aid, in turn, determine consumption, investment, government domestic revenue, and government consumption. The real exchange rate, through its impact on exports and imports, adjusts to ensure that the current account deficit is fully covered by new aid and non-aid capital flows. In a fixed exchange regime in the context of a small open economy (as in Niger) and assuming that inflation in trading partners is exogenous, movements in the real exchange rate result only from changes in domestic inflation. Finally, note that in this model government always spends all aid flows while the central bank is implicitly assumed to sell any aid generated foreign exchange to private agents.

15. The model is easily tractable, it requires estimation of only a few basic parameters, and its dynamics are straightforward. Consider an increase in foreign aid in year t. Domestic demand increases that same year because the increase in government consumption and investment is only partially offset by higher imports. Given that the aggregate supply function is unchanged in year t, the increase in domestic demand will be accompanied by an increase in inflation and a real exchange rate appreciation. In the following year, the increase in foreign aid boosts output through higher physical capital. This eases the pressure of domestic demand on the real exchange rate. Over time, economic growth is reinforced by the coming into stream of new human capital, further reducing real exchange rate and inflationary pressures. The higher output crowds in private investment and reinforces the growth impact of increased aid. Eventually economic growth will revert to its steady state—but only after a long period, mainly because of the delayed growth impact of human capital. The real exchange rate also stabilizes, though at a more appreciated level.

E. Calibration and Simulation of the Model: the Niger Case

16. Niger's economic performance over the past four decades was disappointing. Economic growth averaged just 2.2 percent for 1970–2007, implying an annual 1.1 percent decline in per capita income. However, economic performance has improved since 1999 when the first democratic elections in Niger's history took place. Economic reforms and

political stability have since fostered external aid and higher domestic and foreign private investment, and the average annual GDP growth rate averaged 4.2 percent for 2000–07. Despite this progress, 61 percent of the population was still living below the poverty line in 2007.

17. The model is simulated by using Niger-specific parameters and others borrowed from cross-country studies (Table 1). On the supply side, α is set at 0.35 (in line with estimates for sub-Saharan African countries) and β at 0.30 (in line with estimates by Mankiw, Romer, and Weil (1992)). Data on physical capital are constructed from gross investment by applying the perpetual inventory method. Data on the labor force, which is only available from 1980, are extended back to 1960 by assuming that the labor force grew at the same rate as total population (3.4 percent per year). Human capital is estimated as described in Appendix 1. On the demand side, the equations (11–15 and 18) are calibrated on national accounts data for 2006 and 2007.[7] We assume that both imports and exports have an income elasticity of 1 and we set price elasticities of imports and exports at 1.08 and 1, respectively.[8]

18. Simulation of the model requires that we estimate the size and distribution of aid. To do so, we use 2007 budget data. In that year, 66 percent of foreign aid was allocated to physical investment, 26 percent to human capital formation (health, education, and other social sectors), and 8 percent to other government consumption. The allocation of aid across different uses (i.e., early impact, late impact, and no-impact aid, as defined in paragraph 10) is assumed to remain unchanged throughout the simulation period (Table 2). Our results are expressed in 2007 CFA francs (CFAF). [9]

19. With these assumptions, we consider a baseline scenario where aid flows in terms of GDP hold steady at their 2007 level and several alternative scenarios with higher aid. In particular, we assess the implications of the following cases: (i) a 50 percent *permanent* increase in aid in 2008 that boosts only factors of production; (ii) a 50 percent *one-year* increase in aid in 2008 that also boosts only factors of production; (iii) an increase in aid as in (i) but accompanied by improvements in TFP; (iv) an increase in aid as in (i) but with capacity constraints that make aid less effective; (v) an increase in aid as in (i) but with a different composition of its use in human and physical capital (vi) an increase in aid to a level that would allow Niger to reduce income-based poverty by one-half by 2015; (vi) an

[7] The coefficients of taxes are calibrated based on 2007 levels without filtering-out public investment that is funded by foreign aid during that year. This simplification does not distort our post-2007 projections since we assume that both taxes and pre-2007 foreign aid keep growing at the same pace as GDP growth

[8] These price elasticities are the average for a large number of developed and developing countries as estimated in Senhadji (1998) and Senhadji and Montenegro (1998).

[9] The CFA (*Communauté française d'Afrique)* franc is a currency used in twelve formerly French-ruled African countries, as well as in Guinea-Bissau (a former Portuguese colony) and in Equatorial Guinea (a former Spanish colony). It has a fixed exchange rate to the Euro (1 Euro = 655.957 CFA francs).

increase in aid to a level consistent with what is needed to finance the PRSP (2008–12); and an increase in aid as in (i) but excluding its impact on domestic demand and the crowding in effect of domestic investment.

Table 1. Niger: Assumed Values of Key Parameters for General Equilibrium Simulation

Parameters	Values
Share of Physical Capital in Production	0.35
Share of Human Capital In Production	0.30
Ratio of Public Investment to Tax Revenue	0.71
Ratio of Private Investment to Disposable Income	0.16
Marginal Propensity to Consume	0.84
Income Elasticity of Exports	1.00
Price Elasticity of Exports	1.00
Income Elasticity of Imports	1.00
Price Elasticity of Imports	1.08
Ratio of Tax Revenue to Disposable Income	0.11
Share Total Aid Spent in Imports	0.40
Ratio of Government Consumption to Tax Revenue	1.40

Source: Staff estimates.

Baseline scenario: No increase in aid

20. In the baseline scenario the model is simulated using the parameters listed in Table 1, while keeping foreign aid constant as a share of GDP at its 2007 level. In 2008–20, average annual economic growth is about 5.1 percent, implying income per capita growth of 1.7 percent per year; thus, per capita income rises from US$322 in 2007 to US$414 by 2020. Because inflation would remain at about 2 percent, equal to international inflation, the real exchange rate would remain constant throughout the period. All aggregate demand components grow at the same rate as GDP.

Table 2. Niger: Composition of Assumed Increase in Foreign Aid from 2007 to 2008

	2007 CFAF billion	2008 Increase	
		CFAFbillion.	% of GDP
Total[1]	235.3	108.0	5.0
According to Time of Impact and Production Factor			
Physical Capital (AID_{EI})	155.3	71.3	3.3
Physical Capital for Education and Health (AID_{LIK})	32.9	15.1	0.7
Consumption in Education and Health (AID_{LIC})	28.2	13.0	0.6
Other Consumption (AID_{NI})	18.8	8.6	0.4

Source: Staff Projections based on 2007 Budget.

[1]Total foreign aid in 2007 was equivalent to 11.5% of GDP.

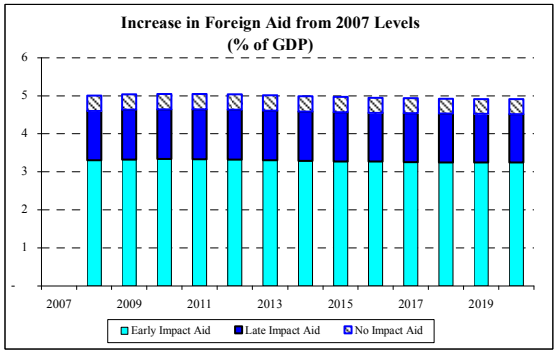
Scenario I: Permanent increase in aid

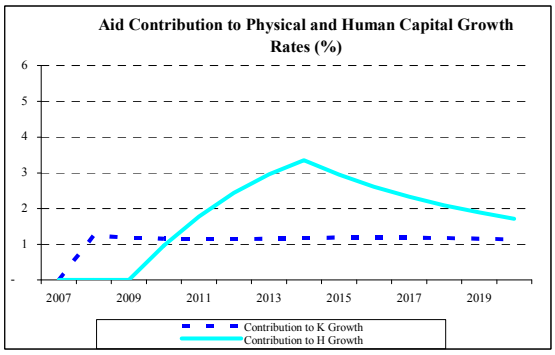
21. A permanent and substantial increase in aid is projected to bring about a major and sustained pickup in economic growth while limiting risks to macroeconomic stability. We assume aid rises by 5 percentage points of GDP in 2008 (up from 10 percent in 2007) and remains at that level thereafter. In 2008, new aid raises physical capital growth by 1 percentage point. This on its own accelerates economic growth by 0.4 percent in 2009. Subsequently, as newly formed human capital comes on stream, growth rises up to1½ percentage points above the baseline in 2014 (Figure 1 and Appendix Table 1). Although growth slows gradually thereafter, it would stay about 1 percent above the baseline growth rate throughout the simulation period. By 2020, per capita GDP would be 12½ percent higher than in the baseline. On other key variables, the increase in aid appreciates the real exchange rate by 3 percent in 2008. Thereafter, the real exchange rate stabilizes but at a more appreciated level relative to the baseline. The appreciation of the real exchange rate reduces exports by 1 percentage point relative to the baseline in 2009–10. However, exports would still be some 10 percent higher than in the baseline over the long run, because of the positive impact of aid on output. The external current account deficit (before aid) would widen by 5 percent of GDP and is financed by new aid flows.

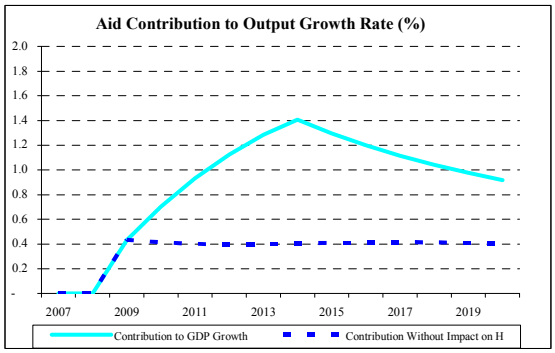
Scenario II: Temporary increase in aid

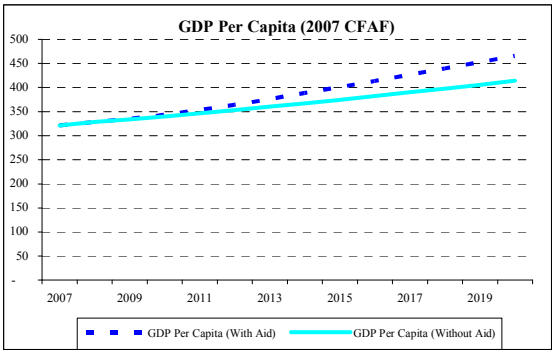
22. The impact on economic growth of a temporary increase in aid would be short-lived (Appendix Figure 1). The increase in aid would raise physical capital by 1 percentage point above the baseline, as in the previous scenario. The higher physical capital boosts GDP growth by 0.5 percent in 2009. However, the growth effect of higher physical capital fades out quickly. Over the medium term, the delayed impact of enhanced human capital mitigates the decline in growth toward that of the baseline. The real exchange rate increases immediately in response to the increase in aid, but then declines and eventually converges to the baseline level. The external current account deficit widens initially with the increase in aid and appreciation of the real exchange rate but returns to the baseline level after a few years.

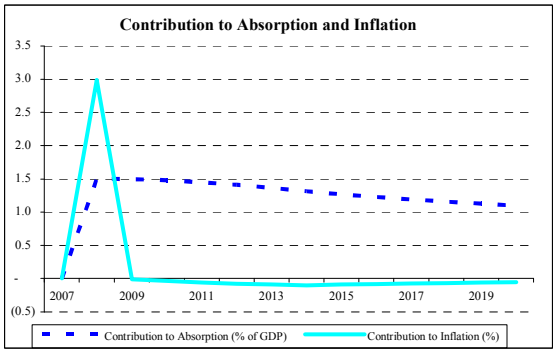
Figure 1: Niger: Economic Impact of AID (Scenario I)











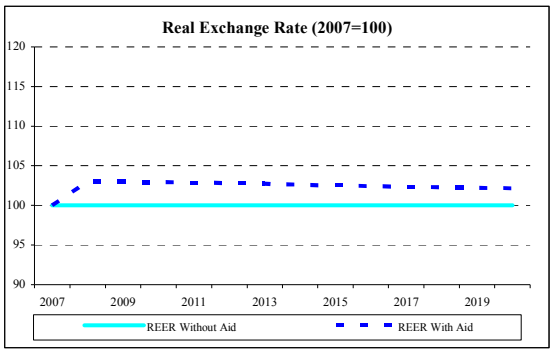
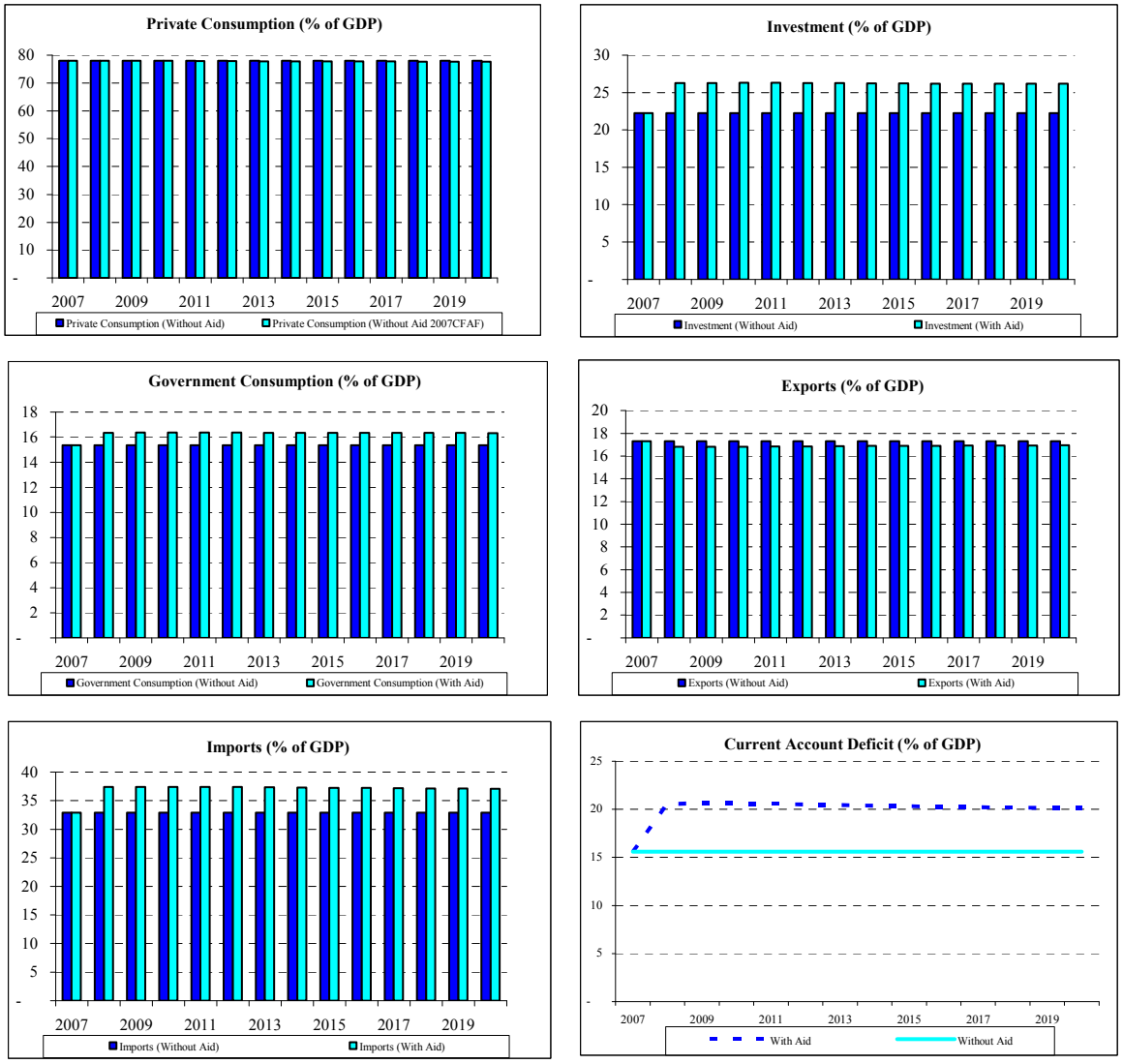


Figure 1: Niger: Economic Impact of AID (Scenario I) (Continued)



Scenario III: Positive impact of aid on TFP

23. As expected, improvements in TFP induced by increased investment financed by aid would boost growth more relative to Scenario I and limit the impact of aid flows on inflation and the real exchange rate (Appendix Figure 2). We assume that an increase in investment of roughly 5 percentage points of GDP raises TFP growth by ½ of a percentage point. As a result, GDP growth will increase also by ½ a percentage point. This would dampen the effects of aid on inflation and the real exchange rate. In this scenario, Niger's per capita income would be some 20 percent higher than in the baseline by the end of the projection period.

Scenario IV: Lower efficiency of aid

24. Capacity constraints and mismanagement would severely erode the benefits of increased aid. We assume that roughly one-quarter of all aid is wasted—less than the one-half estimated by Pritchett (1995) and Arestoff and Hurlin (2005). We justify the lower rate of waste by taking into account continuing reforms in Niger to improve public financial management and the recent emphasis by donors on better aid management.[1] Under these circumstances, the growth impact would be scaled down by 0.4 percentage points relative to Scenario I (Appendix Figure 3). Income per capita by 2020 would exceed the baseline only by 9 percent. Further, less efficient aid use would raise inflation and appreciate the real exchange rate and weaken exports relative to Scenario I. Thus, less efficient use of aid not only curtails the growth dividend from scaled up aid, but also jeopardizes macroeconomic stability.

Scenario V: Increase in aid needed to reach the MDG goal of poverty reduction

25. The expansion of aid to a level that would allow Niger to attain MGD-1 would have to be very large. In this scenario aid is assumed to increase to allow Niger to reduce poverty by 50 percent by 2015 (MDG1) compared to 1990.[2] To find the required level of aid, we first estimate the impact of aid on poverty incidence by using the GDP per capita growth of Scenario I and assume a consumption per capita elasticity of –1.1. These assumptions imply that aid would have to increase by almost 20 percent of GDP for Niger to reach MDG 1. Such an increase could allow Niger to attain annual GDP growth rates of some 10 percent (7 percent in per capita terms), raising per capita GDP to 83 percent above the baseline by 2020. However, the marked increase in aid would substantially increase inflation and appreciate the real exchange rate (Appendix Figure 4). The increased risks to macroeconomic stability could themselves weaken economic growth.

Scenario VI: Change in the allocation of aid

26 A change in the allocation of aid between expenditures for human and physical capital has significant implications for economic growth. Shifting the composition toward human capital accumulation strengthens average economic growth by 1 percentage point (over the entire projection period) relative to Scenario 1 (Appendix Figure 5), even though the assumed share of human capital in output is slightly lower than that of physical capital. This reflects the fact that allocating two-thirds of aid to education and health increases total government expenditure in these sectors by 60 percent, but the same amount of investment in physical capital increases that spending by only 15 percent.

[1] World Bank (2006) also uses an efficiency parameter that is between 0.5 and 0.8 in different simulations.

[2] Poverty incidence is defined as the percentage of the population consuming less than US$2 per day.

Table 3. Niger: Incidence of Poverty Under Different Aid Scenarios, 2007-15

	2007	2008	2009	2010	2011	2012	2013	2014	2015	Reduction since 1993
Scenario I	61.2	59.8	58.3	56.7	54.8	52.8	50.8	48.8	46.9	-25.6
Scenario III	61.2	59.8	58.0	55.9	53.7	51.4	49.1	46.8	44.6	-29.2
Scenario IV	61.2	59.8	58.4	56.9	55.1	53.3	51.5	49.7	47.9	-23.9
Scenario V	61.2	59.8	56.3	52.3	47.9	43.4	39.1	35.0	31.5	-50.0
Assumed Consumption Elasticity (Ravallion, 2004)	-1.3									

Source: Authors' estimates.

Scenario VII: Intermediary scenario of the PRSP 2008-12

27. The 2008–12 PRSP for Niger envisages a massive increase in foreign assistance that according to our simulations would significantly accelerate growth and reduce poverty (Appendix Figure 6). By 2012 foreign aid is projected to increase by about 15 percent of GDP over its 2007 level (less than in Alternative Scenario V), after which we assume that total aid remains constant in real terms. Such an increase could considerably accelerate accumulation of physical and human capital. Even if we neglect the impact of aid on TFP growth, annual GDP growth could increase by up to 2.5 percentage points, reaching 8 percent and staying above 7 percent for the entire period of 2012–20. However, this scenario would also generate major macroeconomic challenges, including a significant increase in inflation and appreciation of the real exchange rate.

Scenario VIII: Excluding demand equations

28. The inclusion of demand-induced growth does not significantly bias the growth impact of aid. To illustrate this we eliminate the demand side of our model and thus remove the crowding-in impact of aid on private investment. The results change only marginally, confirming that the growth impact of scaled-up aid is largely supply-driven (Appendix Table 2).

Table 4. Niger: Increase in GDP Growth Rate Caused by Higher Foreign Aid
(in percent)

	2008	2009	2010	2011	2012	2013	2014	2015
Scenario I	0.00	0.43	0.70	0.93	1.13	1.28	1.41	1.30
Scenario II	0.00	0.43	0.26	0.23	0.20	0.17	0.14	-0.10
Scenario III	0.00	0.93	1.21	1.46	1.67	1.83	1.97	1.87
Scenario IV	0.00	0.33	0.53	0.70	0.85	0.97	1.07	0.99
Scenario V	0.00	3.15	4.12	4.97	5.66	6.17	6.52	6.20
Scenario VI	0.00	0.17	0.89	1.52	2.01	2.38	2.64	2.36
Scenario VII	0.00	0.39	0.84	1.33	1.84	2.33	2.66	2.59
Scenario VIII	0.00	0.43	0.69	0.91	1.09	1.23	1.34	1.20

Source: Staff estimates.

A. Comparison to Other Estimates

29 Our results are broadly consistent with those of other studies in the area (Figure 2 and Appendix Table 3):

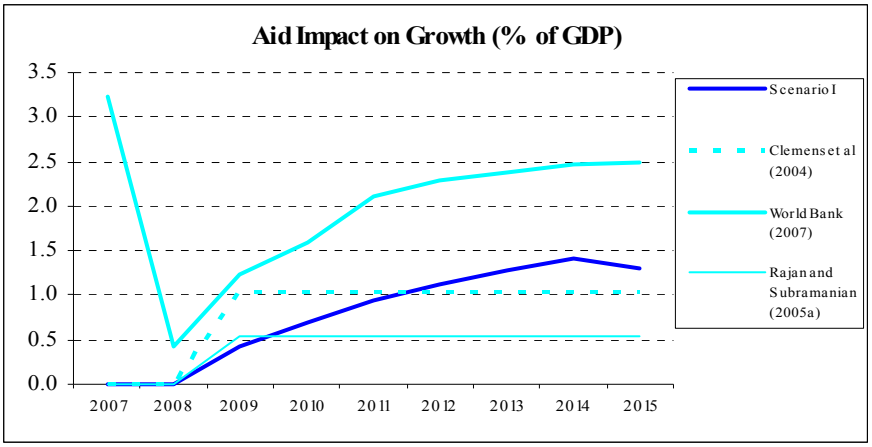
- We compare our results to those obtained by using parameters from cross-country regressions. In particular, we produce estimates based on Clemens et al. (2004), who suggest that a 1 percent increase in early impact aid can lead to a 0.36 percent increase in GDP growth annually for four years. In Figure 2 and Appendix Table 3 we see that in the first years after the increase in aid, GDP growth in our Scenario I is lower than the one implied in Clemens et al. (2004), possibly because our estimates conservatively omit any impact of aid on TFP. On average, in the first four years the difference between the two projections is only 0.2 percent per year. In the long run, GDP growth in Scenario I generally surpasses the estimates in Clemens et al. (2004), reflecting the effect of late impact aid.

- The results of our model are also in line with those obtained by the simulation of a DSGE model in Berg et al. (2008). Assuming a fixed exchange rate regime, no capital mobility, and a passive monetary policy, as is the case for Niger, their model implies that an increase in aid equivalent to 5 percent of GDP leads to an increase in GDP slightly higher than 1 percentage point, and that the real exchange rate would appreciate by slightly less than 3 percent.

- However, our estimates of the growth impact of aid are considerably lower than those in World Bank (2006), which takes into account interactions between education, health, and infrastructure inputs in addition to their overall contribution to capital (broadly defined) formation, and assumes an aid-efficiency parameter of 0.5. Presumably, these interactions lead to a higher impact of aid on GDP relative to our results, despite the low aid-efficiency parameter.

- Because our methodology is premised on a production function with constant returns to scale, our results are in line with the impact of aid suggested in Rajan and Subramanian (2005a). Indeed, the estimated contribution to growth in 2009 under Scenario I is similar to that implied in their study (Figure 2). In the longer run, growth accelerates faster under Scenario I due to the impact of human capital, which did not figure into the framework of Rajan and Subramanian (2005a).

Figure 2. Niger: Aid Impact on Growth (% of GDP)



IV. CONCLUSIONS

30. We have developed a simple macroeconomic model that assesses the effects of higher foreign aid on output growth and other macroeconomic variables, including the real exchange rate. The model is easily tractable and requires estimation of only a few basic parameters. It takes into account the impact of different forms of aid on physical and human capital accumulation while recognizing that the impact on human capital kicks in only over the long run. Our simulations also take into account a possible effect of aid on TFP and a potential erosion of aid-effectiveness because of inefficiencies related to aid delivery.

31. The model suggests that a scaling up of aid to Niger within feasible bounds, up to 15 percent of GDP (a level close to other African countries), is likely to raise annual GDP growth from 4.5 percent to 6.5 percent. The impact on poverty reduction is substantial, a cut of 25 percent by 2015, but still well below the MDG objective. Based on the model, external assistance would have to rise to 30 percent of GDP on a sustained basis to cut poverty by half. It is unlikely that a sustained rise of foreign resources could come from official development assistance alone and therefore, a substantial increase in FDI would be needed. This in turn would require improvements in the investment climate. Notice, though, that since our approach is based on a simple elasticity of poverty reduction to growth, it may mask the possible impact on poverty of the interaction between more dynamic growth and carefully targeted use of resources in the social sectors. Moreover, the impact of aid on GDP and poverty alleviation can be considerably augmented by improving the effectiveness of donors aid management.

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APPENDIX—EFFECT OF LATE IMPACT AID ON HUMAN CAPITAL ACCUMULATION

32. We simulate the gradual effect of late impact aid by assuming that (i) human capital is entirely the result of government expenditures on health and education, and (ii) the pace at which these expenditures impact production is similar to the one at which students who benefit from improved education join the labor force. The latter assumption should likely lead to conservative estimates of the impact of aid on growth because aid allocated to health expenditures and training allocated to current members of the labor force have an immediate effect on human capital. We prefer that bias, considering the skepticism that aid has any impact on growth. It is also true, though, that a large share of aid in the health sector goes to infants and children, and thus its effect on the labor force is only perceptible in the long run.

33. With these assumptions, the human capital of a cohort about to enter the labor force is approximated by the sum of public expenditures on health and education ($G_{H,i}$) over the last five years:

$$h_t = (\sum_{i=t-6}^{i=t-1} G_{H,i}) \tag{1}$$

Thus, the total human capital in an economy is the sum of the human capital of each cohort, weighted by the share of a cohort in the labor force, and allowing for depreciation:

$$H_t = w_t(\sum_{i=t-6}^{i=t-1} G_{H,i}) + w_{t-1}(1-\delta_H)(\sum_{i=t-7}^{i=t-2} G_{H,i}) + w_{t-2}(1-\delta_H)^2(\sum_{i=t-8}^{i=t-3} G_{H,i}) + \ldots \tag{2}$$

where w is the share of each cohort in the labor force. Considering a working life of 40 years and taking into account the population pyramidal structure, we assume that in period t, the recently graduated cohort accounts for 5 percent of the labor force. This weight evolves through time according to annual population growth (g):

$$w_{t-n} = \frac{w_t}{(1+g_t)^n} = \frac{\overline{w}}{(1+\overline{g})^n} \tag{3}$$

in which $\overline{w}$ is the share of the youngest cohort in the labor force (5%), and assuming that population growth is constant ($\overline{g}$). Hence:

$$H_t = \overline{w}(\sum_{i=t-6}^{i=t-1} G_{H,i}) + \frac{\overline{w}}{(1+\overline{g})}(1-\delta_H)(\sum_{i=t-7}^{i=t-2} G_{H,i}) + \frac{\overline{w}}{(1+\overline{g})^2}(1-\delta_H)^2(\sum_{i=t-8}^{i=t-3} G_{H,i}) + \ldots \quad (4)$$

$$H_{t-1} = \overline{w}(\sum_{i=t-7}^{i=t-2} G_{H,i}) + \frac{\overline{w}}{(1+\overline{g})}(1-\delta_H)(\sum_{i=t-8}^{i=t-3} G_{H,i}) + \frac{\overline{w}}{(1+\overline{g})^2}(1-\delta_H)^2(\sum_{i=t-9}^{i=t-4} G_{H,i}) + \ldots \quad (5)$$

and similarly for consecutive terms. Subtracting (5) from (4) gives us our human capital accumulation equation:

$$H_t = \frac{(1-\delta_H)}{(1+\overline{g})} H_{t-1} + I_{H,t} \quad (6)$$

where:

$$I_{H,t} = \overline{w} * (\sum_{i=t-6}^{i=t-1} G_{H,i}) = \frac{1}{20} * (\sum_{i=t-6}^{i=t-1} G_{H,i}) \quad (7)$$

Appendix Table 1: Scenario I—2007-15
(Increase in Aid by 5% of GDP, remaining constant as share of GDP afterwards)

Assumptions	2007	2008	2009	2010	2011	2012	2013	2014	2015
α	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
β	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Increase in Aid from 2007 (2007 CFAF billion)	0.00	108.00	114.48	121.35	128.63	136.35	144.53	153.20	162.39
Increase in Aid from 2007 (% of GDP)	0.00	5.00	5.04	5.05	5.05	5.04	5.02	4.99	4.97
Increase in Early Impact Aid from 2007 (2007 CFAF billion)	0.00	71.28	75.56	80.09	84.90	89.99	95.39	101.11	107.18
Increase in Early Impact Aid from 2007 (% of GDP)	0.00	3.30	3.32	3.33	3.33	3.32	3.31	3.29	3.28
Increase in Late Impact Aid from 2007 (2007 CFAF billion)	0.00	28.08	29.76	31.55	33.44	35.45	37.58	39.83	42.22
of which Capital Expenditures	0.00	15.12	16.03	16.99	18.01	19.09	20.23	21.45	22.73
Increase in Late Impact Aid from 2007 (% of GDP)	0.00	1.30	1.31	1.31	1.31	1.31	1.30	1.30	1.29
Increase of TFP Growth From Increased Foreign Aid (%)	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Exchange Rate (CFAF per US$)	496.05	488.74	481.62	473.80	465.17	456.45	456.45	456.45	456.45
	5.08	*1.70*							

Baseline Scenario	2007	2008	2009	2010	2011	2012	2013	2014	2015
Baseline Capital Growth (%)	5.08	4.37	4.41	4.45	4.51	4.56	4.61	4.65	4.69
Baseline Labor Growth (%)	3.39	3.39	3.39	3.39	3.39	3.39	3.39	3.39	3.39
Baseline Human Capital Growth (%)	4.26	4.00	3.84	4.11	4.55	4.51	4.48	4.46	4.44
Baseline TFP Growth (%)	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Baseline Real GDP Growth (%)	4.53	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
Change in Baseline Consumption (%)	9.52	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
Change in Baseline Investment (%)	10.25	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
Change in Baseline Government Investment (%)	10.25	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
Change in Baseline Private Investment (%)	10.25	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
Change in Baseline Government Consumption (%)	7.55	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
Change in Baseline Exports (%)	8.14	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
Change in Baseline Imports (%)	18.14	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
Baseline Absorption (% of GDP)	115.59	115.59	115.59	115.59	115.59	115.59	115.59	115.59	115.59
Baseline Current Account Deficit (% of GDP)	15.59	15.59	15.59	15.59	15.59	15.59	15.59	15.59	15.59
Change in Baseline Taxes (%)	7.29	5.05	4.76	4.84	4.98	4.99	4.99	4.99	5.00
Change in Baseline Price Level (%)	2.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change in Baseline Real Exchange Rate (%)	2.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Supply Indicators with Aid	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gross Capital Accumulation (2007 CFAF billion)	456.77	566.81	597.51	631.72	669.92	711.57	756.81	805.79	857.22
Government Capital Stock excl. H related (2007 CFAF billion)	2009.50	2168.55	2334.44	2508.28	2691.30	2884.50	3088.93	3305.61	3535.13
Private Capital Stock (2007 CFAF billion)	3731.94	3894.93	4067.98	4252.78	4451.23	4664.80	4894.98	5143.28	5410.30
Investment to GDP (% of GDP)	22.25	25.49	25.52	25.54	25.56	25.57	25.57	25.58	25.59
Human Capital Stock (2007=100)	100.00	104.00	107.99	113.46	120.63	129.01	138.60	149.43	160.46
Capital Growth (%, excl. human capital related)	5.08	5.61	5.59	5.60	5.64	5.70	5.76	5.82	5.88
Human Capital Growth (%)	4.26	4.00	3.84	5.07	6.32	6.95	7.44	7.81	7.39
TFP Growth (%)	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
GDP (current CFAF billion)	2052.59	2223.34	2341.26	2473.27	2621.43	2783.29	2959.38	3150.21	3350.44
GDP (2007 CFAF billion)	2052.59	2158.85	2273.53	2402.56	2548.02	2707.44	2881.34	3070.25	3268.35
Real GDP Growth (%)	**4.53**	**5.18**	**5.31**	**5.68**	**6.05**	**6.26**	**6.42**	**6.56**	**6.45**
Real GDP Per Capita Growth (%)	**1.11**	**1.73**	**1.86**	**2.21**	**2.58**	**2.78**	**2.94**	**3.06**	**2.96**

Demand Indicators with Aid	2007	2008	2009	2010	2011	2012	2013	2014	2015
Consumption (2007 CFAF Billion)	1600.83	1683.69	1772.82	1872.89	1985.53	2108.81	2243.12	2388.87	2541.74
Investment (2007 CFAF Billion)	456.77	566.81	597.51	631.72	669.92	711.57	756.81	805.79	857.22
Government Investment (2007 CFAF Billion)	159.87	254.54	268.66	284.20	301.36	319.95	340.04	361.69	384.47
Private Investment (2007 CFAF Billion)	296.90	312.27	328.86	347.52	368.56	391.62	416.77	444.10	472.75
Investment excl. Human Capital Related (2007 CFAF Billion)	456.77	551.69	581.49	614.73	651.91	692.48	736.58	784.34	834.49
Government Consumption (2007 CFAF Billion)	314.94	352.84	371.74	392.91	416.68	442.69	471.01	501.73	533.96
Exports (2007 CFAF Billion)	355.30	363.08	382.40	404.24	428.95	456.12	485.83	518.18	552.08
Imports (2007 CFAF Billion)	675.24	807.58	850.94	899.20	953.07	1011.75	1075.43	1144.31	1216.65
Imports excl. Aid-Financed (2007 CFAF Billion)	675.24	731.982	770.803	814.257	863.026	916.304	974.260	1037.070	1102.974
Absorption (2007 CFAF Billion)	2372.53	2527.75	2661.93	2812.58	2982.09	3167.62	3369.77	3589.15	3819.25
Taxes (2007 CFAF Billion)	224.30	235.91	248.44	262.54	278.44	295.86	314.86	335.51	357.15
Absorption (% of GDP)	115.59	117.09	117.08	117.07	117.04	117.00	116.95	116.90	116.86
Current Account Deficit (% of GDP)	15.59	20.59	20.61	20.60	20.57	20.52	20.46	20.39	20.33
Price Level (2000=100)	119.43	123.00	122.99	122.95	122.87	122.78	122.67	122.54	122.43
Real Exchange Rate (2007=100)	100.00	102.99	102.98	102.94	102.88	102.80	102.71	102.60	102.51

Growth of Demand Indicators with Aid	2007	2008	2009	2010	2011	2012	2013	2014	2015
Change in Consumption (%)	9.52	5.18	5.29	5.65	6.01	6.21	6.37	6.50	6.40
Change in Investment (%)	10.25	24.09	5.42	5.73	6.05	6.22	6.36	6.47	6.38
Change in Government Investment (%)	10.25	59.22	5.55	5.79	6.04	6.17	6.28	6.37	6.30
Change in Private Investment (%)	10.25	5.18	5.31	5.68	6.05	6.26	6.42	6.56	6.45
Change in Government Consumption (%)	7.55	12.03	5.35	5.70	6.05	6.24	6.40	6.52	6.42
Change in Exports (%)	8.14	2.19	5.32	5.71	6.11	6.33	6.51	6.66	6.54
Change in Imports (%)	18.14	19.60	5.37	5.67	5.99	6.16	6.29	6.40	6.32
Change in Imports excluding aid financed (%)	18.14	8.40	5.30	5.64	5.99	6.17	6.32	6.45	6.35
Change in Absorption (%)	7.52	6.54	5.31	5.66	6.03	6.22	6.38	6.51	6.41
Change in Taxes (%)	7.29	5.18	5.31	5.68	6.05	6.26	6.42	6.56	6.45
Change in Price Level (%)	2.58	2.99	-0.01	-0.04	-0.06	-0.08	-0.09	-0.10	-0.09
Change in Real Exchange Rate (%)	2.58	2.99	-0.01	-0.04	-0.06	-0.08	-0.09	-0.10	-0.09

Appendix Table 2. Niger: Projections Based on Econometric Findings in Clements, Radelet, and Bhavnani (2004), 2007-15

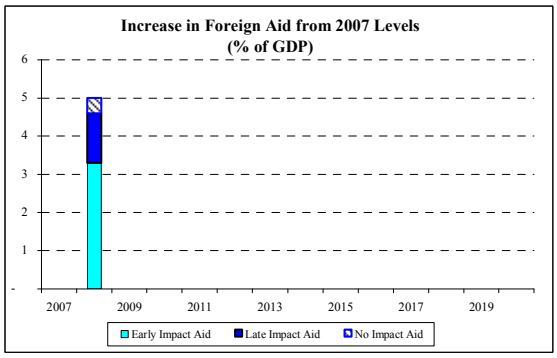
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Baseline Potential GDP Growth (%)	4.53	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
Baseline Potential GDP (CFAF billions)	2053	2202	2356	2522	2704	2900	3110	3336	3578
Annual Change in GDP Deflator (%)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Exchange Rate (CFAF per US$)	496.0	488.7	481.6	473.8	465.2	456.5	456.5	456.5	456.5
Increase in Short Impact Aid from 2007 (CFAF billion)	0.0	71.3	75.8	80.5	85.6	91.0	96.7	102.8	109.3
Increase in Short Impact Aid from 2007 (% of Baseline GDP)	0.00	3.30	3.31	3.32	3.33	3.33	3.34	3.34	3.34
GDP Growth Under Assumed Aid (%)	**4.53**	**5.18**	**5.90**	**6.00**	**6.15**	**6.16**	**6.17**	**6.18**	**6.19**
GDP Under Assumed Aid (CFAF billion)	**2053**	**2202**	**2379**	**2572**	**2785**	**3015**	**3265**	**3537**	**3831**
GDP Under Assumed Aid (2007 CFAF billion)	**2053**	**2159**	**2286**	**2423**	**2573**	**2731**	**2900**	**3079**	**3270**

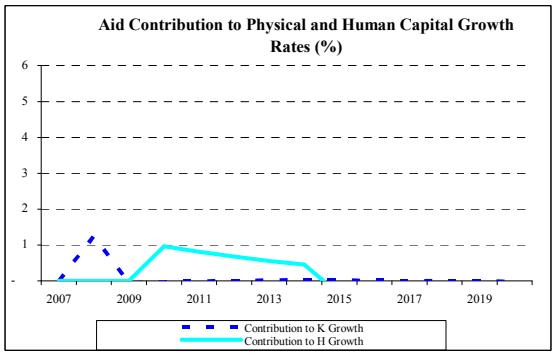
Appendix Table 3. Niger: Alternative Estimates of the Impact of an Aid Increase by 5% of GDP in Niger, 2007-15

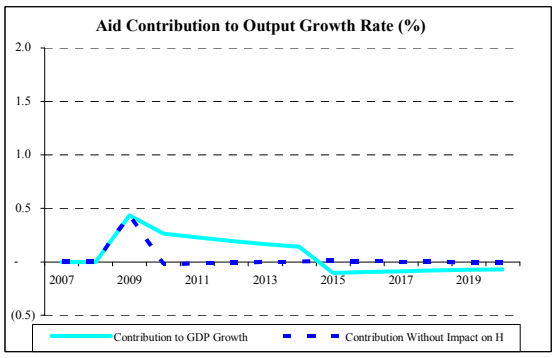
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Scenario I									
Baseline	4.53	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
After Aid	4.53	5.18	5.31	5.68	6.05	6.26	6.42	6.56	6.45
Difference	0.00	0.00	0.43	0.70	0.93	1.13	1.28	1.41	1.30
Supply Only Model									
Baseline	4.53	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
After Aid	4.53	5.18	5.31	5.67	6.03	6.22	6.37	6.49	6.36
Difference	0.00	0.00	0.43	0.69	0.91	1.09	1.23	1.34	1.20
Rajan and Subramanian (2005a)									
Baseline	4.53	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
After Aid	4.53	5.18	5.41	5.50	5.65	5.66	5.67	5.68	5.69
Difference	0.00	0.00	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Clemens et al (2004)									
Baseline	4.53	5.18	4.88	4.97	5.12	5.13	5.14	5.15	5.16
After Aid	4.53	5.18	5.90	6.00	6.15	6.16	6.17	6.18	6.19
Difference	0.00	0.00	1.02	1.03	1.03	1.03	1.03	1.03	1.04
World Bank (2007)									
Baseline	7.10	8.40	8.00	7.70	7.30	7.00	6.80	6.50	6.30
After Aid	10.34	8.82	9.23	9.30	9.41	9.28	9.17	8.97	8.80
Difference	3.24	0.42	1.23	1.60	2.11	2.28	2.37	2.47	2.50

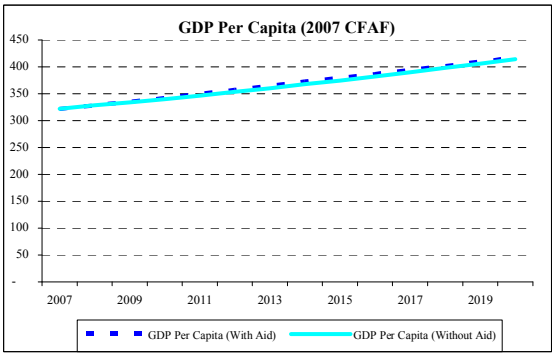
Sources: Rajan and Subramanian (2005a), Clements et al (2004), World Bank (2007), and Authors estimates.

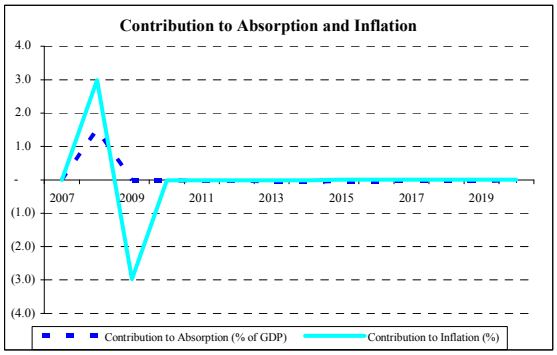
Appendix Figure 1. Scenario II

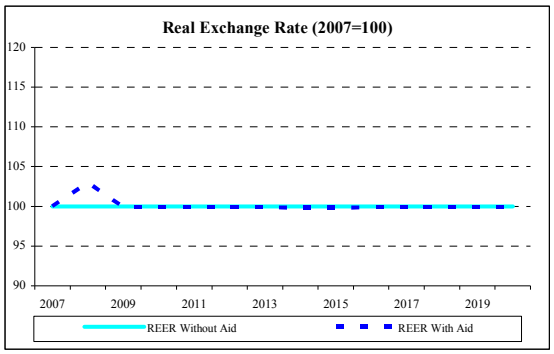




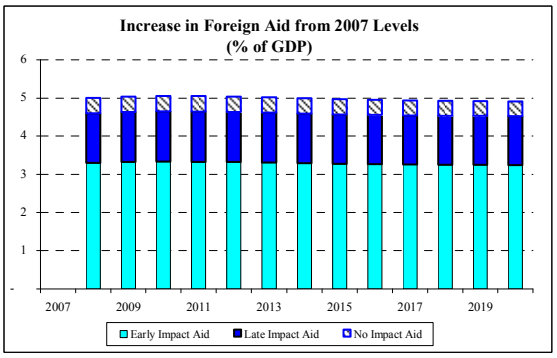


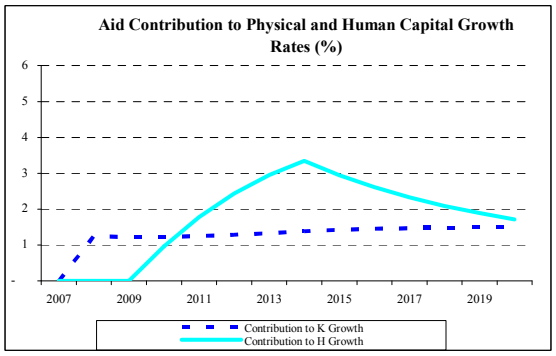


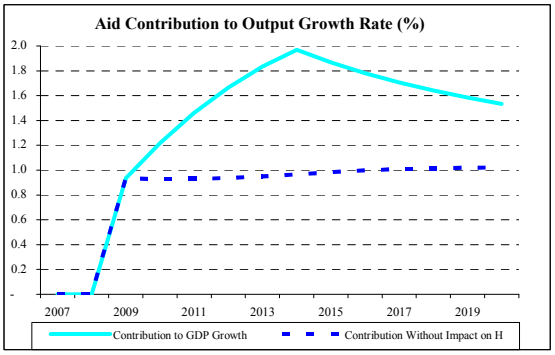


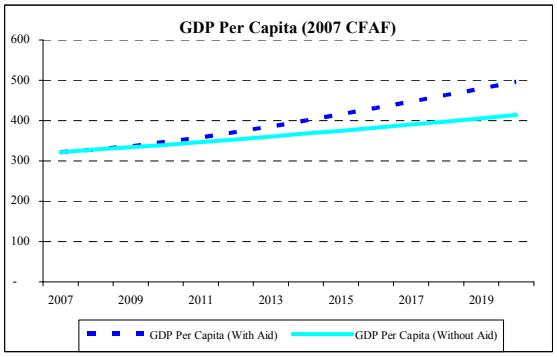


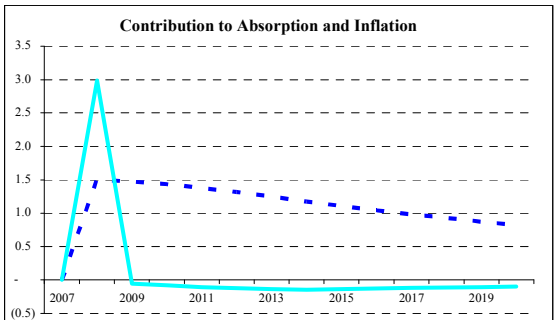
Appendix Figure 2. Scenario III

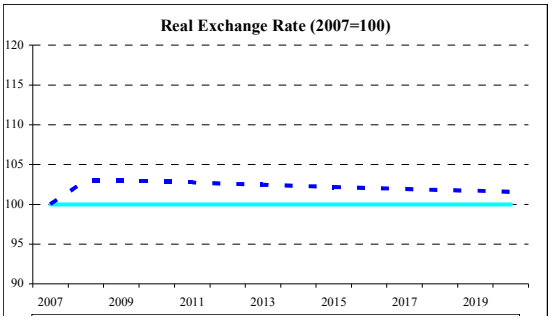




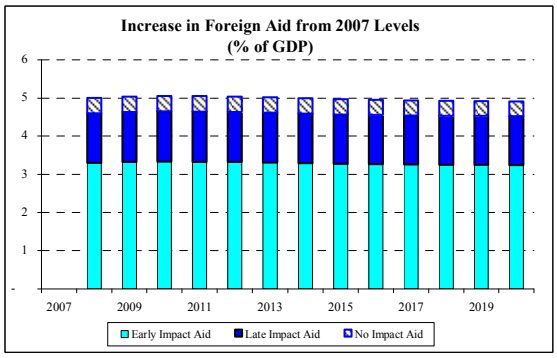


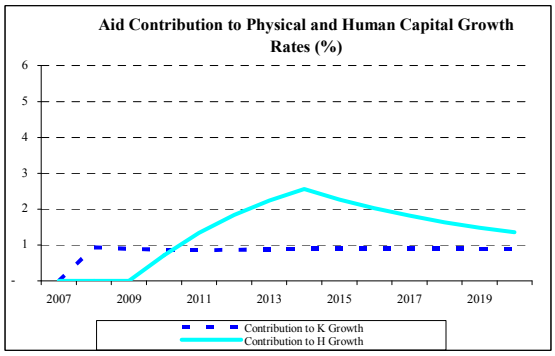


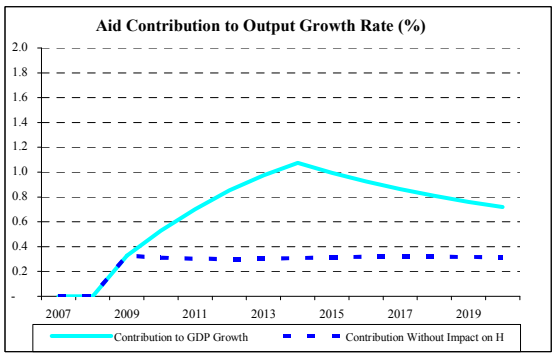


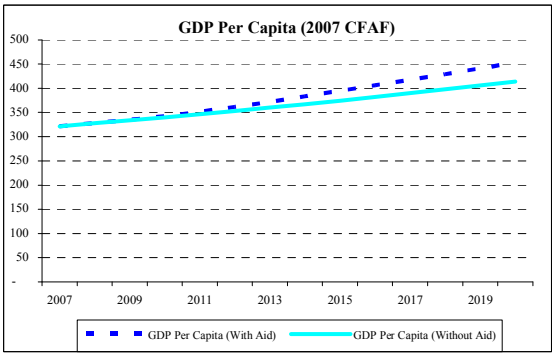


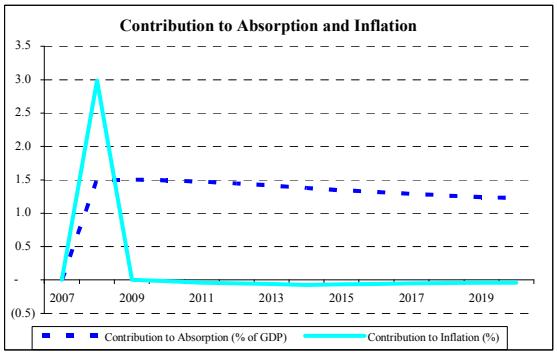
Appendix Figure 3. Scenario IV

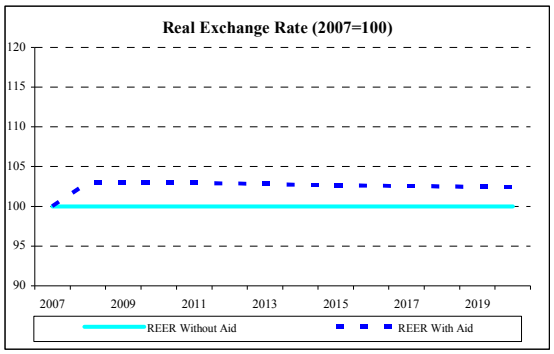




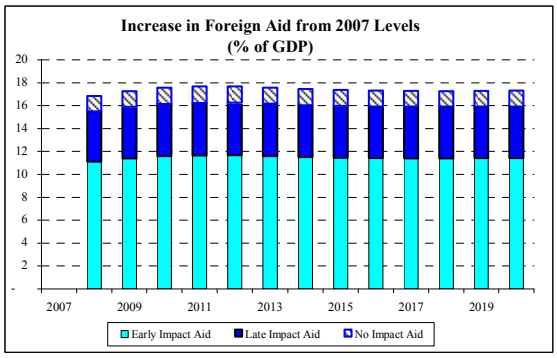


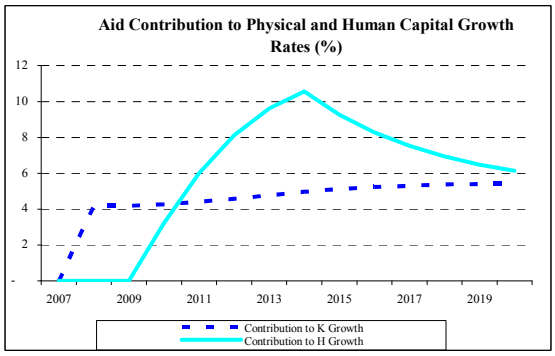


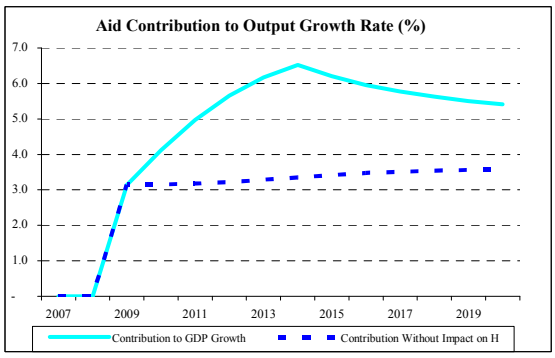


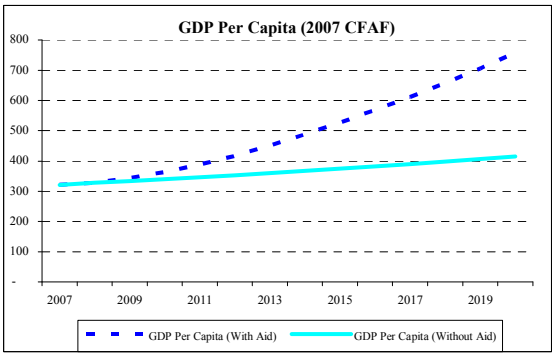


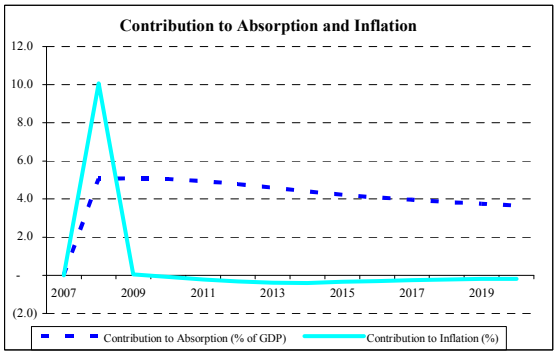
Appendix Figure 4. Scenario V

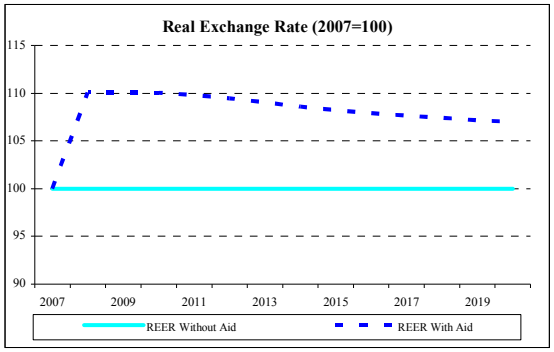


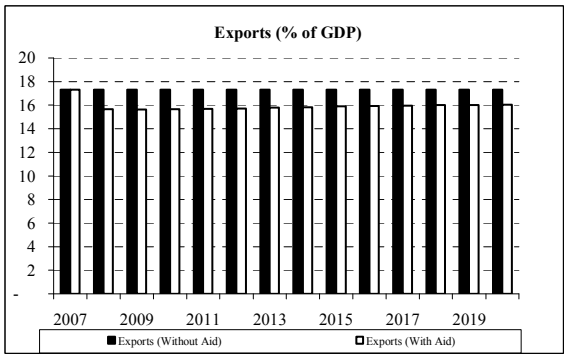


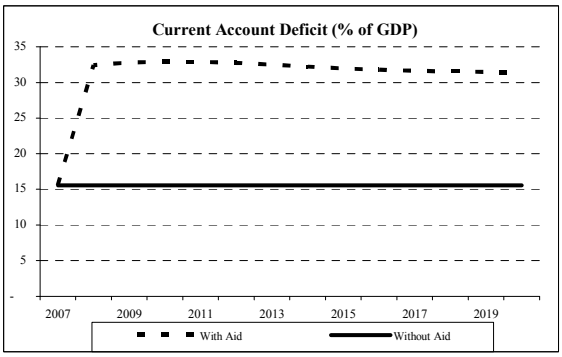




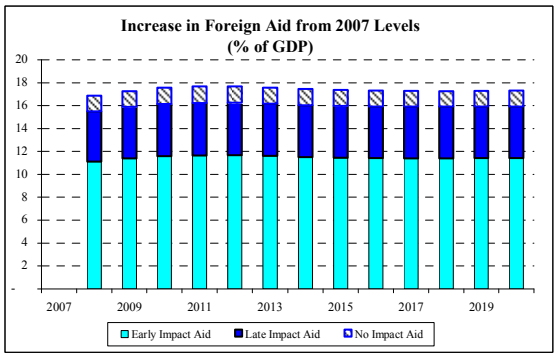


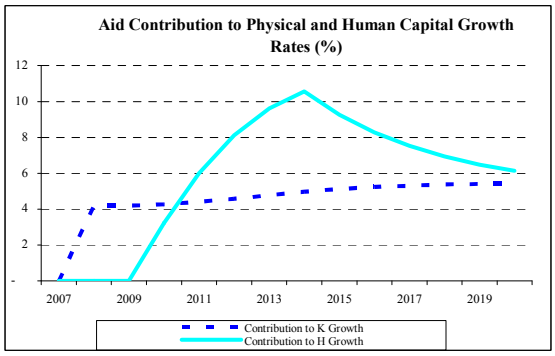


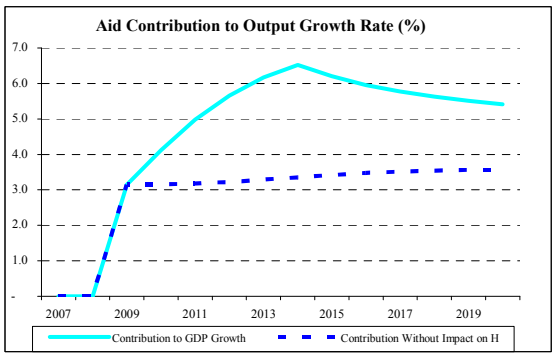


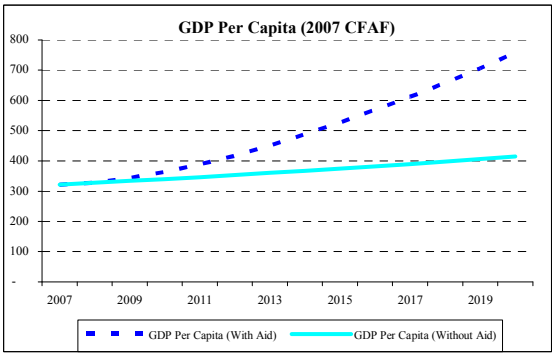


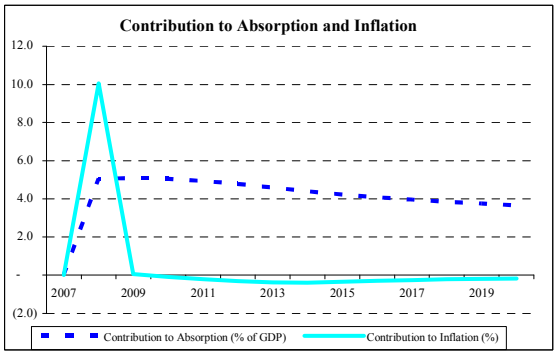
Appendix Figure 5. Scenario VI

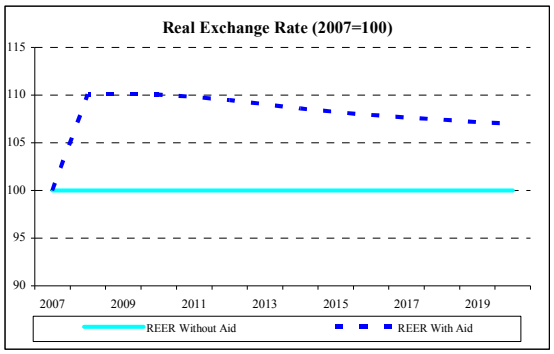




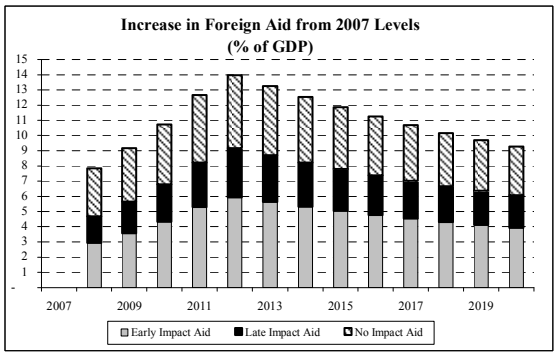


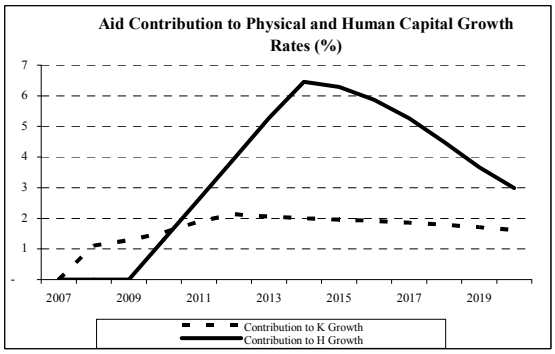


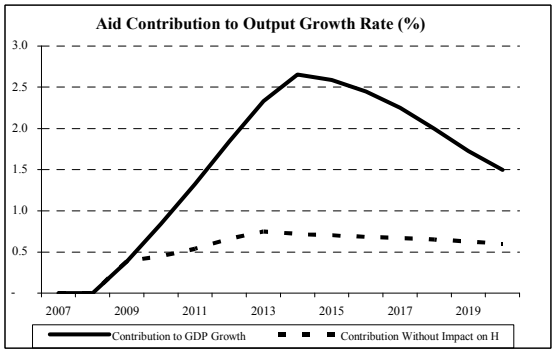


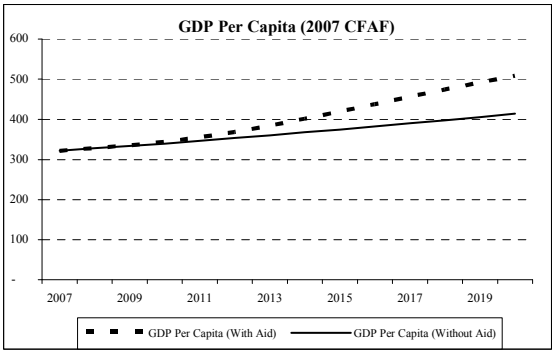


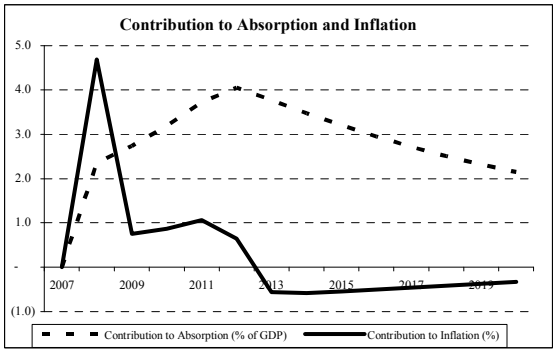
Appendix Figure 6. Scenario VII

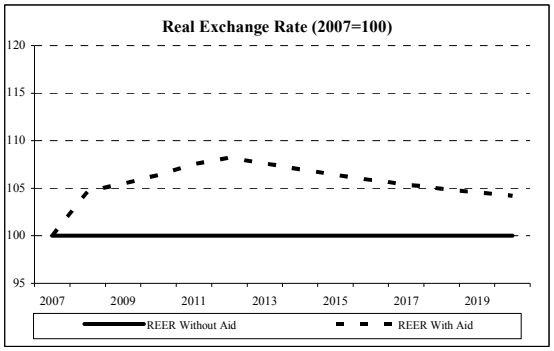












Appendix Figure 7. Scenario VIII