Working Paper

IMF Working Paper

Investment and Growth Dynamics: An Empirical Assessment Applied to Benin

Issouf Samake

WP/08/120

IMF Working Paper

African Department

Investment and Growth Dynamics: An Empirical Assessment Applied to Benin

Prepared by Issouf Samake[1]

Authorized for distribution by Roger Nord

May 2008

Abstract

This Working Paper should not be reported as representing the views of the IMF.
The views expressed in this Working Paper are those of the author and do not necessarily represent those of the IMF or IMF policy. Working Papers describe research in progress by the author and are published to elicit comments and to further debate.

We investigate the nexus of public and private investment and assess the impact of both types of investment on growth. Using annual data for 1965–2005, we employ a coherent set of structural VAR outputs to model investment and growth in Benin. We find that in addition to institutional and regulatory developments, public investment and private capital formation facilitated by access to financial services have a significant impact on growth. The analysis supports the crowding-in effect of public investment. It also confirms that the slow pace of improvement in Benin's economic freedom index, which reflects its relatively weak institutions and slow pace of reform, deters private investment. From the cointegration regressions, the speed-of-adjustment analysis suggests that 27 percent of the deviation of GDP from its long-run equilibrium is corrected every year, which implies that it takes two to three years to cut the gap in half.

Contents   Page

I. INTRODUCTION

1.   Benin has been undergoing democratization since the early 1990s, a process that has been furthered by four peaceful presidential elections held at five-year intervals since 1991. Benin is a small, poor West African coastal country located east of Nigeria and west of Togo. Its population in 2006, 7.5 million, grows nearly 3 percent a year; annual average per capita GDP growth was less than 1 percent a year for 1965–2005.

2.   Despite its peaceful democratization Benin has not yet attracted significant private investment. Of the determinants of growth, the ratio of fixed investment to GDP has been found to have the most explanatory power (Levine and Renelt, 1992). Also, there is increasing recognition that the credibility of fiscal policy management in developing countries partly explains private uncertainty about investment (see Serven, 1998, 1997). Recent analysis of the sources of growth specifically in Benin found that the greatest contribution to the country's growth came from higher investment and an increase in total factor productivity (TFP) that made more efficient use of factors of production.[2] The improvements in factor efficiency stem from reforms in the early 1990s that improved the environment for private investment, giving the private sector a more central role in economic activity. However, both private investment and its pace of growth appear to be minimal over the period under review.[3]

3.   We attempt to investigate the nexus of public and private investment and its impact on growth. Despite theoretical recognition of the impact of both public and private investment on growth, empirical analysis for African countries has been somewhat sparse because of the poor quality and limited availability of data.[4] Nevertheless, there have been some contributions over the years (see World Bank, 2005; Caseroa and Varoudakis, 2004; Devarajan, Easterly, and Pack. 1999; Gunning and Mengistae, 1999; Mataya and Veeman, 1996; Oshikoya, 1994; and Khan and Reinhart, 1990).

4.   This paper analyzes the relationship between private investment and growth and the key determinants of both, with a view to drawing policy lessons from the findings. Academics and policymakers can benefit from stylized facts about how public and private investment can impact growth and help reduce poverty in low-income countries.[5] To the

---

[2] "Benin: Selected Issues and Statistical Appendix," Nov. 04, IMF Country Report Number 04/370.

[3] Between 1995 and 2005 it appears that the ratio of private investment to GDP increased only from 11.1 percent to 12.1 percent, while the ratio of gross investment to GDP shrank from 22.2 percent to 19.6 percent as public investment declined. As discussed in IMF (2005), the decline in public investment may be in part the natural outcome of privatization.

[4] Structural breaks or regime shifts are not per se a problem from econometric standpoint because statistical tests can detect their presence and several econometric modeling procedures can handle them.

[5] See World Bank (2005a and 2005b), United Nations Millennium Project (2005) and the Blair Commission (2005)

extent that private investment is a determinant of long-run growth, a comprehensive assessment of what stimulates it is essential to identify and address related policy issues.

5.   Employing econometric techniques to investigate the short- and long-run behavior of private investment and its links to growth and following earlier growth accounting studies, we establish that private investment is indeed a critical determinant of growth in Benin.[6] Moreover, public investment appears to provide long-run support for private investment and growth.[7] This suggests that channeling to public investment part of the additional fiscal space created by debt relief could benefit Benin in the medium term. The analysis also shows that adverse shocks (e.g., deteriorating terms of trade) can have long-lasting growth effects, while the impact of credit to the private sector has to date been short-lived . There is thus significant potential for institutional reforms to improve the business environment, raise private investment, and invigorate growth.

6.   The paper controls for the problem of small sample size using a retained model estimate (through PcGive). Juselius (2006) explains that the question of how big the sample should be has, unfortunately, no obvious answer—whether the sample is "small" or "big" is a function not only of the number of observations but also of the amount of information in the data. She emphasizes that when the data are very informative about a hypothetical long-run or cointegration relation, there might be good test properties even if the sample period is relatively short, citing the case where the equilibrium error crosses the mean line several times during the period. This result is evidenced in subsequent statistical tests and various reduction processes.

7.   The contribution of this paper to the literature on growth in developing countries is twofold: First, because data related to developing economies tend to be limited and of poor quality we propose a parsimonious structural VECM in the spirit of the general-to-specific approach of Hendry (1995a, 1995b, and 2000). This approach avoids the parameterization problems generally associated with standard VAR models, and it ensures that the data are congruent with the original model. Second, with use of a coherent set of VAR outputs, our modeling procedure combines backward-looking analysis with some forward-looking outputs to determine the impact of investment on growth and to stimulate policy discussion.

8.   The rest of this paper is organized as follows: Section II provides background and stylized facts on Benin's economic performance. Section III briefly describes the theoretical basis of the econometric model and discusses the estimation results. Section IV provides insights on private investment behavior and its impact on growth through analysis of

---

[6] See reference to footnote 2.

[7] In the short run there may be some crowding-out effects. These are typically the conventional productivity, complementarity, and crowding-out effects identified in the literature. See Agénor et al. (2006) for an extensive review. Agenor et al. (2006) provide an overview of channels through which public infrastructures affect growth. On empirical grounds Gupta et al. (2006) find that, though studies focusing on infrastructure have had mixed results, some have found a positive, significant contribution to growth.

variance decomposition (VD), impulse response function (IRF), and historical decomposition (HD) analysis. Section V offers concluding remarks.

II. BACKGROUND AND STYLIZED FACTS

9.   In recent decades private investment and per capita GDP growth in Benin have been modest (see Text Table 1 and Figure 1). Between 1965 and 2005, real GDP[8] grew annually by an average of 3.4 percent, but annual per capita[9] GDP increased by only 0.3 percent. After the 1994 CFA franc devaluation, real GDP growth rebounded to a yearly average of 4.4 percent in 1994–2005 as annual real per capita GDP increased by 1.7 percent.

10.   Since 1994 growth of private investment has been slowing from its historical rates (see Figure 1). Real private investment growth decelerated from an average of 14 percent a year for 1980–93 to 6.1 percent for 1994–2006. Similarly, in the cotton sector (see Box 1), which is a major contributor to economic activity, investment has been too low to cover capital depreciation. Foreign direct investment (FDI) in the cotton sector declined from US$270 million in 1998 (11 percent of GDP) to US$251 million in 2004 (6 percent) even though total FDI inflows nearly doubled, rising from US$33 million in 1998 to US$60 million in 2004 (World Bank, 2006).

Figure 1. Benin: Constant GDP and Private Investment, 1965 – 2005
(Natural log of constant value in CFA franc terms)

Real GDP
(left scale)

Private investment
(right scale)

---
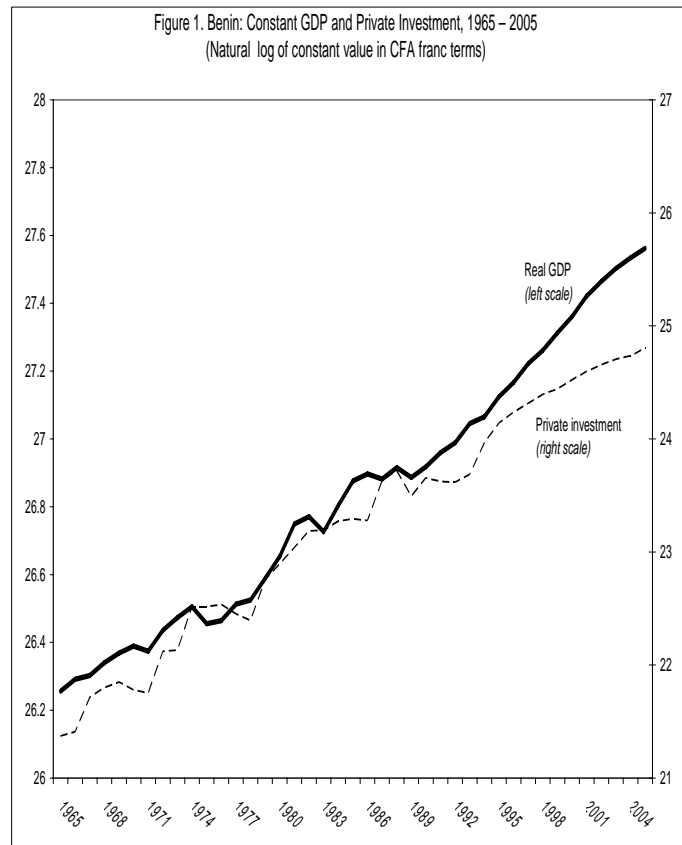
[8] The cotton trade explain most of Benin's output fluctuations. The sector dominates the economy, though cotton seed production has a relatively small share of nominal GDP (about 3 percent on average for 2000-05) and is subject to large swings: Of the approximately 550,000 Benin families who run small farms to generate their main income, about 310,000 grow cotton and sell cotton seed. About 14,000 new small farmers (in net terms) enter the sector each year. Average family size in rural areas is 10 people. Ginning industry capacity is estimated at 600,000 tons.

[9] The population growth rate is about 3 percent per year.

Figure 2. Benin: Selected Economic Indicators, 1965 – 2005
(Natural log of constant value)
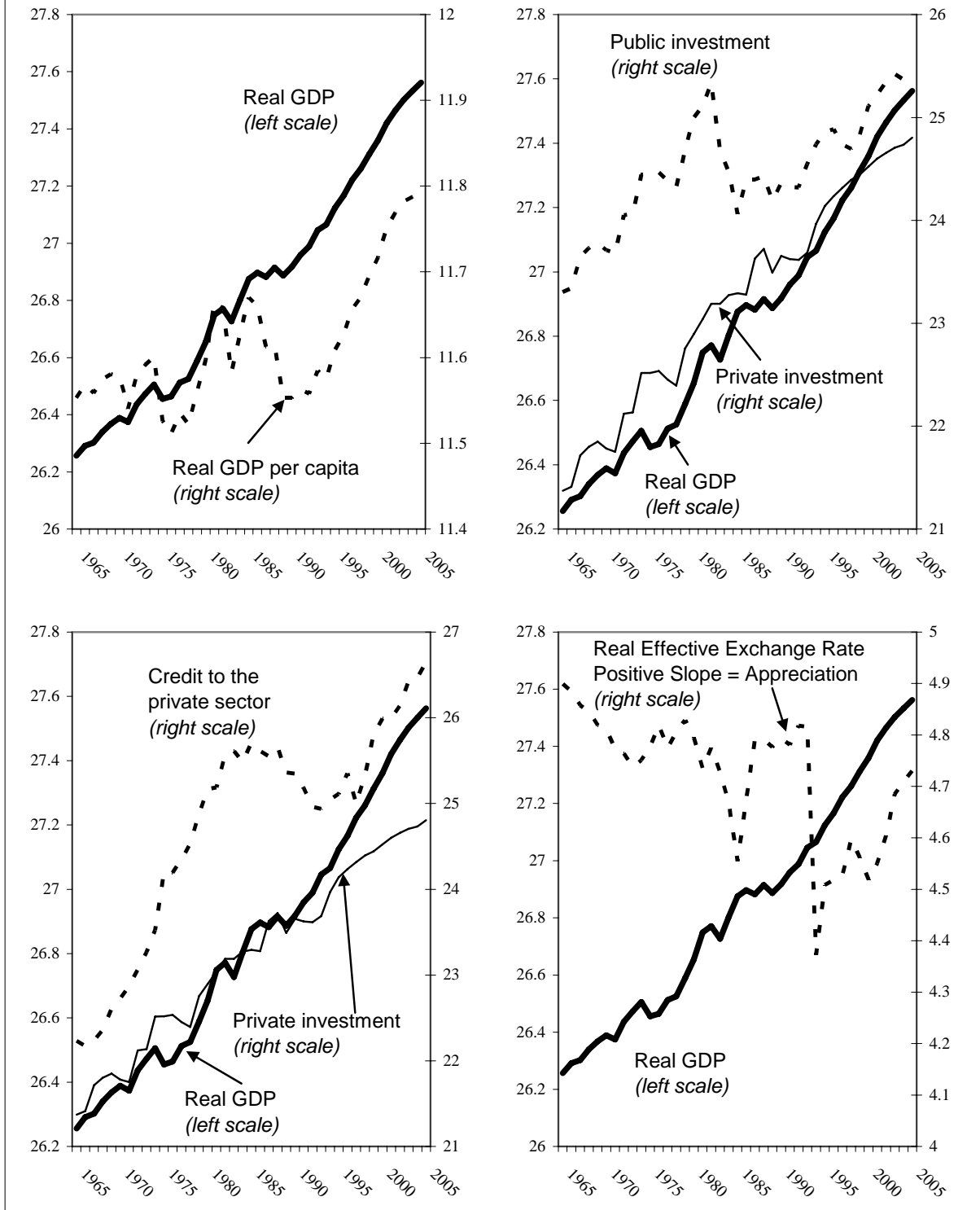
11.   Private investment matters to growth. For the last five years, economic growth has been more robust in CEMAC than in WAEMU countries. This can partly be explained by differences in private investment in the two regions (Text Table 1).[10] High returns in the oil sector, which are associated with greater private investment, have helped CEMAC countries enjoy higher real GDP growth. The only non-oil-producing country in the CEMAC region, the Central African Republic, recorded real GDP growth of –0.4 percent a year on average for 2000–05 and had the lowest private investment ratio in the region.

Text Table 1. Comparative Private Investment, 2000–05			
Country	2000–05	2000–03	2004–05
	(Percent of GDP)		
WAEMU[1]	11.1	11.2	11.1
Benin	12.5	12.2	13.1
Burkina Faso	10.6	10.5	10.8
Côte d'Ivoire	7.7	7.8	7.5
Mali	12.1	12.8	10.5
Niger	5.2	5.1	5.6
Senegal	17.0	17.5	16.2
Togo	16.1	15.5	17.3
CEMAC[1]	21.0	22.5	17.9
Cameroon	16.5	16.3	16.8
Central African Rep.	4.5	4.5	4.5
Chad	27.3	33.5	14.8
Congo, Republic of	16.0	15.7	16.6
Equatorial Guinea	41.1	48.9	25.5
Gabon	19.8	20.1	19.1
Memorandum items:	(real GDP growth in percent)		
WAEMU[1]	3.0	2.6	3.6
CEMAC[1]	5.7	5.2	6.6

Source: I.M.F. - *World Economic Outlook, 2006.*
[1] PPP weighted.
WAEMU: West African Economic and Monetary Union.
CEMAC: Communauté Economique des Etats d'Afrique Centrale.

12.   Benin's institutions, regulatory system, and financial sector situation probably deter private investment (Text Table 2). The World Bank's 2006 *Doing Business* report ranks Benin 137 of 175 countries in terms of ease of doing business. This lackluster performance derives partly from cumbersome licensing requirements, difficult labor market conditions, scarcity of credit, and high factor costs. Yet Benin is still above the WAEMU average.

13.   The business environment is improving only very slowly. Benin has made the least progress of all WAEMU countries on this front in recent years. On the *Doing Business* indicators, Benin moved up only 2 points between 2005 and 2006; Côte d'Ivoire improved by 15 points. Excessive regulation and other institutional factors may have kept Benin from improving more, as did delays in implementing reforms and in addressing institutional weaknesses, especially in the cotton sector.

---

[10] The issue of the productivity of capital is not discussed here.

Text Table 2. Selected Countries: Doing Business[1]

	Ease of Doing Business		Starting a Business		Dealing with Licenses		Employing Workers		Registering Property		Getting Credit	
	2006 rank	Change 2006/05	2006 rank	Change 2006/05	2006 rank	Change 2006/05	2006 rank	Change 2006/05	2006 rank	Change 2006/05	2006 rank	Change 2006/05
Benin	137	2	126	-13	133	-2	121	2	85	-1	117	0
Other WAEMU[2]/												
Burkina Faso	163	8	131	2	168	-2	153	-1	164	-1	117	0
Côte d'Ivoire	141	15	154	-10	158	-1	133	0	101	64	143	0
Mali	155	10	163	-3	122	20	131	-1	93	6	143	0
Niger	160	9	147	12	126	29	168	0	103	-2	143	0
Senegal	146	6	150	-2	66	1	152	1	151	0	143	0
Togo	151	3	169	-3	132	-7	145	1	155	-19	143	0
Other countries												
Nigeria	108	1	118	-3	129	5	56	0	170	1	83	-7
South Africa	29	-1	57	-8	45	-6	87	7	69	1	33	0
Thailand	18	1	28	-5	3	3	46	0	18	-2	33	8

Sources: World Bank, 2006. www.doingbusiness.org
[1]Countries are ranked from 1 to 175 with 1 being the best performer.
[2]Except Guinea-Bissau.

III. THE MODEL AND METHODOLOGICAL ISSUES

A. Modeling Procedure

14.   The vector autoregression (VAR), a popular class of econometric models for studying data dynamics, fits our attempt to address growth-investment dynamics. It is convenient and nicely describes the dynamics of the data. It also indicates not only the long-run equilibrium but also the pace of adjustment toward the equilibrium so long as the VAR is congruent with the data.

15.   Although VARs or vector error correction models (VECMs) provide a solid basis for summarizing data properties, they may not apply to specific economic structures because of their reduced-form status (Lutepohl and Kratzig, 2004). Shapiro and Watson (1988) introduced the class of structural VARs (SVARs); instead of identifying the autoregressive parameters, SVAR models look at the error component terms of congruent systems. HD, VD, and IRF are standard VAR outputs. How they apply to this study is shown in Text Table 3.

16.   The structural VECM approach gives a clearer picture of the relationship between the selected economic variables and their dynamic behavior. By contrast, descriptive statistics or ordinary least square regressions do not account for endogeneity problems or for contemporaneous and dynamic interactions between variables. For instance, simple descriptive statistics do not account for the silent dynamics of the direct and indirect contribution of private investment to the business cycle. Text table 3 shows the links between the issues addressed and the econometric methodology applied.

Text Table 3. Study Objective and Econometric Methodology

Questions to Address	Econometric Methodology
1 What are the long-run determinants of private investment and growth?	Cointegration relations
2 What would be the dynamic adjustment of GDP (or of private investment) toward its long-run equilibrium in response to various structural shocks?	Error correction model (representation)
3 What would have been the historical trend of GDP (private investement) if it had to be filtered from private investment (supply shock)?	Historical decomposition (HD)
If policy does not change and looking forward,	
4 How much would private investment (or GDP) likely contribute to GDP growth (or private investment)?	Variance decomposition (VD)
5 What would be dynamic behavior of private investment (or GDP) in response to various shocks?	Impulse response function (IRF)

Notes:
[1]Depending on unit root results that may lead to SVAR analysis for I(0) series or SVECM for I(1), most recent studies employ simultaneously HD, VD and IRF because of their complementarity.

[2] HD, VD, and IDF provide complementary insights to the analysis.

17.   There are five steps to the estimation process:

1.   Time series analysis and unit root tests

2.   Unrestricted VAR specification analysis, including lag length choice and diagnostics checks for misspecification

3.   Cointegration analysis and exogeneity tests

4.   Conditional structural VECM, eliminating all insignificant variables using the PcGETS (which eliminates automatically the least significant variables)

5.   IRF, VD and HD analysis on the basis of step 4.

B. Variable Choices and Ordering

18.   As the background discussion suggests, understanding the impact of private investment on Benin's long-run growth must begin with an understanding of the country's institutional factors and the regulatory framework. There is not much empirical research in this area, particularly for developing countries. Most studies have looked separately at financial development or trade liberalization and growth, or have emphasized the role of public policy, fiscal policy, or institutions. Less attention has been paid to the relationship

between private sector dynamics and growth; instead, many analyses have controlled for public investment, financial sector development, external factors, and institutional changes.

19.   The analysis here uses the time-to-build approach to estimate the potential impact of private investment on growth. In this approach, capital stock becomes productive once planned investment projects are completed in sequence. It acknowledges that lags in investment returns depend on production technology (see Altug, 1989, 1993; and Kydland and Prescott, 1982), unlike the cost-of-adjustment model[11] or under uncertainty models, which attribute investment lags to inactivity as investors await new information.[12] The empirical model used here is a structural vector autoregression model (SVECM) that captures the time lag needed for initial investment to contribute to future growth[13] and that addresses endogeneity problems among the system variables.

20.   The model incorporates the following endogenous variables:

$$Y_t^{'} = (TOT_t, GINV_t, CRED_t \ PINV_t \ GDP_t, INST_t)\ ^{14}$$

where *TOT*, the log of trade volume index, is the external factor variable; *GINV*, the log of public investment, is the proxy for the fiscal variable; *CRED*, the log of credit to the private sector, is the proxy for the financial variable (rather than the interest rate); *PINV* is the log of private investment incorporating private sector behavior; and *GDP*, the log of constant *GDP*

---

[11] The neoclassical prospective cost-of-adjustment approach is based on the idea that decision-makers choose the capital stock rather than the investment rate; therefore, as the cost of capital changes, such models instantly adjust capital stock to the "desired" level. The "desired" capital could be considered the optimal level, which differs from actual capital stock.

[12] Because removing investment is costly, where there is uncertainty the decision maker may delay investment until new information is available.

[13] Including, among others, Breitung, Chirinko, and Kalckreuth (2003) and Zhou (2000), who attempted to use the time-to-build approach and VAR methodologies to explain the relationship of investment to its determinants.

[14] The number of endogenous variables was limited to six to avoid degrees-of-freedom problems given that there are relatively few annual observations (41). Though public aid could be an important system variable, data are not available for 1965–2005; also, during the last decade, aid inflows (grants, concessional loans, and debt relief) into Benin averaged only 3 percent of GDP.

at market price, represents supply factors.[15] A variable capturing institutional strength, $INST_t$, is measured using the POLITY project alternative to Freedom House.[16]

21.   The choice of variables is motivated by both the background discussion above and the findings in the literature.[17] Public capital (*GINV*) is included in the model to help assess whether fiscal policy has a crowding-in or crowding-out effect on private investment. *CRED,* credit to the private sector, is chosen because, as is well documented, it is more effective than the interest rate channel in capturing the effectiveness of monetary policy (see, for instance, Dailami and Giugale, 1991). The *CRED* variable can also be viewed as a structural variable, given that Benin's financial sector has grown in response to continuing reforms. Furthermore (see Figure 2), this variable helps capture the extent to which financial deepening may stimulate growth.

22.   For convenience the system variables are ordered according to an assumed decrease in exogeneity[18]: terms of trade is assumed to be most exogenous, and GDP most endogenous. Public investment and credit to the private sector are considered policy instruments, but credit to the private sector is assumed to be endogenous to the fiscal instrument.[19]

---

[15] There is controversy in the literature about the choice of proxy for the fiscal policy variable. We chose public investment for the following reasons: (i) in Benin, as in other developing countries, fiscal revenue is mostly driven by taxes on international trade; thus, it provides less information about the behavior of fiscal authorities than public expenditure or public investment; (ii) the ex post variability of revenue may mask the objectives of the fiscal authorities; and (iii) because the number of system variables is limited and we are interested in the dynamic of public and private investment, we focus on public investment rather than total public expenditure.

[16] Monty Marshall from the Center for International Development and Conflict Management, University of Maryland, College Park, provided us with data on institutions. See Appendix on *INST* for more detail. A positive change in *INST* suggests stronger institutions.

17 See Ghura and Hadjimichael (1996) and Calamitsis, Basu, and Ghura (1999), who use similar variables in the modified version of the neoclassical growth model.

[18] The rationale for the ordering is to facilitate structural factorization, which uses data-oriented as well as theory-based restrictions. This technique, unlike the Cholesky ordering, is based on an orthogonalized set of innovations that does not depend on the vector autoregressive ordering to which impulse responses are sensitive (see Pesaran and Shin, 1998).

[19] Because private sector investment is a component of aggregate demand, it is assumed to have only a transitory impact on GDP.

C. The Model

23.   The full representation of the model is as follows:

$$Y_t = \sum_{i=1}^{p} \pi_i Y_{t-i} + CD_t + \varepsilon_t , \tag{1}$$

where Y_t is 6x1 vector of observations at time t, for t=1, ..., T. , π_i $(i = 1,..., p)$ are constant parameters; p is the number of lags; ε_t is an unobservable Gaussian zero-mean independent white-noise process with a time-invariant positive definite covariance matrix; D_t contains deterministic regressors; and C and π_i are constant parameters. The VAR system (1) is also assumed to be stable; that is ,the polynomial defined by the determinant of the autoregressive operator has no roots in and on the complex unit circle, formally,

$\det(I_6 - \sum_{i=1}^{P} \pi_i x^i) \neq 0$ *for* $|x| \leq 0$. By subtracting and adding various lags of Y_t, (1) can be rewritten in equilibrium-correction form as:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + CD_t + \varepsilon_t . \tag{2}[20]$$

A variable preceded by the operator Δ can be interpreted as the percentage change. Equation (2) can also be rewritten as:

$$\Delta Y_t = \alpha\left(\beta' Y_{t-1}\right) + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + CD_t + \varepsilon_t . \tag{3}$$

This "error correction" representation has the advantage of representing the dynamics for each individual (system) variable in terms of its deviation from its long-run equilibrium (the first term[21]) and in terms of its year-to-year or short-term change (the last two terms). The rank of Π determines how the process Y_{t-1} enters the system, and the statistical hypothesis of cointegration is based on the rank of Π. If we assume that $rank(\Pi) \leq r$, then

---

[20] Equation (2) is the basis for cointegration analysis. $\Pi = -\left[I - \sum_{i=1}^{p} \pi_i\right]$,

$\Gamma_i = -\left[\sum_{j=i+1}^{p} \pi_j\right], \quad i = (1,..., p-1)$.

[21] The relations $\beta' Y_{t-1}$ are the cointegrating relations, and the coefficients β are the long-run parameters. The coefficients α can be interpreted as the speed of adjustment to the long-run equilibrium.

Π can be written as $\Pi = \alpha\beta'$, where α and β [22] are $n \times r$ vectors. If $rank(\Pi) = n$, then all variables Y_{t-1} are stationary (I(0)); if $rank(\Pi) = 0$, then ΔY_t is stationary; and if $0 \prec rank(\Pi) = r \prec n$, there are cointegrating relationships.

D. Structural Model

24.   The structural model representation is useful for impulse response and variance decomposition analyses. The empirical analysis, in estimating an SVAR, imposes a number of restrictions for identification purposes. The structural representation of equation (1) is[23]

$$A\Delta Y_t = \alpha^*\left(\beta' Y_{t-1}\right) + \sum_{i=1}^{p-1}\Gamma_i^*\Delta Y_{t-i} + C^* D_t + B\varepsilon_t \qquad (4)$$

where $\alpha = A^{-1}\alpha^*$, $\Gamma_i = A^{-1}\sum_{i=1}^{p-1}\Gamma_i^*$, $C = A^{-1}C^*$, and $v_t = A^{-1}B\varepsilon_t$.

Assuming two cointegration vectors, the long-run effects of ε_t shocks can be written as

$$\Phi = \beta_\perp\left(\alpha_\perp'(I_6 - \sum_{i=1}^{p-1}T_i)\beta_\perp\right)^{-1}\alpha_\perp' \text{ and } C = \Phi A^{-1}B \text{ [24] are of rank 4 (that is = 6–2, because there}$$

are six endogenous variables and two cointegration relationships). A and B are nonsingular.

Impulse response and identification issues
25.   The IRF analysis tracks the path over time of the change in private investment and real GDP after a one-unit shock to terms of trade, public investment, credit to the private sector, private investment, and GDP. Assuming the below MA representation of (4) is

$$Y_t = \Phi\sum_{i=1}^{t}v_i + \Phi^*(L)v_t + X_{0,t}, \qquad (5)$$

where $\Phi^*(L) = \sum_{j=0}^{\infty}\Phi_j^* L^j$ is an infinite-order polynomial in the lag operator L with coefficient matrices of Φ_j^* [25] going to zero as $j \to \infty$, and $X_{0,t}$ contains all initial values and exogenous

---

[22] The matrix Alpha and Beta are not unique; their linear transformations can also provide valid representations of equation (3) (see Johansen, 1988, and Hendry, 1995).

[23] Variables in equation (2) are stationary.

[24] The long-run matrix estimate is provided in Appendix Table 6.

[25] $\Phi_0 = I_6$ and the $\Phi_j = \sum_{i=1}^{j}\Phi_{j-i}\pi_i$ can be computed recursively.

variables. Φ is the long-run forecast error impulse response, Φ_j^* is the short-run forecast error impulse response. A meaningful IRF will require at least 6*(6-1)/2=15 restrictions.

- Given that there are 2 cointegration relationships, 2 at most have transitory effects or 0 have long-run impacts.

- There are at least $4 = 6{-}2$ shocks with permanent effects.

- These two transitory shocks will induce 8=2*(6–2) independent restrictions.

- Following King et al. (1991), 2*(2–1)/2 = 1 contemporaneous restriction identities will be imposed.

- Using a data-oriented approach by degree of significance, we impose 4*(4–1)/2 additional restrictions.

- Together, the total number of restrictions for the system identified will be [2*(6-2)]+[2*(2-1)/2]+[4*(4-1)/2]=15.

Variance decomposition

26.   Our VD analysis estimates the relative significance of each random innovation to the system variable by subjecting all endogenous variables in the SVAR model to standard deviation shocks: for each period, the resulting simulated error for a given endogenous variable is decomposed into the error arising from its own innovation and the error stemming from the shock to the other endogenous variables.

27.   Formally, at forecast origin T, an h-step ahead forecast is obtained recursively as:

$$Y_{T+h/T} = \sum_{i=1}^{p} \pi_i y_{T+h-i/T}$$ and the corresponding forecast error is[26]

$$Y_{T+h} - Y_{T+h/T} = \sum_{i=0}^{h-1} \Phi_i^* v_{T+h-i}$$ in structural innovation form:

$$Y_{T+h} - Y_{T+h/T} = \sum_{i=0}^{h-1} \Theta_i \varepsilon_{T+h-i}$$, where $\Theta_i = \Phi_i^* A^{-1} B$.

The kth element $Y_{k,T+h}$ of the forecast error vector is

---

[26] See Lutkepohl (1991).

$$Y_{k,T+h} - Y_{k,T+h/T} = \sum_{i=0}^{h-1}\sum_{n=1}^{K}\Theta_{kn,i}\varepsilon_{n,T+h-i} \text{, where kn}^{\text{th}} \text{ element of } \Phi_i \text{ is } \Phi_{kn,i}\text{, and } \varepsilon_{nt} \text{ are}$$

contemporaneously and serially uncorrelated and have unit variance; then the percentage contribution of variable n to the h-step forecast error variance of variable k is

$$w_{kn}(h) = \left. \sum_{i=0}^{h-1}\Theta_{kn,i}^2 \middle/ \sum_{n=1}^{K}\sum_{i=0}^{h-1}\Theta_{kn,i}^2 \right.$$

Historical decomposition

28.   HD allows us to evaluate the portion of the forecast error attributable to each of the structural shocks. This sheds light on the relative importance of selected shocks in different periods. Let M and j be such that: where $0 \le t \le t + j \le T$, T is the total number of observations.

$$Y_{t+j} = \left[Z_{t+j} + \sum_{i=j}^{\infty}\Theta_j\varepsilon_{t+j-i}\right] + \left[\sum_{i=0}^{j-1}\Theta_i\varepsilon_{t+j-i}\right]$$

The first term is the forecast of Y_{t+j} based on information available at time t. The second sum is the part of Y_{t+j} due to innovation in periods t+1 to t+j.

IV.   EMPIRICAL EVIDENCE

A.   Statistics Tests

29.   ***The analysis uses annual data for 1965–2005*** from *World Bank Development Indicators 2006* and *IMF International Financial Statistics* of June 2006. The data in these series (except for terms of trade and institutions) are at constant prices (2000 = 100).

30.   Unit root test results (see Appendix Table 1) indicate that most of the economic variables are nonstationary. From equation (1), all six variables are entered with 4 lags. Based on F-statistics, a 1-lag VAR seems to be appropriate; however, after several attempts and given the limited number of observations, we find it useful to generalize the model to allow for 2 lags to ensure that error terms are outliers. The unrestricted VAR(2) diagnostic test is conducted to ensure that it is congruent with the data (Text Table 2). The tests confirm the absence of serial autocorrelation and heteroscedasticity. The residuals are normally distributed without an ARCH effect. Further, the model variables were stable enough at lag 2 to pass the 1-up and N-down Chow tests, indicating that the system is stable.

31.   Next, Johansen's likelihood ratio (LR) trace test is applied to test for the cointegration rank of the six-variable system. The test indicates 2 cointegrating equations at 5 percent

significance (see Appendix Table 3 and Appendix Figures 1 and 2). The analysis focuses on the behavior of private investment and its relationship with GDP. The exogeneity test statistics (WETS) indicate that *TOT, CRED,* and *INST* are only weakly exogenous; *GINV* and *GDP* are weakly exogenous to the private investment long-run equation; and *PINV* is weakly exogenous to the GDP equation.[27]

32.   Finally, a parsimonious structural VECM is estimated using the full information maximum likelihood (FIML) method of the general-to-specific approach in the I(0) space; this yields more efficient estimates. The general-to-specific approach consists of eliminating redundant or insignificant variables.[28] As a result, the number of parameter estimates fell significantly, to 21 from 78 for the unrestricted initial VAR system; in addition, coefficient estimates improved. Appendix Table 5 and Appendix Figures 3 and 4 show that the final model is congruent with the data. The recursive constancy Chow tests indicate that the system of three endogenous variables is stable; the GDP, PINV, and GINV equations are normally distributed, showing no serial correlation or heteroscedasticity.

B. Economic Interpretations

33.   The investment equation supports the conclusion that the trade index and public investment have a positive impact on private investment in the long run.[29, 30] It appears that credit to the private sector does not have a significant long-run impact on private investment or on GDP growth. However, public investment and the export index have both a direct and an indirect effect—via private investment—on GDP growth. This result is consistent with the literature, which suggests that public investment stimulates private investment (Oshikoya, 1994; Odedokun, 1997; and Ramirez, 2000).

$$PINV = 0.140 * TOT + 0.437 * GINV + 0.653 * INST + ECM(PINV) \qquad (6)$$
$$\qquad [2.444] \qquad [2.005] \qquad [1.993]$$
$$GDP = 0.569 * TOT + 0.337 * GINV + 0.276 * PINV + 0.498 * INST + ECM(GDP) \qquad (7)$$
$$\qquad [2.894] \qquad [1.977] \qquad [2.009] \qquad [2.015]$$

---

[27] The joint test: $WETS = \chi^2(7) = 2.1 \prec 14.1 \, the \, critical \, value.$ The individual tests also confirm the null hypothesis.

[28] PcGets could also provide better results; however, the PcFIML estimates a structural model that is useful for the rest of the analysis, including IRF, VD, and HD.

[29] To identify the cointegrating vector, and because their long-run impacts are insignificant, we impose a zero restriction on the *LGDP* and CRED coefficients in the *PINV* equation and on the CRED coefficient in the GDP equation. ECM(PINV) is the error correction term for private investment and ECM(GDP) for the GDP equations.

[30] While most signs are expected, this is a data-driven approach. Also, the GETS results imply that all variables of the retained model are significant; typically, the GETS procedure consists of automatically eliminating all insignificant variables.

Text Table 4. Error Correction Model, 1965 - 2005
(Retain model using PcFIML[1])

	Public Investment -- GINV--	Private investment -- PINV --	Growth -- GDP--
	Loading parameters		
ECM(GDP)	-0.36		-0.27
	[-2.01]**		[-1.99]**
ECM(PINV)		-0.24	
		[-2.14]**	
	Short-run parameters[2]		
DTOT(-1)			0.13
			[1.716]*
DGINV(-1)	0.12	0.14	0.16
	[3.571]**	[3.26]**	[1.66]*
DPINV(-1)	0.14		0.14
	[2.152]**		[1.905]*
DCRED(-1)	0.22	0.15	0.11
	[3.08]**	[3.31]**	[2.457]**
DGDP(-1)	0.77	0.35	0.15
	[3.626]**	[1.88]*	[2.761]**
DINST(-1)	0.10	0.45	0.14
	[1.84]*	[3.11]**	[1.76]*
CONSTANT	4.23	-7.98	1.13
	[2.02]**	[-2.42]**	[2.01]**

Note: t-statistics in [ ], 41 observations, optimal lag length = 2,
(*) and (**) significant at 10 percent and 5 percent respectively.
ECT(GDP)= Error correction term for GDP;
ECT(PINV)= Error correction term for private investment;
[1]Model reduced by the General–to–specific from the original VAR(6)
  using the PcGets modukle automatically eliminates
  all insignificants variables.
[2]variables in first difference.

ECM(PINV) is the error correction term for the private investment equation and *ECM(GDP)* the error correction terms for the GDP equation. They are the residual terms between actual value (left-hand side) and estimated values (right-hand side).

34.   From the short-run dynamic equations (Text Table 4), it follows that:

i.   Private investment is a long-run determinant of growth, though its sluggish adjustment tends to dampen output response in the short run. A 1 percent increase in private investment will yield an 0.3 percent long-run increase in GDP (Equation 7). The GDP dynamic equation suggests that 27 percent of its deviation from long-run equilibrium (Equation 7) is corrected every year, so it takes two to three years to close half the gap.[31] Finally, changes in institutions, past growth performance, public investment, and credit to the private sector positively and significantly affect private investment.

---

[31] This is somewhat different from conditional convergence studies in which the estimate refers to the rate at which the capital-output ratios in a panel of countries generally tend to converge to the steady-state levels predicted by, say, the Solow model.

Business Cycle and Speed of Adjustment of Output (single country case)

From equation 7 and text table 4, change in growth can be approximated by:

$$\Delta GDP_t = -\alpha[GDP_t - GDP_{LR}] \quad (8)$$

where GDP_{LR} is the long-run GDP, GDP_0 is the initial GDP, and α is the estimated loading parameter or speed of adjustment parameter.

Following Chiang (1984), (8) indicates that GDP evolves toward its long-run level at a constant speed (-α) proportional to its distance from GDP_{LR}:

$$GDP_t - GDP_{LR} \cong -\alpha[GDP_0 - GDP_{LR}] \text{ , or using the adjustment time t:}$$

$$GDP_t - GDP_{LR} \cong e^{-\alpha t}[GDP_0 - GDP_{LR}]$$

We define the adjustment ratio λ as: $\lambda = \dfrac{GDP_t - GDP_0}{GDP_{LR} - GDP_0}$, from (8)

$$\lambda = \frac{GDP_t - GDP_0}{GDP_{LR} - GDP_0} = \frac{(GDP_t - GDP_{LR}) + (GDP_{LR} - GDP_0)}{GDP_{LR} - GDP_0)} = 1 - e^{-\alpha t}$$

Then the time needed to close λ percent of the gap (or half-life $\lambda = 0.5$) is:

$$t = -\frac{\ln(1-\lambda)}{\alpha} \text{ , } \alpha = 0.27 \text{ (see Text Table 4).}$$

---

ii. The terms of trade, public investment, and institutions have a positive effect on private investment in the long run. There is no evidence of public investment crowding out private investment in the short run. Credit to the private sector, supply factors, and the institutional framework significantly affect private investment in the short run. The positive impact of institutions on growth is confirmed by Ali (1997) and Ali and Crain (1999), who found that economic freedom is a more robust determinant of growth than are political freedom and civil liberties.

iii. Interestingly, we find that the long-run response of private investment to public investment is 0.4, consistent with what Oshikoya (1994) found for Cameroon. However, he finds 0.54 for Morocco and 0.61 for Mauritius, while for the pooled middle-income countries the coefficient estimate is 0.10. This suggests that the elasticity of private-public investment elasticity in Benin is far from being among the lowest. It also indicates that there may be a specification problem, for instance the absence of the real exchange rate, which is not modeled here.

iv. The results demonstrate the complementarity of public and private investment. Both in theory and empirically the effect of public investment on private investment is mixed or ambiguous. For Benin both short- and long-run positive elasticity supports a crowding-in effect. This may work through the direct effects of productivity on public investment.

v. The limited impact of credit to the private sector on growth may be associated with the country's financial depth and structure. Although in recent years in Benin banks seem to have been profitable and have complied with prudential ratios, the financial markets are

still quite shallow: As measured by the ratio to GDP of broad money or of credit to the private sector, financial depth is more limited than the average for SSA (see Gulde et al., 2006).[32]

Variance decomposition

Text Table 5. Forcast-Error Variance Decomposition[1]

Horizon	Standard Error	Shock to				
		Terms of Trade	Public Investment	Credit to Private sect.	Private Investment	Supply Factor
		Variance decomposition of private investment				
Year 1	1.186	7.000	10.458	3.761	76.921	1.859
Year 2	1.297	7.134	10.997	3.715	65.605	12.549
Year 4	1.931	6.132	10.761	5.772	58.377	18.958
Year 6	2.275	3.918	11.702	7.949	51.637	24.795
Year 8	2.379	2.887	12.495	10.557	46.854	27.207
Year 10	2.532	1.530	12.506	12.594	45.900	27.471
		Variance decomposition of GDP				
Year 1	2.594	1.488	10.005	0.182	13.741	74.585
Year 2	2.867	1.428	10.578	0.368	16.447	71.179
Year 4	3.210	6.417	10.647	0.338	27.660	54.937
Year 6	3.716	7.326	11.036	0.361	25.412	55.865
Year 8	3.938	8.099	12.458	0.785	24.848	53.811
Year 10	4.091	8.458	12.434	0.778	26.138	52.192

[1] Based on structural factorization.

35.   As expected, both private investment and real GDP explain the predominance of their own shocks. In the period right after a shock, private investment explains about 77 percent of its own shocks and GDP about 75 percent of its own. The fact that private investment and GDP movements are explained by past values suggests that they have a significant lagged effect.

36.   The contribution of private investment to GDP growth appears to be large and lasting. The contribution of a shock to the supply factor on the private investment forecast error suggests that labor market and investment conditions have more impact on private investment forecast error than terms of trade, credit to the private sector, or and public investment. A shock to private investment apparently has the strongest and most lasting effect on GDP.

---

[32] Microfinance is not analyzed in this study because reliable detailed data are lacking. The statistics that are available indicate that more than 70 percent of microfinance institutions in Benin operate informally and that more people access financial services through microfinance institutions in Benin than in other sub-Saharan African countries. Microfinance institutions collect about 8.3 percent of total deposits and lend on average 17.4 percent of credits.

37.   Credit to the private sector has relatively little effect on GDP forecast error variance but is more significant for private investment. Although the impact of GDP forecast error variance remains below 1 percent, the portion of private investment forecast error variance attributable to credit to the private sector increases from about 3.8 percent to 12.6 percent, indicating the possibility that credit has an indirect output effect channeled through private investment. Finally, the limited effect may reflect the fact that credit in Benin tends to be short-term.

Historical decomposition

38.   The results of HD analysis support the previous findings on variance decomposition: since the 1990s public investment has become the most significant determinant of private investment. Supply factor[33] shocks were more marked in 1975–90, and the impact of credit, though significant, was relatively limited.

39.   Supply factors significantly affect private investment. Figure 3 suggests that private investment would have been higher if it had been driven by supply factors,[34] which had been a major influence on private investment until early in 1990, when central planning gave way to a market-oriented economy.

Figure 3. Benin: Historical Decomposition of Private Investment, 1975–2005 (Annual change)

Source: IMF staff estimates.
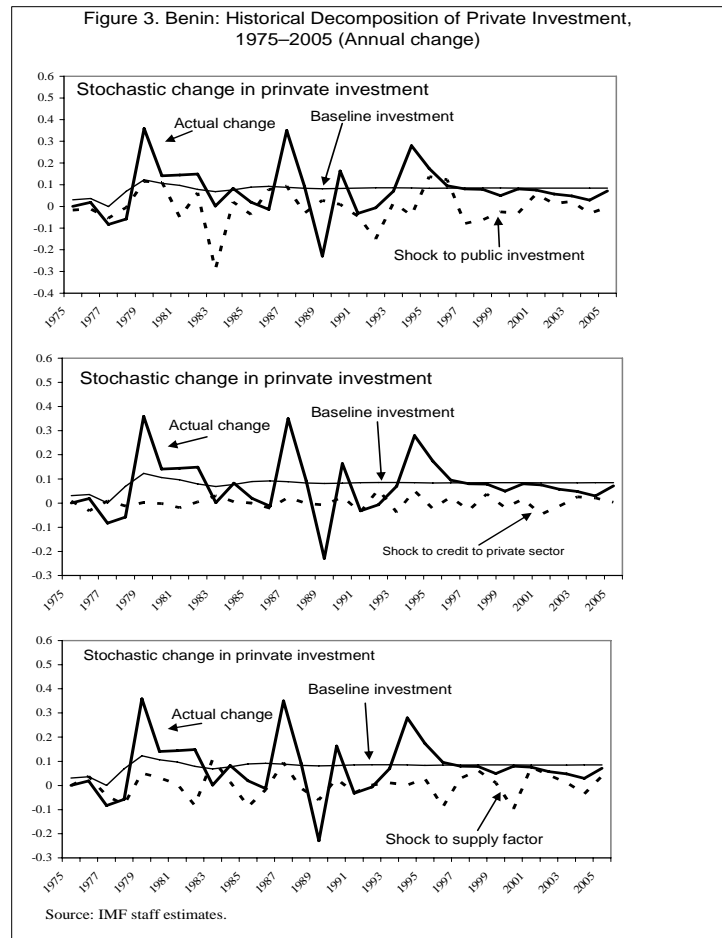
[33] Such as low labor cost, capital land, and physical capital stock.

[34]The institutional variable is not controlled for.

Impulse response function

40. Private investment overreacts to its own shock. Except for shocks to private investment, the GDP and private investment response is less than 1:1. Because investment is irreversible, any adverse shock could lead private investment to stop abruptly before resuming its decline. Though the response of private investment changes to a terms-of-trade shock is limited, the response to a private sector credit shock persists.

41. The IRF analysis confirms most of the VD analysis results. The GDP response to a private investment shock holds. GDP growth picks up in the first year after the shock, but in the sixth year after a slowdown, private investment is positively correlated with marginal comovement of the output response to public investment. Overall, though, the GDP change in response to a terms of trade shock is more pervasive and persistent than the change to private investment or private sector credit.

Figure 4. Impulse Response to a "*Shock*" in Terms of Trade, Public Investment, Credit to Private Sector, Private Investment, and GDP

Source: Fund staff estimates.
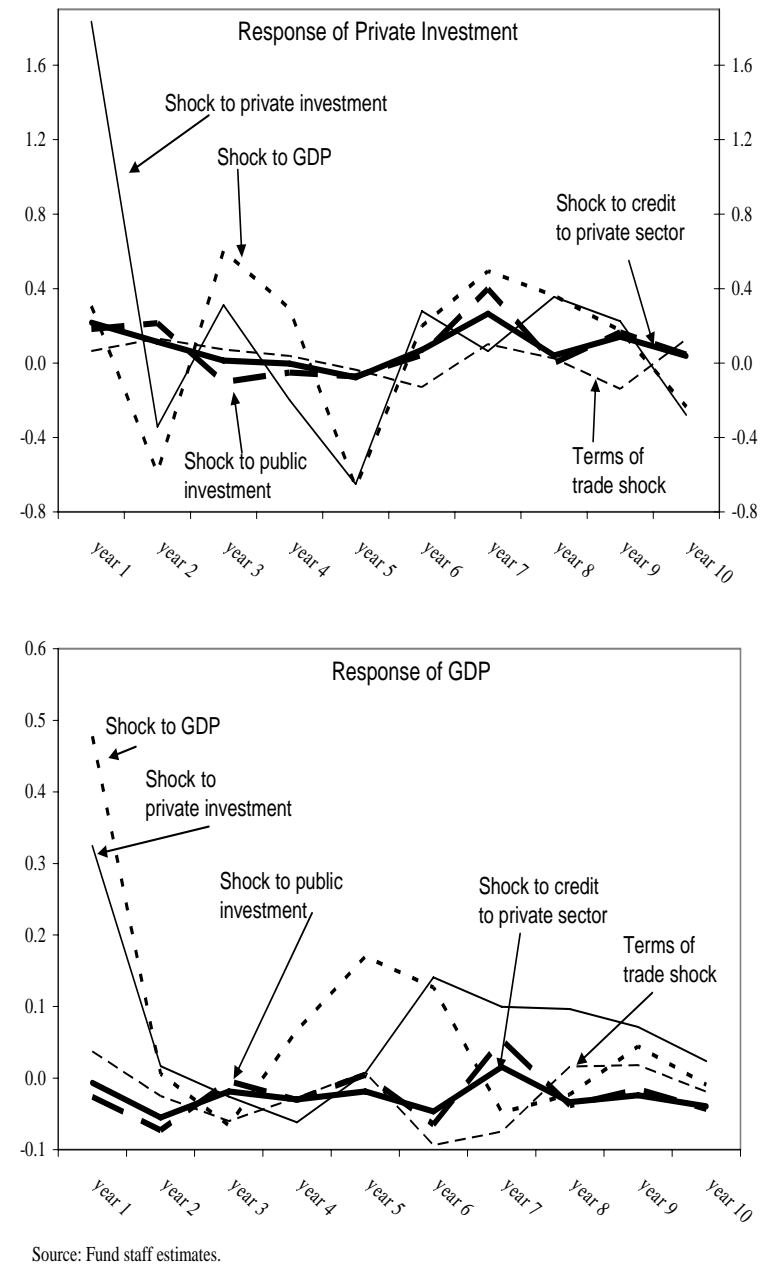
V.   IMPLICATIONS AND CONCLUSIONS

42.   We model investment and growth in Benin using a consistent set of VAR outputs; using annual data for 1965–2005, we employ a coherent set of structural VAR outputs. First, both the short- and the long-run elasticity of investment are estimated using a conditional parsimonious VECM. Second, we estimate HD, VD, and IRF statistics from a structural VECM.

43.   Institutional and regulatory frameworks, terms-of-trade developments, public investment, and credit to the private sector appear to have a positive impact on growth. It also appears that Benin's poor rating on the economic freedom index is an obstacle to private investment; the rating in turn reflects the relative weakness of its institutions and the slow pace of structural reforms. Cointegration analysis of speed of adjustment suggests that 27 percent of the deviation of GDP from its long-run equilibrium is corrected every year, so that it takes two to three years to cut the gap in half. Credit to the private sector indirectly affects growth through its impact on private sector investment; this effect, however, is short-lived, apparently because credit in Benin has tended to be short-term.

44.   In sum, controlling for the small sample size, the analysis proposes a policy-oriented approach to understanding the public and private investment nexus and its link to growth. The analysis comprises both backward analysis (parsimonious structural VECM and HD) and forward-looking outputs (VD and IRF). The results are consistent with those of recent studies.

45.   Thus, an empirical growth-oriented strategy should be able to pinpoint both short- and long-run relationships between economic fundamentals. This is of particular importance in understanding the public-private investment nexus and its effect on growth. It appears that the two types of investment have a complementary rather than a crowding-out effect.

46.   Under certain conditions, we find, both the short- and long-run effects of public and private investment on growth are positive. Furthermore, the HD and IRF suggest that growth in Benin is public-private-partnership-led, and that fiscal policy should avoid or limit any short-run private sector crowding-out effects. However, the analysis does not identify or discuss channels through which, say, public investment affects growth, such as conventional productivity, crowding-in, and crowding-out effects and other channels documented in Agénor and Moreno-Dodson (2006). A more challenging exercise would be to conduct an empirical micro-foundation and externality-based analysis. In fact, public investment may impact the informal sector, including microfinance institutions. Because we did not integrate these factors into the analysis, and because the share of the informal sector in output and financial services is increasing, a scaling up of public expenditure after HIPC and MDRI relief debt could have significant real impact beyond we can predict.

Appendix A: Variable Definitions and Data Sources

Data used in this study are available from the author on request. The primary data, although largely drawn from the World Bank Development Indicators, were prepared by the Beninese authorities. In most developing countries, data quality is poor, though since 1998, as statistical methodologies for the West African Economic and Monetary Union are harmonized, Benin has adhered to the General Data Dissemination System (GDDS); hence, data quality and timeliness of reporting have improved. The GDDS web site, which describes areas of improvement, can be accessed at http://dsbb.imf.org/Applications/web/gdds/gddscountrylist/.

GDP   Natural log of constant *GDP* at market price (constant prices 2000=100).

          Source: World Bank Development Indicators 2006

GINV   Natural log of public investment (constant prices 2000=100).

          Source: World Bank Development Indicators 2006

PINV   Natural log of private investment (constant prices 2000=100).

          Source: World Bank Development Indicators 2006

CRED   Natural log of credit to the private sector (constant prices 2000=100).

          Source: World Bank Development Indicators 2006

TOT   Natural log of trade volume index (Index 2000=100).

          Source: World Bank Development Indicators 2006

INST   Variable capturing institutional strength.

          Source: POLITY project alternative to Freedom House

Appendix B: Institution variable (INST)

We use the POLITY project's web site: http://members.aol.com/cspmgm(old URL: http://www.cidcm.umd.edu/polity) as an alternative to the Freedom House (http://www.freedomhouse.org) measure of freedom or democracy, as measured by various political system variables, including democracy (DEMOC) and autocracy (AUTOC).

$$DEMOC_t = DEMOC_t^{r=1} * \frac{function(GDP_t)}{function(GDP_t^{r=1})} * DEMOCM_t$$

$$AUTOC_t = AUTOC_t^{r=1} * \frac{function(GDP_t)}{function(GDP_t^{r=1})} * AUTOCM_t$$

$DEMOCM_t$ and $AUTOCM_t$ are respectively, multipliers of $DEMOC_t$ and $AUTOCM_t$.

We note INST, the POLITYDEMOC variable equal to democracy – autocracy + 10, a measure that runs from 0 to 20.

The following is drawn from the POLITY (POLITY 2) project Dataset Users Manual (see Marshall and Jaggers, 2002).

Institutionalized Democracy: Democracy is conceived as three essential, interdependent elements: (i) the presence of institutions and procedures through which citizens can effectively express preferences about alternative policies and leaders; (ii) the existence of institutionalized constraints on the exercise of power by the executive; and (iii) the guarantee of civil liberties to all citizens in their daily lives and in acts of political participation. Other aspects of plural democracy, such as the rule of law, systems of checks and balances, freedom of the press, and so on are means to, or specific manifestations of, these general principles. The democracy indicator is an additive 11-point scale (0-10).

Institutionalized Autocracy: This refers to the more neutral term autocracy and defines it in terms of the presence of a distinctive set of political characteristics. In mature form, autocracies sharply restrict or suppress competitive political participation. An 11-point autocracy scale is constructed additively.

POLITY 2 is a combined POLITY score revised to facilitate use of the POLITY regime measure in time-series analyses. The POLITY score is computed by subtracting the AUTOC score from the DEMOC score; the resulting scale ranges from +10 (strongly democratic) to !10 (strongly autocratic).

Appendix C: Statistical Tests and Results

Appendix Table 1. Unit Root Tests, 1965–2005

	Levels (with constant and trend)		First difference (with constant)	
	Dickey-Fuller test	Phillips-Perron test	Dickey-Fuller test	Phillips-Perron test
TOT	-2.23	-2.27	-6.97***	-8.91***
GINV	-2.2	-2.26	-2.83	-3.63**
PINV	-1.47	-1.46	-6.96***	-11.58***
GDP	-1.75	-1.72	-5.89***	-5.97***
CRED	-1.26	-1.48	-5.50***	-5.63***
INST	-2.45	-2.45	-3.26*	-3.35*

MacKinnon critical values for Dickey-Fuller and Phillips-Perron test are
1 percent = -4.2050; 5 percent = -3.5266; 10 percent = -3.1946

* Rejection of the null hypothesis (unit root) at 10 persent level
** Rejection of the null hypothesis (unit root) at 5 persent level
*** Rejection of the null hypothesis (unit root) at 1 persent level

Appendix Table 2. Optimal Lag Length

Significance of each lag 1/		Significance of all lags up to 4		
Lag 4	0.79730 [0.7470]	Lag 4 - 4	F(36,33)	0.79730 [0.7470]
Lag 3	0.92976 [0.5860]	Lag 3 - 4	F(72,43)	1.0871 [0.3893]
Lag 2	1.0227 [0.4759]	Lag 2 - 4	F(108,47)	1.3715 [0.1125]
Lag 1	1.7858 [0.0479]*	Lag 1 - 4	F(144,48)	8.6101 [0.0000]**

1/ F-Statistics, F(36,33)

Appendix Table 3. Residual Analysis of Unrestricted VAR(2)

	Multivariate model	LTOT	LGINV	LPINV	LCRED	LGDP	INST
AR 1-2 test 1/	1.20 [0.24]	1.28 [0.36]	1.31 [0.30]	0.05 [0.95]	1.81 [0.19]	0.93 [0.41]	1.32 [0.29]
Normality 2/	2.33 [0.31]	1.50 [0.47]	2.69 [0.26]	2.56 [0.28]	3.98 [0.14]	4.56 [0.10]	0.77 [0.68]
ARCH 1-1 3/	N.A.	1.02 [0.32]	0.07 [0.79]	0.01 [0.93]	0.70 [0.41]	0.46 [0.50]	0.01 [0.93]
Hetero test 3/	0.22 [1.00]	0.03 [1.00]	0.09 [1.00]	0.04 [1.00]	0.04 [1.00]	0.13 [1.00]	0.08 [1.00]

1/ F(2,24) test uses for individual variables and F(72,54) for multivarriate model statistics critical values.
2/ Chi^2(2) tesr uses for individual variables and Chi^2(12) for multivarriate model statistics critical values.
3/ F(1,24) test uses.
4/ F(24,1) test uses for individual variables and F(252,21) for multivarriate model statistics critical values.

Appendix Table 4. Unrestricted Cointegration Rank Tests 1/

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Prob.**
None	0.6889	116.62	[0.001]**
At most 1	0.60008	73.42	[0.023]*
At most 2	0.39311	39.51	[0.243]
At most 3	0.26657	21.03	[0.366]
At most 4	0.21308	9.56	[0.322]
At most 5	0.018623	0.7	[0.404]

1/ Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

(*) and (**) denotes rejection of the hypothesis at the 0.1 and 0.05 level

respectively. 41 observations from 1965 - 2005.

Test assumes no intercepts and no trend.

The test is carried with two lags in VAR(6).

Appendix Table 5. AR, Normality, and Heteroschedasticity Tests
(Endogenous variables of retain model)

Variable	Statistic	Empirical value
	AR 1-2 test	
DLGINV	$F(2,26)$	1.17675 [0.33172]
DLPINV	$F(2,26)$	1.0881 [0.3517]
DLGDPR	$F(2,26)$	1.1891 [0.3205]
Overall	$F(18,62)$	1.11169 [0.4272]
	Normality test	
DLGINV	$Chi^2(2)$	4.1666 [0.1245]
DLPINV	$Chi^2(2)$	4.4208 [0.1403]
DLGDPR	$Chi^2(2)$	4.6703 [0.0968]
Overall	$Chi^2(6)$	5.009 [0.317]
	Heteroschedasticity test	
DLGINV	$F(16,13)$	0.51667 [0.8944]
DLPINV	$F(16,13)$	0.55957 [0.8648]
DLGDPR	$F(16,13)$	0.98801 [0.5163]
Overall	$F(96,52)$	0.76737 [0.8688]

Appendix Table 6. Structural Model / Long-Run Matrix.

	Coefficient	Std. Error	z-Statistic	Prob.
C(51)	0.311774	0.012827	24.30662	0.00000
C(32)	2.256391	0.154673	14.5881	0.00000
C(42)	0.410929	0.047935	8.572693	0.00000
C(52)	0.675861	0.047281	14.29444	0.00000
C(43)	-0.394492	0.10197	-3.868698	0.00010
C(53)	0.296516	0.024207	12.24921	0.00000
C(63)	-1.086297	0.226408	-4.797953	0.00000
C(24)	0.372954	0.06073	6.141146	0.00000
C(64)	1.44096	0.080704	17.8549	0.00000
C(25)	1.206314	0.058477	20.6287	0.00000
C(35)	2.910962	0.037685	77.2443	0.00000
C(45)	0.49015	0.042782	11.45696	0.00000
C(46)	0.404006	0.058044	6.96031	0.00000

$$C = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & C_{24} & C_{25} & 0 \\ 0 & C_{32} & 1 & 0 & C_{35} & 0 \\ 0 & C_{42} & C_{43} & 1 & C_{45} & C_{46} \\ C_{51} & C_{52} & C_{53} & 0 & 1 & 0 \\ 0 & 0 & C_{63} & C_{64} & 0 & 1 \end{bmatrix}$$

Included observations: 36 after adjustments

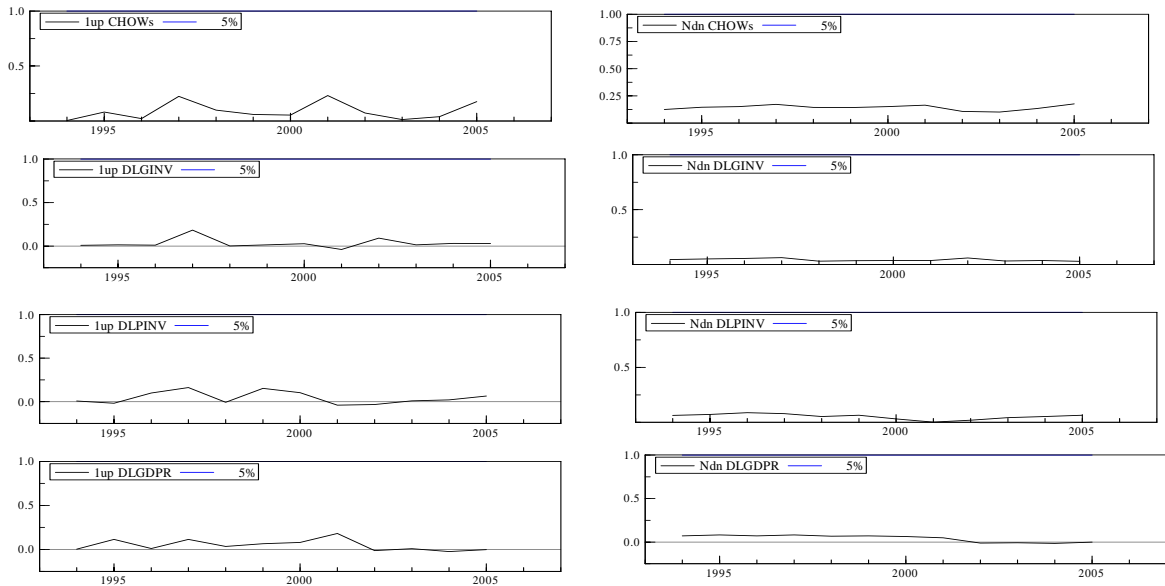Model: Ae = Bu where E[uu']=I, and B=I
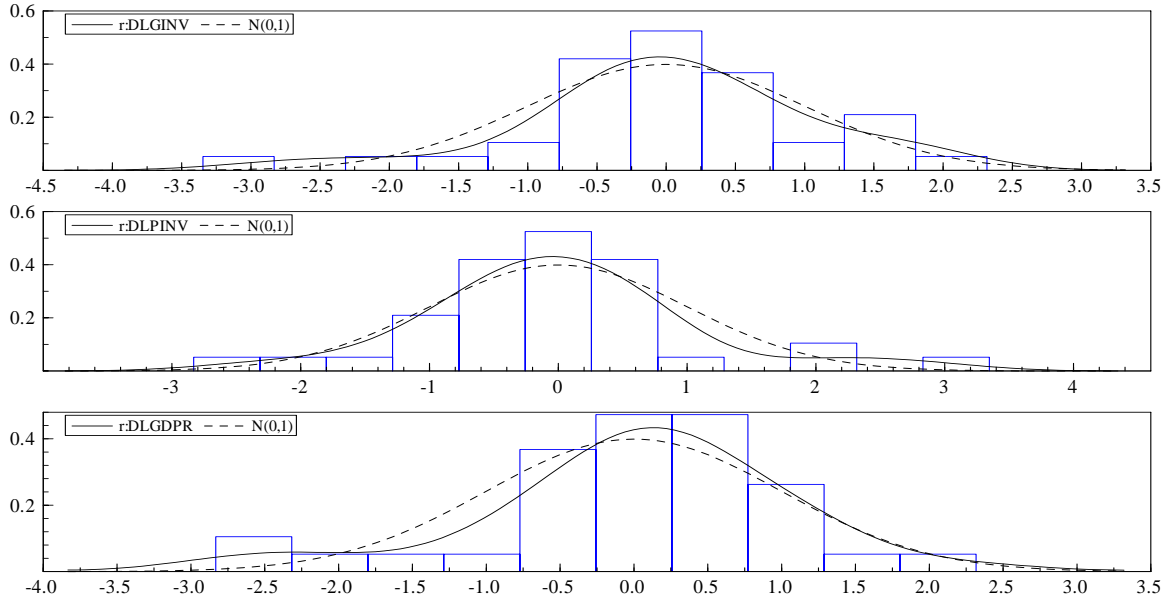
Appendix Figure 1. Time Series of Cointegration Vectors
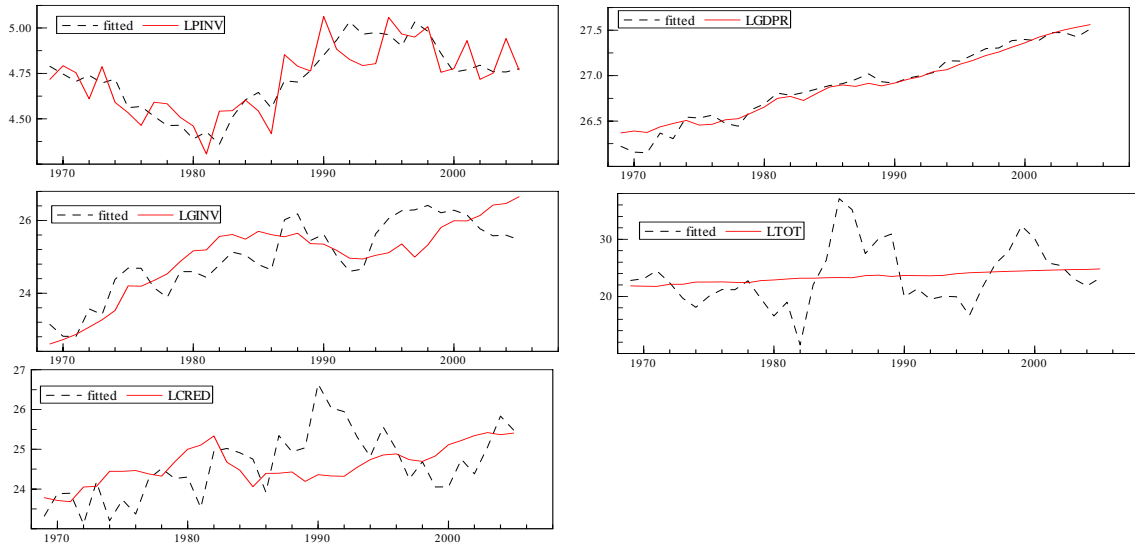
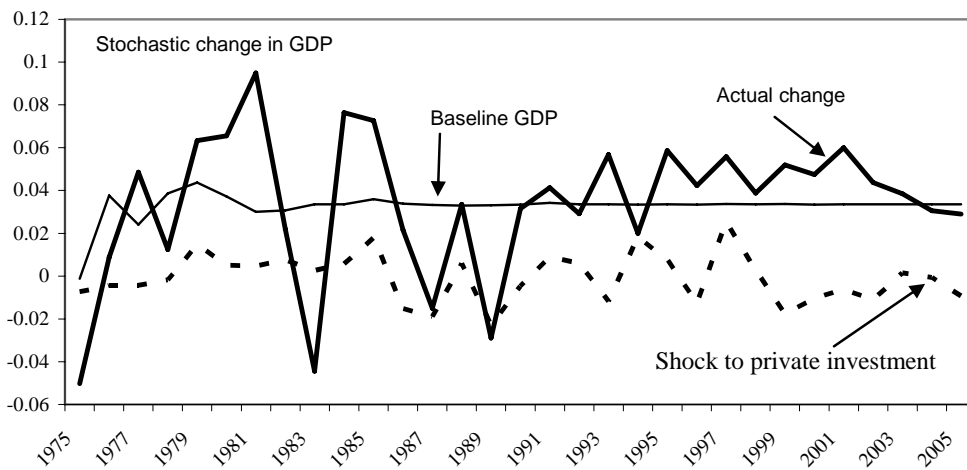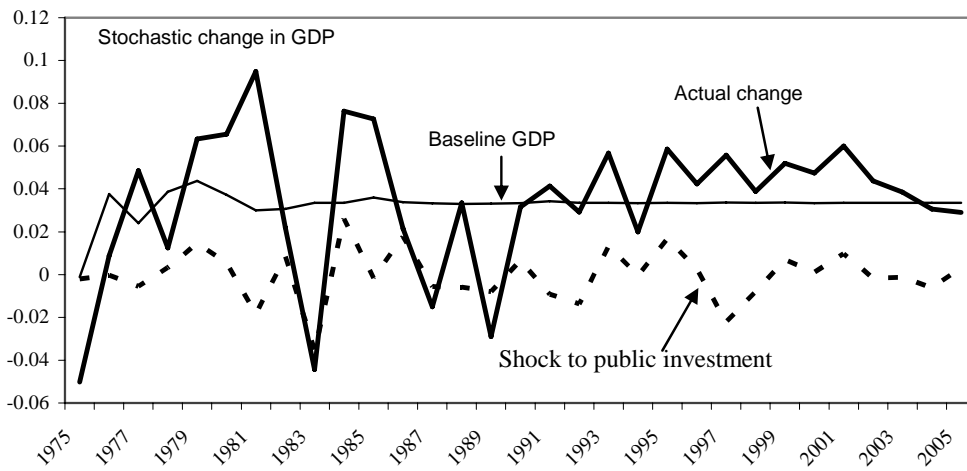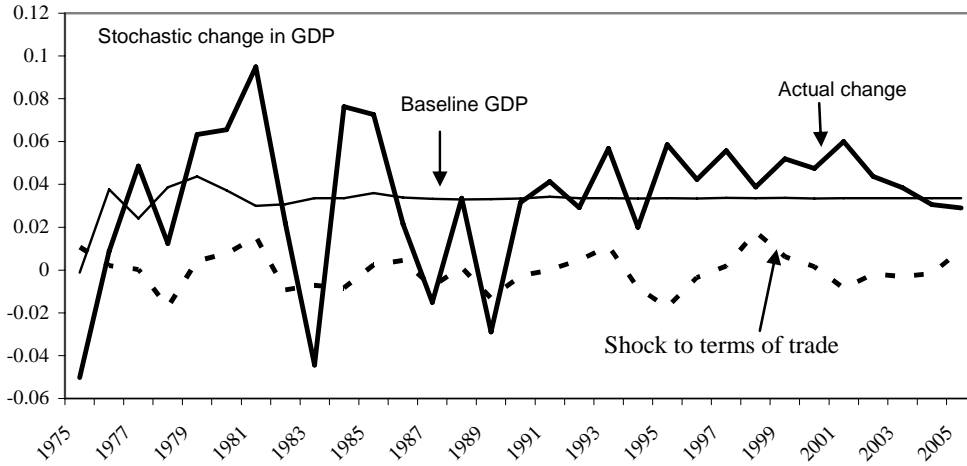Appendix Figure 2. Cointegration Analysis: Recursive Eigenvalues
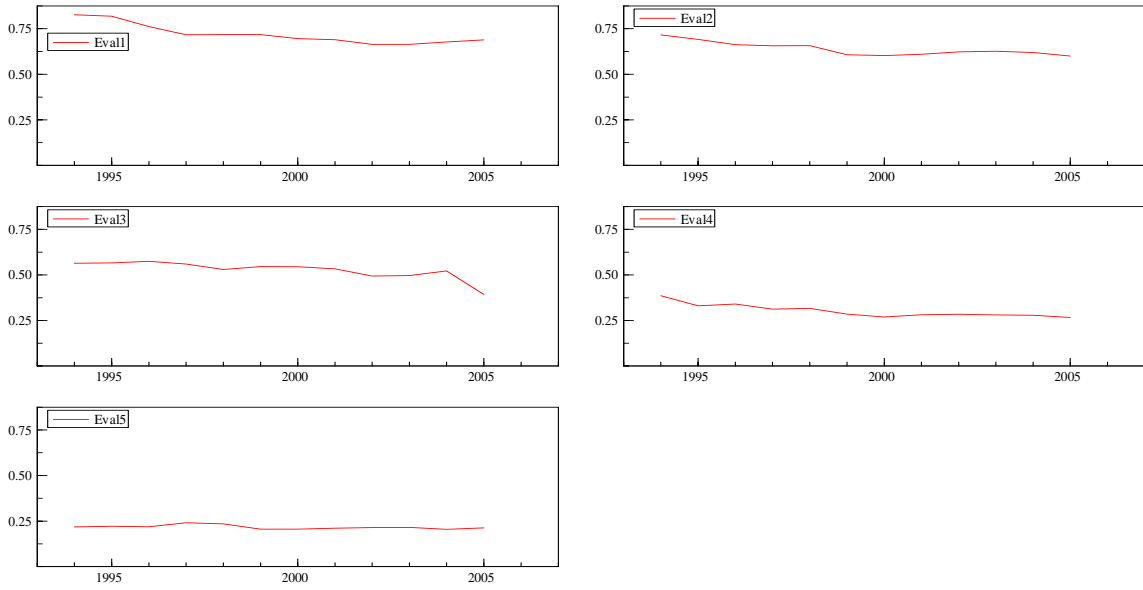
Appendix Figure 3. Recursive Constancy Statistics

Appendix Figure 4. Residual Normality Tests

Appendix Figure 5. Benin: Historical Decomposition of GDP, 1975 - 2005
(Annual change)

Source: Staff estimate.

References

Agénor, Pierre-Richard, Alejandro Izquierdo, and Henning Tarp Jensen, 2006, "A Theory of Infrastructure-led Development," Working Paper No. 83, Centre for Growth and Business and Business Cycle Research (Oxford: Blackwell Publishing).

Agénor, Pierre-Richard, and Blanca Moreno-Dodson, 2007, "Public Infrastructure and Economic Growth: New Channels and Policy Implications," in *Public Expenditure,* ed. by Maura Francese, Daniele Franco, and Raffaela Giordano (Rome: Banca d'Italia).

Ali, Abdiweli, 1997, "Economic Freedom, Democracy, and Growth," *Journal of Private Enterprise,* Vol. 13 (fall), pp. 1–20.

———, and W. Mark Crain, 2001, "Political Regimes, Economic Freedom, Institutions, and Growth," *Journal of Public Finance and Public Choice,* Vol. 19 (1), pp. 3–22.

———, 2002, "Institutional Distortions, Economic Freedom, and Growth," *Cato Journal,* Vol. 21 (3), pp. 415–26.

Altug, S., 1989, . "**Time-to-Build and Aggregate Fluctuations: Some New Evidence**," International Economic Review, Department of Economics, University of Pennsylvania and Osaka University Institute of Social and Economic Research Association, vol. 30(4), pages 889-920, November.

———,1993, "Time to Build, Delivery Lags, and the Equilibrium Pricing of Capital Goods," *Journal of Money, Credit, and Banking*, Vol. 25, pp. 301–19.

Bar-Ilan, A., and W. A. Strange, 1996, "Investment Lags," *American Economic Review,* Vol. 86, pp. 610–22.

Blair Commission for Africa, 2005, http://www.africanprogress.net/Blair_Commission.htm

Blejer, Mario, and Mohsin Khan, 1984, "Government Policy and Private Investment in Developing Countries, *IMF Staff Papers,* Vol. 31, pp. 379–403.

Breitung, J., S. Chirinko, and U. von Kalckreuth, 2003, "Vectorautoregressive Investment Model (VIM) and Monetary Policy Transmission: Panel Evidence from German Firms," Economic Research Centre of the Deutsche Bundesbank, Discussion Paper (Berlin**:** Deutsche Bundesbank).

Calamitsis, A. Evangelos, Anupam Basu, and Dhaneshwar Ghura, 1999, "Adjustment and Growth in Sub-Saharan Africa*,*" IMF Working Paper 99/51 (Washington: International Monetary Fund).

Casero, A. Paloma, and A. Varoudakis, 2004, *Growth, Private Investment, and the Cost of Doing Business in Tunisia: A Comparative Perspective* (Washington: World Bank)*.*

Chiang, Alpha C., 1984, *Fundamental Methods of Mathematical Economics,*
 3rd edition (New York: McGraw-Hill).

Dailami, M. and Giugale, M., April 1991, "Reflection on Credit Policy in Developing
Countries: Its Effect on Private Investment" PRE Working Paper Series, WPS654.

Dawson, John W., 1998, "Institutions, Investment and Growth: New Cross-Country and
 Panel Data Evidence," *Economic Inquiry,* Vol. 36 (4), pp. 603–19.

Devarajan, S., W. Easterly, and H. Pack, 1999, "Is Investment in Africa Too High or Too
 Low? Macro and Micro Evidence," *Journal of African Economies*, Vol. 10,
 supplement 2, pp. 81–108.

Ghura, Dhaneshwar, and Michael T. Hadjimichael, 1996, "Growth in Sub-Saharan Africa,"
 IMF Staff Papers, Vol. 43 (September), pp. 605–34.

Greene, Joshua, and Delano Villanueva, 1991, "Private Investment in Developing Countries:
 An Empirical Analysis, *IMF Staff Papers,* Vol. 38 (1), pp. 33–58.

Gulde, Anne-Marie, Catherine Pattillo, Jakob Christensen, Kevin Carey, and Smita Wagh,
 2006, *Sub-Saharan Africa: Financial Sector Challenges* (Washington: International
 Monetary Fund).

 Guncavdi, Oner, Michael Bleaney, and Andrew McKay, 1998, "Financial Liberalization and
 Private Investment: Evidence from Turkey," *Journal of Development Economics,*
 Vol. 57, pp. 443–55.

Gunning, J.W., and T. Mengistae (1999), "Determinants of African Manufacturing
 Investment: The Microeconomic Evidence," *Journal of African Economies*, Vol. 10,
 Supplement 2, pp. 48–80.

Gupta, Sanjev, Robert Powell, and Yongzheng Yang, 2006, *Macroeconomic Challenges of
 Scaling Up Aid to Africa: A Checklist for Practitioners* (Washington: International
 Monetary Fund).

Gwartney, James D., Robert A. Lawson, and Randall G. Holcombe, 1999, "Economic
 Freedom and the Environment for Economic Growth," *Journal of Institutional and
 Theoretical Economics,* Vol. 155, pp. 643–63.

Gwartney, James D., Robert A. Lawson, and Dexter Samida, 2000, *Economic Freedom of the
 World: 2000 Report* (Vancouver: Fraser Institute).

Hendry, D. F., 1995a, *Dynamic Econometrics* (Oxford: Oxford University Press).

———, 1995b, "Econometrics and Business Cycle Empirics," *Economic Journal,*
 Vol. 105, pp. 1622–36.

———, 1996, "On the Constancy of Time-series Econometric Equations," E*conomic and Social Review*, Vol. 27, No. 5, 401–22.

———, 2000, "Epilogue: The Success of General-to-Specific Model Selection," in in *Econometrics: Alchemy or Science? Essays in Econometric Methodology*, ed. by D. F. Henry (Oxford: Oxford University Press).

———, and H.-M. Krolzig, 1999, "Improving on 'Data Mining Reconsidered' by K. D. Hoover and S. J. Perez," *Econometrics Journal*, Vol. 2,No. 2, pp. 202–19.

International Monetary Fund, "Public Investment and Fiscal Policy—Lessons from Pilot Country Studies," Fiscal Affairs Department (in consultation with other departments, the World Bank, and the Inter-American Development Bank) available at: http://www.imf.org/external/np/pp/eng/2005/040105a.htm.

———, 2005, 2008, "Private Investment Dynamics and Growth in Benin," IMF Country Report No. 08/84 (Washington: IMF).

Johansen, S., 1991, "Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models," *Econometrica,* Vol. 59, pp. 1551–80.

———, 1995, *Likelihood-based Inference in Cointegrated Vector Autoregressive Models* (London: Oxford University Press).

———, and K. Juselius, 1992, "Testing Structural Hypotheses in a Multivariate Cointegration Analysis of the PPP and the UIP for the UK," *Journal of Econometrics,* Vol. 53, pp. 211–44.

Juselius, Katarina, 2006, *The Cointegration VAR Model: Methodology and Applications* (New York: Oxford University Press).

Khan, Mohsin, and Manmohan S. Kumar, 1997, "Public and Private Investment and the Growth Process in Developing Countries, *Oxford Bulletin of Economics and Statistics,* Vol. 59, pp. 69–88.

King, R.G., C.I. Plosser, J.H. Stock, and M.W. Watson, 1991, "Stochastic Trends and Economic Fluctuations," *American Economic Review,* Vol. 81, pp. 819–40.

Kydland, Finn E., and Edward Prescott, 1982, "Time to Build and Aggregate Fluctuations," *Econometrica*, Vol. 50 (November), pp. 1345–70.

Liedholm, C., M. McPherson, and E. Chuta (1994), "Small Enterprise Employment Growth in Rural Africa," *American Journal of Agricultural Economics*, Vol. 76, No. 5, pp. 1177–82.

Lutkepohl, H., and M. Kratzig, 2004, *Applied Time Series Econometrics* (Cambridge: Cambridge University Press).

Marshall, G. Monty, and Keith Jaggers, 2002. *Polity IV Project Political Regime Characteristics and Transitions, 1800–2002; Dataset Users' Manual.* http://members.aol.com/cspmgm

Mataya, C.S., and M.M. Veeman, 1996, "The Behaviour of Private and Public Investment in Malawi," *Canadian Journal of Economics*, Vol. 29, Special issue: Part 2, pp. S438–S442.

Odedokun, Matthew O., 1997, "Relative Effects of Public Versus Private Investment Spending on Economic Efficiency and Growth in Developing Countries," *Applied Economics,* Vol. 29, pp. 1325–36.

Oshikoya, Temitope W., 1994, "Macroeconomic Determinants of Domestic Private Investment in Africa: An Empirical Analysis," *Economic Development and Cultural Change,* Vol. 42, pp. 573–96.

Pattillo, Catherine, and Paul Cashin, 2000, "Terms of Trade Shocks in Africa: Are They Short-Lived or Long-Lived?" IMF Working Paper 00/72 (Washington: International Monetary Fund).

Pesaran, M.H. and Shin, Y., 1998, "Generalised impulse response analysis in linear multivariate models, *Economic Letters*, **58**, 1, 17-29.

Ramirez, Miguel D., 2000, "The Impact of Public Investment on Private Investment Spending in Latin America: 1980–95," *Atlantic Economic Journal,* Vol. 28 (2), pp. 210–25.

Serven, Luis, 1998, "Macroeconomic Uncertainty and Private Investment in LDCs: An Empirical Investigation," photocopy (Washington: World Bank).

Shapiro, Matthew D. and Watson, Mark W., 1988-89. "**Sources of Business Cycle Fluctuations**," NBER Working Papers 2589, National Bureau of Economic Research, Inc.

United Nations Millennium Project, 2005, **http://www.unmillenniumproject.org/**

World Bank, 2005, *World Development Report 2005: A Better Investment Climate for Everyone* (Washington: World Bank).

———, 2006, *West and Central Africa: Strategies for Cotton Sector Development in West and Central Africa–Towards a Regional Textile and Garment Industry* (Washington: World Bank).

Zhou, Chunsheng, 2000, "Time-to-Build and Investment," *Review of Economics and Statistics,* Vol. 82, No. 2, pp. 273–82.