KAPSARC

مركز الملك عبدالله للدراسات والبحوث البترولية

King Abdullah Petroleum Studies and Research Center

Sectoral investment analysis for Saudi Arabia

Muhammad Javid, Fakhri J. Hasanov, Carlo Andrea Bollino, Marzio Galeotti

March 2021

Doi: 10.30573/KS--2021-DP011

About KAPSARC

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is a non-profit global institution dedicated to independent research into energy economics, policy, technology and the environment across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

This publication is also available in Arabic.

Legal Notice

Key Points

This study aims to investigate the determinants of short- and long-run investment behavior in Saudi Arabia for eight non-oil sectors. Saudi Arabia is currently proceeding with its historic Vision 2030 reform plan, which aims to significantly increase the private sector's contribution to the country's gross domestic product. Thus, analyzing investments at the sectoral level is important for Saudi Arabia. Such an analysis can provide policymakers with a deeper understanding of potential opportunities for boosting private sector growth.

This study therefore uses a cointegration and equilibrium correction approach to empirically analyze investments by sector over the period from 1989–2017. We identify a long-run relationship among investments, output and the real interest rate for all sectors except agriculture. Additionally, the real exchange rate has long-run relationships with investments in the agriculture, non-oil manufacturing and other services sectors.

This study focuses on private investment, meaning that the resulting policy recommendations are mostly relevant for private decision-makers. Nevertheless, the government can play a role in achieving the desired level of investments in non-oil sectors.

> Decision-makers may consider that investments in different non-oil sectors in Saudi Arabia react differently to their theoretically-predicted determinants. This finding implies that sector-specific tailored investment policies are preferable to a one-size-fits-all investment policy.

> The government can create additional demand for a sector's goods and services through current and capital spending. Government spending can expand a sector's economic activity and, thus, investments in that sector

> The government may wish to reduce the share of imports in its purchasing and prioritize locally-produced goods and services.

> The government may consider imposing additional import fees and tariffs so that Saudi economic agents can switch to domestically-produced goods and services.

> The authorities may consider further enhancing export-oriented policies to increase foreign demand for non-oil sectors' goods, boosting their investments.

> The real interest rate may be useful for decision-makers looking to impact long-run sectoral investment decisions. It may be especially useful in such sectors as other services, distribution, and transport and communication.

1. Introduction

Investment is crucial for the economy and economic policy. By increasing an economy's productive capacity, it not only contributes to economic performance over the business cycle but also improves the economy's long-run growth prospects. According to Dornbusch, Fischer, and Startz (2014), countries with high growth rates devote a substantial fraction of their output to investment. For example, Singapore, Korea and China all grew rapidly owing to their high investment rates. In contrast, Bangladesh, Burundi, Ethiopia and Malawi, for example, have had low investment rates and remain less developed. It is therefore important for countries to utilize capital investments to drive their growth prospects. This motivation is particularly relevant for fast-growing, young and emerging economies.

It is crucial for policymakers to have a coherent and comprehensive understanding of the determinants of investment and their quantitative impacts. Such an understanding is necessary to design an appropriate set of policies to trigger investment and spur economic growth. This study therefore aims to provide policymakers with a state-of-the-art analysis of investment in Saudi Arabia. To achieve this aim, we investigate the literature on both theoretical specifications and empirical estimations of investment behavior.

Studying investment in mature, industrialized economies is less interesting from applied macroeconomics and econometric analysis perspectives. Such economies have little or no demographic growth, and investment is mainly used to replace existing capital stock or develop completely new technologies (e.g., information technology, the Internet of Things and artificial intelligence). Replacement is theoretically straightforward, and new technologies are breakthroughs with no past data for conducting efficient econometric estimations. Furthermore, investment tends to be the most volatile component of expenditures over the business cycle, making it more difficult to study and predict (Aizenman and Marion 1999).

On the contrary, Saudi Arabia features fast demographic expansion, rapid gross domestic product (GDP) growth and vast economic diversification programs. For example, Saudi Arabia is currently proceeding with its historic Vision 2030 reform plan. This program's strategic macroeconomic pillars aim to increase the private sector's contribution to GDP from 40% to 65%. The plan also targets raising the share of non-oil exports in non-oil GDP from 16% to 50% and reducing unemployment from 12% to 7%. These formidable challenges require massive investments. Thus, it is crucial to analyze investment's role in promoting long-run production capacity expansion and sustaining robust and healthy long-term growth. Such analyses may be particularly important to policymakers.

Despite the importance of studying investment in Saudi Arabia, macroeconomic analyses of such investments have not received attention in the literature. This paper makes four contributions to the literature. First, we econometrically analyze the determinants of Saudi Arabia's fixed investments. Specifically, we investigate the impacts of output, real interest rates and real exchange rates on investment in the short and long terms.

Second, we analyze investments at the sectoral level. To the best of our knowledge, this study is the first to investigate investment in Saudi Arabia by sector. We estimate different intensities and sectoral speeds of adjustment (SoA) of investment. The latter measures the speed at which investment returns to its long-run equilibrium after a short-run perturbation and is a relevant instrument for policy recommendations. This study focuses on non-oil sectors, which are the main focus of the government's diversification strategy. This sectoral analysis is particularly important for Saudi Arabia because we can provide policymakers, businesses and academics with a deeper understanding of potential growth opportunities. Sector-level growth and investment trends have important implications for future overall development strategies. Understanding differences by sector is necessary to choose the most effective policy allocation in the presence of resource constraints.

Third, we utilize data from recent years. Our data cover a period in which a low oil price regime emerged and the Saudi government implemented major domestic energy price and fiscal reforms. Fourth, we provide a new empirical framework that incorporates non-stationarity and cointegration. Previous studies on investment largely fail to account for these issues.

The rest of this paper is organized as follows. We review the literature in Section 2. Section 3 illustrates the empirical framework and the econometric methodology. Section 4 describes the data and the variables used in the investigation, and Section 5 presents the estimation results. Section 6 summarizes the empirical results and provides a discussion. Section 7 concludes.

2. Literature review

The modern study of investment began in the 1930s, when the Great Depression inflicted widespread economic suffering on Europe and America. At this time, a theory of the business cycle was greatly needed to understand the drivers of the downturn. John Maynard Keynes responded to that need with “The General Theory of Employment, Interest and Money,” which he wrote in 1936 (Keynes 1936). Investment is the component of aggregate demand that falls the most in business cycle downturns. Thus, it was a natural candidate for Keynes to consider in searching for the causes of declines in demand.

To this day, the underlying principles of Keynes’s theory of investment remain the basis for the study of investment behavior. His theory states that investment is the result of firms balancing the expected return on new capital with the cost of capital. This cost depends primarily on the real interest rate. This study focuses on fixed investment. Economists usually reserve the term ‘fixed investment’ for transactions that increase real aggregate wealth in an economy. These transactions typically involve the purchase (or production) of new real durable assets, such as factories and machines. The fixed investment category that receives the most attention is business fixed investment, which refers to businesses’ purchases of new structures and equipment for production.

Appendix A presents developments in investment theory and updates to the main specifications of the investment function developed in subsequent research since Keynes. In this section, we describe the most recent results that are most relevant for Saudi Arabia. Our literature review shows that analyses of investment behavior in developing countries, particularly those in Arab countries, are scarce. The main reason for this lack of studies on emerging countries is the limited availability of suitable data for econometric analysis.

In a macroeconomic framework, investment is a crucial component of aggregate demand. Thus, it is both a determinant of GDP and a variable driven by aggregate demand. The few studies that have been conducted focus on both directions of analysis. Mann and Sephton (2015) estimate several vector error correction models (VECMs) to determine the impacts of various types of spending on Saudi Arabia’s real non-oil GDP. They use aggregate annual data from 1971 to 2012 for their analysis and consider private investment, defense, education, health care and housing expenditures. Mensi et al. (2018) estimate nonlinear autoregressive distributed lag models of quarterly data from 1992 to 2014. They analyze the impacts of private investment, public investment, oil production and inflation on Saudi Arabia’s non-oil GDP.

Elheddad (2019) investigates a dataset of greenfield foreign direct investment (FDI) inflows to the six Gulf Cooperation Council countries during the period 2003–2013. He finds that sectoral FDI positively affects public domestic investment and negatively affects private investment. Bolbol and Omran (2005) provide an interesting investigation of the effects of stock returns, cash flow and sales as determinants of fixed investment. They use data for 83 firms in five Arab countries from 1996 to 2001. The study finds that cash flow has no effect on investment, possibly because of the dividend policy. Moreover, the growth rates of investment and sales are only weakly related.

Additionally, some related studies focus on other developing countries. Acosta and Loza (2005) empirically estimate an error correction model of changes in investment as a function of changes in output for Argentina. The long-run solution implies that investment and output have a linear relationship. In the short term, the exchange rate, the change in public investment, and external debt and domestic financing conditions significantly determine investment. Here, the change in public investment is an indicator of crowding out, and external debt and domestic financing conditions indicate risk.

Meyer, Manete, and Muzindutsi (2017) examine the effects of government expenditure and sectoral investment on economic growth in South Africa. The consider the mining, manufacturing and financial sectors and use quarterly time series data from 1995 to 2016. The VECM results indicate that in South Africa, financial sector investment is the only significant driver of short-run economic growth. The long-run results, in contrast, show that only manufacturing sector investment has a positive impact on economic growth. Government spending is found to have a minimal effect on economic growth.

3. Empirical specification and econometric methodology

The specification of the investment equation to be estimated must account for the nature and availability of the data for empirical analysis. Our main goal is to estimate separate investment equations for different sectors of the Saudi economy. Thus, we need to analyze sectoral data. The set of available variables that can be included in the econometric specification is somewhat limited as a result.

More importantly, because we consider time series data, we must consider the stationarity of the variables before performing the analysis. According to integration and cointegration theory, the variables in an empirical model have a stable long-run relationship if two conditions apply. Namely, they must all be integrated of order one, and their linear combination must be integrated of order zero. The final specification of the investment equation therefore depends on the results of the stationarity analysis.

Appendix B thoroughly reviews the various empirical specifications for investment equations that have been advanced in the literature. Here, we summarize the main features of the proposed specification for this study. This specification is the best option because it balances coherence with the theory and data availability.

The investment function is based on a general linear relation between investment and its main long-run determinants. We also develop an error correction mechanism (ECM) to account for short-run dynamics. In the general linear relationship, we use a log-linear representation for all variables except the real interest rate. Thus, the long-run relationship between investment and its determinants is as follows:

$$inv_t = a_0 + a_1 gva_t + a_2 RI_t + a_3 rer_t + w_t. \quad (1)$$

Here, inv, gva and rer are the logarithms of real fixed investment, real value added and the real exchange rate, respectively. RI is the real interest rate. We choose these regressors based on the literature review in Appendix A.

In practice, actual investment may deviate from the right-hand side of (1) in the short run. To account for such deviations, we assume that discrepancies are corrected on a period-by-period basis. We model this dynamic process using an ECM, which we estimate via a two-step process. First, we construct the equilibrium correction term (ECT):

$$ECT_t = inv_t - \hat{a}_0 - \hat{a}_1 gva_t - \hat{a}_2 RI_t - \hat{a}_3 rer_t. \quad (2)$$

Here, the terms with hats are the estimated values of the parameters in (1). In the second step, we use the ECT to estimate the ECM. This model embeds the long-run ECT into the short-run dynamics as a function of changes in the independent and dependent variables, as follows:

$$\Delta inv_t = b_0 + b_1 ECT_{t-1} + \sum_{i=1}^{n} c_i \Delta inv_{t-i} + \sum_{i=0}^{m} d_i \Delta gva_{t-i} + \sum_{i=0}^{p} f_i \Delta RI_{t-i} + \sum_{i=0}^{q} g_i \Delta rer_{t-i} + v_t. \quad (3)$$

Note that deterministic regressors, such as time trends and dummy variables, can be included in both the long-run (2) and short-run (3) equations. These terms can capture technological changes, structural developments, shocks and other unusual factors that may be relevant (e.g., Hendry and Juselius [2000]; Juselius [2006]; Pesaran, Shin, and Smith [2001]).

To estimate (3), we follow the general-to-specific modeling (GTSM) approach and use automatic model selection (AMS) (Doornik 2009; Doornik and Hendry 2009, 2018; Santos, Hendry, and Johansen 2008). AMS combines GTSM, impulse indicator saturation (IIS) and step indicator saturation (SIS), making it more powerful than conventional modeling devices.

IIS and SSI automatically capture all one-time, temporary or permanent breaks in a modeled variable's time path. Thus, the modeler does not need to know how many breaks occurred or when they occurred.

With this approach, we first include all potentially relevant variables and their lags and leads based on the theoretical framework. The result of this step is referred to as a general unrestricted model. This approach then selects a specific model, the final ECM, by excluding statistically insignificant variables and comparing the standard errors of the regressions. We perform tests for autocorrelation, serial correlation, normality, heteroscedasticity, misspecification and encompassing as well as IIS and SIS if needed.

4. Data, variable construction and descriptive statistics

We estimate investment equations for eight sectors of the Saudi Arabian economy. The sectors for which data are available are as follows, with codes in parentheses.

- Agriculture and forestry (*AGR*)
- Construction (*CON*)
- Distribution: Retail, wholesale, hotels and catering (*DIS*)
- Finance, insurance, real estate and business services (*FIBU*)
- Manufacturing (*MANNO*)
- Other services: Community, social and personal services (*OTHS*)
- Transport and communication (*TRACOM*), excluding pipeline transportation of hydrocarbons
- Utilities (*U*)

We obtain annual time series data for these sectors for the period 1989–2017, as shown in Table 1.

Table 1. Descriptions and sources of the variables

Variable code	Description	Source
INV	Non-energy private gross fixed capital formation, excluding fixed investments in private dwellings (millions of Saudi riyals at 2010 prices).	OE June 2019 release
GVA	Gross value added (millions of Saudi riyals at 2010 prices).	GaStat via SAMA Yearly Statistics
RI	Real interest rate, calculated as the nominal interest rate (three-month interbank lending rate) minus the inflation rate. The inflation rate is calculated as percentage rate of change in the GDP deflator. The GDP deflator is calculated as the ratio of nominal to real GDP, in percentage terms.	Three-month interbank lending rate is taken from the OE June 2019 release. Nominal and real GDPs are collected from GaStat via SAMA Yearly Statistics
RER	Real exchange rate, calculated as the nominal exchange rate between Saudi riyals and United States (U.S.) dollars multiplied by the ratio of the U.S. GDP deflator to the Saudi GDP deflator. An increase in this value indicates a depreciation of the riyal against the dollar.	Nominal exchange rates are taken from SAMA Yearly Statistics.The U.S. GDP deflator of 2012=100 is taken from the OE June 2019 release and converted to a base year of 2010.

Notes: OE=Oxford Economics Global Economic Modeling Database; SAMA=Saudi Arabian Monetary Authority; GaStat=General Authority of Statistics.

We denote investments and gross value added in sector *X* as '*INVX*' and '*GVAX*'. Here, *X* indicates the sectors listed above (i.e., *AGR, CON, DIS, FIBU, MANNO, OTHS, TRACOM* and *U*). For example, *INVAGR* and *GVAAGR* indicate investment and value added, respectively, in the agriculture sector.

Figures 1 and 2 show the natural logarithms of investments and value added in each of the eight sectors. Figure 3 plots the interest rate and the natural logarithm of the real exchange rate over time. Lowercase letters indicate the natural logarithmic expression of a given variable.

Figure 1. Time profile of the natural logarithm of investment by sector

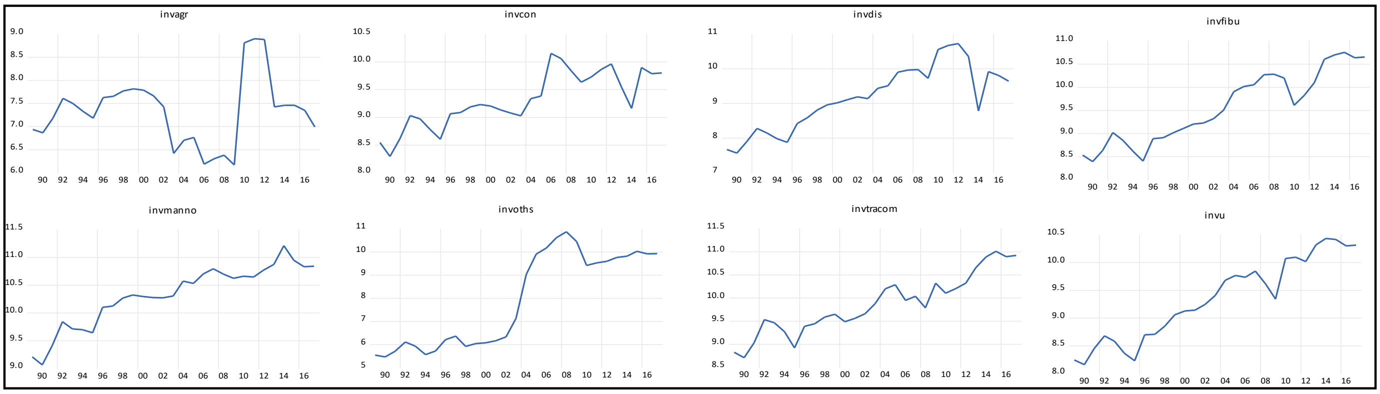

Figure 2. Time profile of the natural logarithm of value added by sector

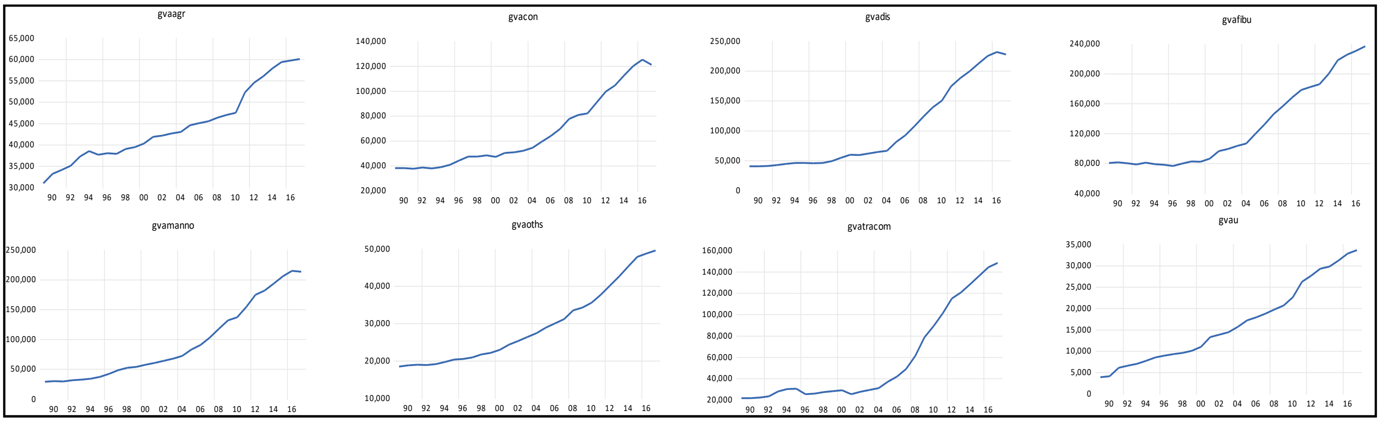

Figure 3. Time profiles of the real interest rate and the logarithm of the real exchange rate

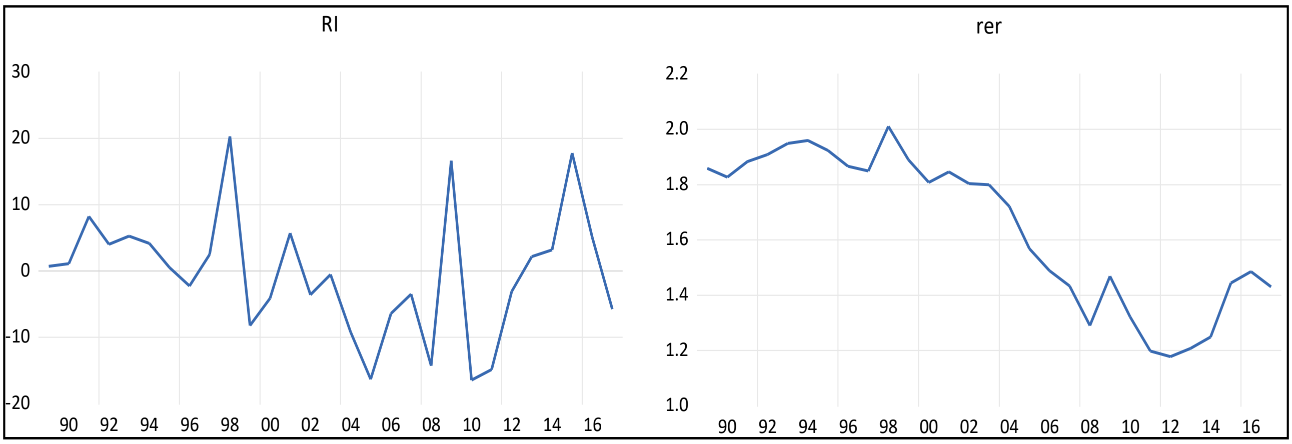

Table 2 presents descriptive statistics of the variables used in the econometric estimations and tests.

Table 2. Descriptive statistics of the variables

	invagr	*invcon*	*invdis*	*invfibu*	*invmanno*	*invoths*	*invtracom*	*invu*
MEAN	1.99	9.31	9.16	9.56	10.32	7.91	9.86	9.34
ST.DEV.	0.10	0.49	0.93	0.77	0.55	2.04	0.64	0.74
	gvaagr	*gvacon*	*gvadis*	*gvafibu*	*gvagov*	*gvamanno*	*gvaoths*	*gvau*
MEAN	10.68	11.02	11.34	11.69	11.24	10.23	10.72	9.54
ST.DEV.	0.19	0.41	0.64	0.41	0.69	0.33	0.69	0.62

	RI	*rer*
MEAN	-0.38	1.64
ST.DEV.	9.36	0.27

We make a few general observations. The investment series by sector are more volatile than the value added series are. Investments in agriculture, other services, distribution, and financial and business services are more volatile than those in construction, non-oil manufacturing, utilities, and transport and communication. From 1989 to 2017, investment grew the most in the other services sector and the least in the agriculture sector. Thus, we can essentially categorize the sectors into two groups. The first includes fast-growing sectors with higher variability, such as the other services and distribution sectors. The second includes sectors with more stable growth, such as the non-oil manufacturing, utilities, and transport and communication sectors.

The gross value added plots indicate a generalized acceleration of the economy around 2005 for several sectors, excluding the agriculture, utilities and other services sectors. This trend is in line with the developmental stages of the Saudi economy. The non-oil economy grew rapidly from 2004 to 2014, mainly owing to government spending fueled by high oil prices in international energy markets. Similarly, sectoral trend lines, particularly for agriculture, construction, distribution and non-oil manufacturing, have either flattened considerably or even declined since 2015. The decline in oil prices after 2015 has reduced government expenditures (e.g., Al-Moneef and Hasanov [2020]; Hasanov, AlKathiri, et al. [2020]; Hemrit and Benlagha [2018]).

Table 3 reports the average ratio of investment to value added by sector for five-year sub periods and the entire sample period. As expected, this ratio is larger for utilities, transport and manufacturing.

Table 3. Ratios of investment to value added by sector

Years	**Statistic**	*AGR*	*CON*	*DIS*	*FIBU*	*MANNO*	*OTHS*	*TRACOM*	*U*
1989-1993	*MEAN*	0.04	0.16	0.07	0.08	0.43	0.02	0.40	0.84
	ST.DEV.	0.01	0.05	0.02	0.02	0.12	0.00	0.12	0.09
1994-1998	*MEAN*	0.05	0.18	0.09	0.08	0.50	0.02	0.41	0.60
	ST.DEV.	0.01	0.03	0.03	0.02	0.06	0.01	0.12	0.11
1999-2003	*MEAN*	0.05	0.19	0.15	0.11	0.49	0.03	0.55	0.79
	ST.DEV.	0.02	0.02	0.01	0.01	0.05	0.01	0.07	0.07
2004-2008	*MEAN*	0.01	0.28	0.19	0.19	0.47	0.95	0.58	0.94
	ST.DEV.	0.00	0.09	0.02	0.01	0.06	0.50	0.24	0.11
2009-2013	*MEAN*	0.09	0.19	0.20	0.14	0.29	0.50	0.31	0.87
	ST.DEV.	0.06	0.03	0.06	0.05	0.02	0.29	0.06	0.20
2014-2017	*MEAN*	0.03	0.11	0.07	0.16	0.23	0.40	0.33	0.84
	ST.DEV.	0.02	0.05	0.02	0.07	0.13	0.07	0.16	0.37
1989-2017	*MEAN*	0.05	0.19	0.13	0.13	0.41	0.32	0.44	0.84
	ST.DEV.	0.04	0.06	0.06	0.05	0.11	0.42	0.15	0.17

5. Empirical results

Before presenting the results, we note again that gross investment, value added and the real exchange rate data are converted to natural logarithms before estimation. The real interest rate is not converted to a natural logarithmic form. Natural logarithms are denoted by lowercase letters.

As explained in the previous section, the first step of the econometric investigation is to check for the presence of a unit root. Tables 4 and 5 present the outcomes of augmented Dickey Fuller (ADF) (Dickey and Fuller 1979) and Phillips-Perron (PP) (Phillips and Perron 1988) tests, respectively. We conduct these tests on both the (log) levels of the variables and their first differences (i.e., their growth rates). The variables should be integrated of order one, that is, non-stationary in their levels and stationary in their first differences.

According to the ADF test statistics, we can conclude that the investment variables follow unit root processes. There is weak evidence that invfibu, invtracom and invu may be trend stationary. However, the null hypothesis of a unit root process cannot be rejected for these investment series at the 5% significance level. Moreover, the PP test results indicate that the null hypothesis of a unit root cannot be rejected for any of eight investment series.

However, the *ADF* and *PP* tests results both strongly reject the null hypothesis for first differences, suggesting that all of the investment variables are stationary in first differences. The evidence also invariably point to I(1) processes in all sectors for value added and for the real exchange rate. Thus, we can conclude that all of these variables follow unit root processes. In contrast, the real interest rate follows a I(0) process according to both tests' results.

Table 4. *ADF* unit root test

	Levels				First Differences		
	t-statistic	*C*	*T*	*k*	**t-statistic**	*C*	*k*
Invagr	-2.506	x		0	-5.134a	c	0
Invcon	-3.071	x	x	0	-5.740a	x	0
Invdis	-2.401	x	x	0	-6.390a	x	0
invfibu	-3.454c	x	x	1	-4.807a	x	2
Invmanno	-2.473	x	x	0	-5.635a	x	0
Invoths	-2.327	x	x	1	-2.818a		0
invtracom	-3.349c	x	x	0	-5.787a	x	2
invu	-3.426c	x	x	0	-5.576a	x	1
Gvaagr	-1.925	x	x	0	-4.634a	x	0
Gvacon	-2.304	x	x	0	-3.172b	x	0
gvadis	-1.908	x	x	1	-2.585	x	0
gvafibu	-2.738	x	x	1	-2.774c	x	0
gvamanno	-2.649	x	x	1	-3.000b	x	0
gvaoths	-2.793	x	x	0	-2.823c	x	0
gvatracom	-1.571	x	x	1	-3.037b	x	0
gvau	-3.317	x	x	0	-5.014a	x	0
RI	-4.781a			0			
rer	-1.804	x	x	0	-4.957a	x	0

Notes: (*i*) The maximum lag order is set to two, and the optimal lag order (*k*) is selected based on the Schwarz criterion. (*ii*) The letters *a*, *b* and *c* indicate rejection of the null hypothesis of a unit root at the 1%, 5% and 10% significance levels, respectively. (*iii*) The critical values for the tests are taken from MacKinnon (1996). (*iv*) The letters *C* and *T* represent the presence of an intercept and a trend, respectively, in the test regressions. (*v*) The letter x indicates that the corresponding option is selected in the final unit root test equation. (*vi*) The estimation period is 1989 to 2017.

Table 5. *PP* unit root test

	Levels			First Differences	
	t-statistic	*C*	*T*	**t-statistic**	*C*
Invagr	-2.590	x		-5.134a	
Invcon	-2.866	x	x	-6.581a	x
Invdis	-2.369	x	x	-7.005a	x
invfibu	-2.165	x	x	-4.555a	x
Invmanno	-1.846	x	x	-6.513a	x
Invoths	-1.703	x	x	-2.771a	
invtracom	-3.140	x	x	-5.925a	x
invu	-3.123	x	x	-8.988a	x
Gvaagr	-2.240	x	x	-4.635a	
Gvacon	-2.280	x	x	-3.172b	x
gvadis	-2.068	x	x	-2.580c	x
gvafibu	-2.545	x	x	-2.755c	x
gvamanno	-2.491	x	x	-2.946c	x
gvaoths	-2.878	x	x	-2.750c	x
gvatracom	-1.384	x	x	-3.005b	x
gvau	-3.710b	x	x		
RI	-4.778a				
rer	-1.908	x	x	-4.957a	x

Notes: (*i*) The Newey-West automatic bandwidth criterion is used to select the optimal lag length in *PP* regressions. (*ii*) The letters *a*, *b* and *c* indicate rejection of the null hypothesis at the 1%, 5% and 10% significance levels, respectively. (*iii*) The letters *C* and *T* represent the inclusion of an intercept and a trend, respectively, in the test regressions. (iv) The letter *x* indicates that the corresponding option is selected in the final unit root test equation. (*vi*) The estimation period is 1989 to 2017.

Given these test results, we next assess whether the variables under scrutiny have a long-term relationship. To that end, we use the autoregressive distributed lagged bounds testing (*ARDL-BT*) approach. Thus, we initially estimate the *ARDL* equation (1) for each sector except transport and communication. Given the short time span of our sample, we choose a maximum lag order of two to estimate equation (3). Table 6 reports the cointegration test results and the estimated long-run elasticities or coefficients.[1]

5. Empirical results

Table 6. Long-run estimation and cointegration test results

Regressor \ Sector	*AGR*	*CON*	*DIS*	*FIBU*	*MANNO*	*OTHS*	*TRACOM*	*U*
gva	2.78b	0.84a	1.07a	1.71a	0.80a	2.83a	0.96a	1.07a
RI		-0.02a	-0.06a	-0.01c	-0.03a	-0.14a	-0.04a	-0.01b
rer	2.99a				0.85c	-2.38a		
C	-27.6c	0.16	-2.75c	-10.3a	-0.05	-16.81b	-0.37	-0.87
F-statistics	2.87$	5.86**	5.84**	4.39***	6.69*	25.6*	29.79&	9.19*

Notes: (*i*) The letters a, b and c indicate significance at the 1%, 5% and 10% levels, respectively. (*ii*) *C* denotes the intercept. (*iii*) The F-test is the bounds test for cointegration. (*iv*) *, ** and *** indicate that the null hypothesis of no cointegration is rejected at the 1%, 5% and 10% significance level, respectively. '$' indicates the value of the chi-square sample statistic from the added variables cointegration test developed by Park (1992). '&' indicates the value of the trace statistic from the Johansen reduced rank approach. *A* probability of 0.006 indicates rejection of the null hypothesis of no cointegration at the 5% significance level.

The last row of Table 6 shows the cointegration test results for the eight sectors. For all but the agriculture and transport and communication sectors, the numerical values in this row are the sample F-statistics from *ARDL* bounds testing. These F-statistics indicate that the null hypothesis of no cointegration can be rejected in favor of the alternative hypothesis of cointegration for these six sectors.

The F-statistics for agriculture and transport and communication are instead estimated using *CCR* and *VAR*, respectively. For the agriculture sector, the bounds testing results suggest the existence of cointegration between investment, value added and the real exchange rate. However, the *ARDL* estimation does not provide meaningful results, whereas a *CCR*-based estimation and cointegration test does. Thus, we report the *CCR* estimation and test results in Table 6. The value of 2.87 shown in the table is the chi-square sample statistic of the added variables cointegration test using a probability of 0.24. This test was developed by Park (1992). The null hypothesis of this test is that cointegration among the tested variables exists. The probability value obtained from the test indicates that the null hypothesis of cointegration cannot be rejected. In other words, the test indicates that investment, value added and the real exchange rate have a long-run relationship in the agriculture sector. The results for the transport and communications sector are also reported in Table 6.[2]

The cointegration test results indicate that sectoral investment establishes a long-run relationship with value added in all sectors. The real interest rate enters the long-run relationship among the variables in all sectors except the agriculture sector. The real exchange rate is also part of the long-run relationships in the agriculture, non-oil manufacturing and other services sectors. Table 6 shows that the estimated long-run relationships for all sectors are theoretically interpretable and statistically significant.

As both investment and value added are expressed in logarithms, the estimated coefficients in Table 6 correspond to long-run elasticities. Thus, in the financial and other services sectors, a 1% increase in value added leads to long-run increases in gross investment of 1.7% and 2.8%, respectively. For distribution and utilities, the corresponding elasticities are slightly greater than one. In the remaining sectors, investment is inelastic relative to value added. All of the coefficients of the real interest rate are negative, as expected, and these semi-elasticities are very small in the long run. Finally, the real exchange rate has a small positive impact in the non-oil manufacturing sector and a large negative effect in the other services sector.

Saudi Arabia is an oil-based economy, and its economic indicators are largely influenced by fluctuations in the oil market. Such fluctuations occur for a variety of reasons, including economic crises, political instability in oil-producing countries and changes in policies, among others. Thus, Saudi Arabia's macroeconomic data may be subject to outliers over time caused by external oil market conditions and domestic policy changes(see Figure 1). If such outliers are present in the data generation process but are not captured in the econometric analysis, the estimations may be less accurate. We therefore use dummy variables for different years in the short-run analysis.

Table 7 presents the final *ECM* specifications estimated using the *GTSM* strategy. The table shows that all of the SoA coefficients are negative, less than one in absolute value, as expected, and statistically significant. These results confirm the validity of the *ECM* specification, as the long-run relationships among the variables are not stable otherwise. Additionally, the Engle-Granger theorem shows that if the variables are cointegrated, then an equilibrium correction representation of the long-run relationship should exist.

Table 7. Final ECM specifications by sector

Regressor \ *Sector*	*AGR*	*CON*	*DIS*	*FIBU*	*MANNO*	*OTHS*	*TRACOM*	*U*
ECT_{t-1}	-0.16^{c}	-0.50^{a}	-0.27^{b}	-0.41^{a}	-0.66^{a}	-0.15^{a}	-0.15^{b}	-0.36^{b}
C		-0.01		0.04	-0.05	0.03	0.11^{b}	0.07^{b}
Δinv_{t-1}			0.14	0.32^{c}		0.33^{a}		
Δinv_{t-2}					1.31*c*			
Δri_{t}		-0.01^{b}	-0.02^{a}		-0.01^{b}	-0.02^{a}		-0.01^{a}
Δri_{t-1}								
Δri_{t-2}			-0.01^{b}					
Δgva_{t}					1.08^{b}			
Δgva_{t-1}	1.00^{b}							
Δgva_{t-2}	-1.40^{a}							
ΔDP2014		-0.50^{a}	-1.29^{a}					
DP2014						0.34^{a}		
DP2006		0.66^{a}					-0.47^{b}	
DP2010				-0.55^{a}		-1.04^{a}		
DP2004						1.32^{a}		
DP2003	-1.07^{a}							
DP1995							-0.47^{b}	
DP2008								-0.35^{b}
ΔDP1995								-0.25^{b}
ΔDST1012	1.99*a*							
HET	0.95 (0.50)	0.49 (0.84)	1.17 (0.36)	0.20 (0.89)	0.57 (0.72)	0.77 (0.58)	0.41 (0.75)	0.73 (0.58)
JB	0.54 (0.76)	0.02 (0.99)	0.82 (0.66)	0.11 (0.95)	0.56 (0.75)	2.21 (0.33)	0.19 (0.91)	0.32 (0.85)
RR	1.61 (0.12)	0.63 (0.54)	0.21 (0.84)	0.26 (0.80)	0.85 (0.40)	0.07 (0.94)	0.07 (0.95)	0.61 (0.55)

Notes: (*i*) The letters *a*, *b* and *c* indicate significance at the 1%, 5% and 10% levels, respectively. (*ii*) Impulse dummies are used for certain sectors, as follows: DP2014 for *CON, DIS* and *MANO*; DP2010 for FIBU; DP2004-08 for OTHS; and DP1995 and DP2013-14 for U. Here, DPXXXX takes a value of one for the year XXXX and a value of zero otherwise. (*iii*) HET indicates the White test for heteroscedasticity. JB indicates the Jarque–Bera normality test. RR indicates Ramsey's misspecification test. The values in parentheses are p-values.

Table 7 shows that all of the ECT coefficients are negative, as expected. The coefficients range from -0.15 to -0.66. The SoA to equilibrium after a shock is low in the distribution, other services and transport and communication sectors. In the construction, finance and non-oil manufacturing sectors, the SOA is higher. For instance, the non-oil manufacturing sector adjusts approximately 66% of the way back to the long-run equilibrium one year after a shock. The table also shows the short-run coefficients that are statistically significant, most notably for the real interest rate. The model also passes all of the diagnostic tests for heteroscedasticity (White heteroskedasticity test), the normality of the errors (Jarque-Bera test) and misspecification (Ramsey regression equation specification error test).

6. Discussion

This section discusses the results of our empirical analysis. The unit root test results, reported in Tables 4 and 5, indicate that the logarithm levels of the sectoral investment and value-added series are non-stationary. The logarithm of the real exchange rate is also non-stationary, whereas the real interest rate is found to be stationary in levels. Non-stationarity means that the mean, variance and covariance of a given variable change over time. Non-stationary variables do not follow mean-reverting processes. In other words, any shocks caused by policymakers or socioeconomic and other processes create permanent changes. Non-stationary variables may also share a common stochastic trend. In this case, they have a long-run relationship, that is, they are cointegrated.

Table 6 shows that the variables under consideration for each sector are cointegrated. In other words, the variables form meaningful relationships that can be interpreted consistently with economic theory. Hence, it is useful to estimate numerical values for these relationships and use them to inform decision-making processes. Table 6 presents the estimated long-run coefficients of the investment equation for the sectors considered in this analysis. Theoretically, we can interpret the sectoral investments determined by the long-run relationship shown in Table 6 as the investments that provide the desired level of capital.

To keep the discussion of these results brief and informative, we organize it by explanatory variable rather than by sector, as we consider eight sectors. In all sectors, value added has a statistically significant and theoretically expected long-run impact on investment. The magnitudes of the estimated elasticities of value added with respect to investment are around unity in the construction, distribution, non-oil manufacturing, transport and communications, and utilities sectors. Numerically, in the long run, a 1% increase in value added leads to an approximately 1% increase in investment in these sectors, keeping other factors constant. The corresponding elasticities for the agriculture, financial and other services sectors are around two. Ceteris paribus, a 1% increase in value added causes 2.8%, 1.7% and 2.8% expansions in investment in these respective sectors. The positive impact of value added on investment is intuitive to understand. An expansion in economic activity and the resulting increases in income and profits allow investors to increase their investments. We note that an income increase leads to more investment in the agriculture, other services and financial sectors than in other sectors in Saudi Arabia.

We find that the real interest rate has a negative and statistically significant impact on investment in all sectors except the agriculture sector. As discussed in the theoretical framework section, economic agents reduce their investments when the cost of capital is high. Conversely, they are encouraged to invest more if the cost of capital is low. Investments' reactions to changes in the aggregate real interest rate have different magnitudes in different sectors. The coefficient of the real interest rate ranges from -0.01 to -0.04 for the financial, utilities, construction, non-oil manufacturing, and transport and communication sectors. This coefficient is relatively higher for the distribution sector. Investments in the other services sector are the most sensitive to changes in the real interest rate. A one percentage point increase (decrease) in the former causes a 14% decrease (increase) in the latter, holding other factors unchanged.

We find no impact of the real interest rate on investment in the agriculture sector. We believe this result is because the government heavily subsidizes and incentivizes this sector. Hence, market drivers, such as interest rates, have little influence over private investment decisions in the sector. The government has some valid reasons for providing these incentives, such as food security, rural development and economic diversification. Studies conclude that the government incentive programs play positive roles in the agriculture sector (Al-Shayaa, Baig, and Straquadine 2012; Alyousef and Stevens 2011; Grindle, Siddiqi, and Anadon 2015; Mousa 2018; Tuncalp and Yavas 1983). Additionally, Hasanov and Shannak (2020), among others, find that the agriculture sector is very capital-intensive. Using data from 1988 to 2014, they estimate that the capital elasticity of the agricultural value added is close to unity. They also find that the labor elasticity is very small. These findings suggest another explanation for the insignificant impact of the interest rate in the agriculture sector. Regardless of the cost of capital (i.e., the interest rate), the agriculture sector requires a certain amount of investment determined by its nature.

Similar explanations can apply to the small effect of the real interest rate on investment in the utilities sector. This sector is mostly under government control in Saudi Arabia and is capital-intensive by nature. Hasanov et al. (2020) estimate the capital elasticity of output in this sector to be 0.66 for 1996–2016. Indeed, the necessary investments to expand this sector to meet the growing demand for utilities are very likely to be made even if the cost of capital is high. Utilities is a strategic sector, as it provides electricity, water and gas to the country. Thus, the government intervenes when needed by providing either soft loans or other measures of support.

The real interest rate likely has a small impact on investment in the financial sector because this sector is more labor-intensive than capital-intensive. For example, Hasanov et al. (2020) estimate the labor elasticity of output in this sector to be 0.78. Hence, the financial sector is not considerably influenced by changes in the cost of capital.

The real interest rate also has a small impact on investment (-0.02) in the construction sector. This sector's activity is largely driven by government bids and contracts, as a significant portion of government spending is directed to this sector. The average share of government spending in total spending for non-residential building and other construction was 68% during 2013–2017 according to GaStat data (2017). Consequently, the government has a stake in achieving a certain development level in this sector, including private investments, to successfully complete its projects. Additionally, government support may cause the relatively moderate impacts of interest rates on investment in the non-oil manufacturing and transport and communication sectors.

Conversely, the other services (community, social and personal services) and distribution (retail, wholesale, hotels and catering) sectors are mostly privately owned. These sectors receive less government support. Thus, their investments are more responsive to changes in the real interest rate compared to those in the other sectors discussed above.

Next, we find that the real exchange rate's long-run impact on investment is statistically significant and theoretically interpretable in the agriculture, non-oil manufacturing and other services sectors. The effect is positive for the former two sectors and negative for the latter sector. Numerically, a 1% rise in the real exchange rate causes 2.99% and 0.85% increases in investments in the agriculture and non-oil manufacturing sectors. In the other services sector, investment declines by 2.38% if the real exchange rate rises by 1%. Theoretical aspects of the impact of exchange rate changes on aggregate and sectoral investments are well-documented in the literature. Goldberg (1993), Campa and Goldberg (1995) and Harchaoui, Tarkhani, and Yuen (2005), among others, provide relevant discussions. Additionally, Goldberg (1993) discusses differences in the effects of exchange rate movements on tradable and non-tradable sectors from a theoretical perspective.

The exchange rate used in this study is riyals per U.S. dollar in real terms. Thus, an increase in the exchange rate indicates a depreciation of the riyal. We find that a depreciation of the riyal increases investments in the agriculture and non-oil manufacturing sectors. This result is consistent with the theoretical discussions of the impact of exchange rate movements on tradable sectors in the above-mentioned studies. The reasoning is that when the riyal depreciates in real terms, Saudi Arabia's agriculture and non-oil manufacturing products become more attractive to foreign purchasers. Increased exports of these tradable goods lead profits and income to rise, enabling these sectors to expand investment to meet the increased demand for their products. The opposite relation holds when the riyal appreciates in real terms (i.e., export revenues decline). Thus, investment opportunities in the agriculture and non-oil manufacturing sectors fall. For Saudi Arabia's agriculture sector, we do not think that the so-called location and wealth effects of exchange rate movements on domestic investment are valid (see Goldberg [1995] for a detailed explanation of the effects of exchange rates on investments). Both the nature of the sector and the harsh climate conditions make these two explanations less likely. However, location effect and wealth effect may be valid for non-oil manufacturing. Lower-cost labor from neighboring and other Southeast Asian countries (e.g., Pakistan, India, Philippines, Nepal and Bangladesh) is likely a factor in this sector. It turns out that the positive effect of the exchange rate depreciation on the agriculture investments stemmed from only the profit/cost effect of the exchange rate.

Our finding that a real exchange rate depreciation decreases investment in other services fits with the theoretical explanations documented in the above-mentioned studies. In Saudi Arabia, a depreciation in the riyal in real terms can negatively affect the other services sector through two main channels. The first is that a depreciation in the riyal expands tradable sectors, such as agriculture and manufacturing. High returns on capital and high wage rates in tradable sectors may shift investment and labor resources from the services sector to these sectors. Such a shift occurs if the substitution effect between these sectors holds. Additionally, according to the Balassa-Samuelson hypothesis, increased productivity in tradable sectors increases the price levels in non-tradable sectors (Balassa 1964; Samuelson 1964). Such price increases can further harm the services sector. The second channel is related to imports. Specifically, when the riyal depreciates in real terms, intermediate services and goods, including investments imported from abroad for the services sector, become more costly. These increased costs may force producers to reduce production and, thus, investment in the services sector.

We now turn to the short-run estimation results. Table 7 documents the final ECM specifications based on the GTSM approach. We discuss the SoA coefficients in more detail, as they provide useful information for decision-making processes. Specifically, they describe the speed of the correction process in each sector. All eight SoA coefficients have the expected negative signs and are statistically significant at conventional levels.

A given investment series may deviate from its established long-run relationship that provides the desired level of capital owing to a policy or socioeconomic shock. In that case, the estimated SoA coefficients imply that the disequilibrium is corrected toward the long-run equilibrium path.

The SoA coefficients vary across sectors, mainly owing to the nature of the sectoral investments and the established long-run relationships. However, all of the correction processes take less than one year. The sector with the fastest correction speed is the non-oil manufacturing sector. Investment in this sector reverts 66% of the way to the equilibrium level in the year following a shock. The other services sector has the slowest adjustment speed. Investment reverts 15% of the way to the equilibrium following a shock, and a full correction takes seven years.

More generally, we observe that investments in the sectors with considerable government support usually have higher SoA coefficients relative to the other sectors. For example, the non-oil manufacturing, construction and utilities sectors have greater SoA coefficients relative to the other services and distribution sectors. This observation may imply that government support or intervention help sectors' investments revert to their equilibrium relationships more quickly.

This interpretation seems reasonable if we consider the example of non-oil manufacturing. The government's long-term economic development policy places non-oil manufacturing at the core of its diversification policies. The realization programs within the Saudi Arabia Vision 2030 plan, such as the National Transformation program, have specific initiatives and targets for this sector. For example, the program aims for non-oil exports to reach 50% of non-oil GDP by 2030 (Government of Saudi Arabia 2016; NTP 2017). Clearly, any increase in non-oil exports is heavily determined by the expansion of non-oil manufacturing. SAMA data (2019) show that non-oil manufacturing goods, such as petrochemicals and construction materials, comprised 93% of non-oil exports during 2005–2019. The remaining 7% of exports were agriculture products. Additionally, Saudi Arabia's Fiscal Balance Program includes an industrial support package to mitigate possible harmful effects of domestic energy price increases. The program has also implemented fiscal revenue collection measures in the industrial branches, in which non-oil manufacturing is prioritized (FBP 2017).

These observations and interpretations likely apply to the construction and utilities sectors as well. For example, as mentioned above, the utilities sector provides the country with electricity, gas and water. Hence, it is important for investments in this sector to return to their optimal level quickly following a shock. However, this interpretation does not hold for the agriculture sector. The difference may be due to the distinguishing features of this sector in Saudi Arabia. It may also be a result of a data accuracy issue .[3]Hasanov and Shannak (2020) estimate the SoA process of value added in agriculture to be 56% over one year for the period 1988–2014. In other words, they find that the speed to adjustment is faster for value added than for investment in agriculture.

The SoA coefficients in the financial sector are relatively larger than those in other sectors with little or no government support or intervention (i.e., the other services and distribution sectors). This result may be related to the nature of the financial sector. This sector provides Saudi Arabia with financial, insurance, real estate and business services. The country would have trouble operating normally if these services were disrupted for a long time, particularly in the case of banking services.

6. Discussion

Table 7 also shows the explanatory variables that survive in the final ECM specifications for the growth rate of investment. The contemporaneous and lagged growth rates of value added survive only in the final specification for the agriculture sector. The growth rates of the real exchange rate survive only in the final ECMs for the agriculture and non-oil manufacturing sectors. The contemporaneous values of the real interest rate growth rates are statistically significant in the construction, distribution, non-oil manufacturing, other services and utilities sectors. The two-year lagged value of the real interest rate is significant only in the distribution sector. The one-year lagged value of the interest rate has no explanatory power for short-run investments in any sector.

We provide some interpretations of these coefficients. The short-run cumulative impact of value added on investment is 2.3 in the agriculture sector. Thus, one percentage point increases in the contemporaneous, one- and two-year lagged growth rates of value added cumulatively cause a 2.3 percentage point increase in the growth rate of agriculture investment. This increase is less than the long-run impact of 2.8.

Agriculture investment growth increases by one percentage point if the change in real exchange rate depreciation increases by one percentage point in the previous year. However, a one percentage point increase in the two-year lagged change in depreciation causes a 1.4 percentage point decline in the investment growth rate. The cumulative impact is a 0.4 percentage point decline. We think that the short-run negative impact of a real exchange rate depreciation on investment can be explained by the imported intermediate goods and services used in agriculture production. An exchange rate depreciation increases the costs of these goods, discouraging farmers from investing and producing more. Although the negative effect of a depreciation appears to outweigh the positive effect in the short run, the effects flip over time.

A one percentage point increase in changes in the real interest rate leads to one percentage point declines in the investment growth rates in several sectors. These sectors are the construction, non-oil manufacturing and utilities sectors. In the distribution and other services sectors, such an increase causes the investment growth rate to decline by two percentage points. Again, the real interest rate has a smaller impact in the short run than in the long run.

Lastly, we observe that investments show persistency in the distribution, financial, non- oil manufacturing and other services sectors. Unfortunately, we are unable to compare the numerical values obtained in this research (long- and short-run) with those from other studies. We did not find any previous econometric studies on sectoral investments in Saudi Arabia.

7. Conclusions and policy insights

Saudi Arabia has adopted several policies to stimulate non-oil economic growth and reduce dependence on oil over the course of several decades. Since the 1970s, various national development plans have been designed and implemented. These plans aim to boost human capital and develop new industry and service sectors in Saudi Arabia.

The share of non-hydrocarbon output in GDP has increased steadily, but it remains highly correlated with oil prices and there is large room for economic diversification, a key component of sustainable growth (Callen et al. 2014).

Given this background, investment can be considered a key factor in promoting the efficient allocation of capital. Capital should move away from hydrocarbons and energy-intensive industries to sectors that promote sustainable growth and job creation. This need has been emphasized in the literature (IMF 2016b). Non-oil sector investments in Saudi Arabia can contribute to the country's economic performance through a variety of channels. Investment can impact output and employment by increasing aggregate demand, expanding productive capacity and providing a foundation for economic diversification. It can also boost productivity by enabling the introduction of new production techniques and processes, particularly in the case of FDI. Thus, empirical investigations of investment relationships are important to help decision-makers take effective measures.

Sometimes, investigating a given process at the aggregate level does not provide appropriate consideration or understanding of sectoral implications. Thus, this study explored the relationship between private investment and its determinants at the sectoral level. All of the high-level government initiatives and targets for non-oil economic diversification require sectoral considerations and sector-specific policies. This study aims to support these needs.

One result that decision-makers may wish to consider is that investments in different non-oil sectors in Saudi Arabia react differently to the determinants of investment. This finding implies that a one-size-fits-all investment policy should not be implemented. Instead, tailored, sector-specific policy measures should be considered.

Decision-makers may also consider that in all sectors, increases in economic activity lead to similar or greater increases in investments in the long run. This study considered private investment and, thus, our policy recommendations are primarily relevant for private decision-makers. Nevertheless, the government can still play a role to achieve the desired investment level in each sector by influencing sectoral output. For example, the government can create additional demand for a sector's goods and services. One option for doing so is to reduce the share of imports in government purchasing and prioritize locally produced goods and services. Such a policy can also support the local content strategy, which is a major consideration for the kingdom's economic diversification. The government can purchase goods and services, where it is possible and relevant to do so, even if such purchases are limited. However, the positive impacts will spill over other sectors, as all sectors are linked in their activities. The magnitudes of the estimated investment elasticities with respect to output show that all sectors can benefit from such a policy measure.

Decision-makers may also note that the real interest rate may be a useful tool for influencing sectoral investment decisions in the long run. It may be particularly useful for such sectors as other services, distribution, and transport and communication. This tool is also useful in the short run for these sectors and for the construction, non-oil manufacturing and utility sectors.

Our findings show that a deprecation of the riyal in real terms benefits non-oil tradable sectors, such as agriculture and non-oil manufacturing. However, a depreciation policy is not straightforward to implement because the riyal has been nominally pegged to the dollar since 1987. This fixed exchange rate regime has supported the development of the economy remarkably (Alkhareif et al. 2017). The real exchange rate can also be influenced through the domestic price. However, the ability to affect this channel is also limited given the recently implemented fiscal and domestic energy price reforms in Saudi Arabia. These reforms increase production costs and, thus, might make goods and services more expensive and less attractive to trading partners. Therefore, the government introduced industry and agriculture support packages to protect these sectors from any potential harm caused by these reforms and maintain their international competitiveness. The Fiscal Balance Program describes different aspects of these packages (FBP 2017).

Acknowledgments

We thank Fatih Karanfil and Raed Al Mestneer for their valuable comments and suggestions. We accept sole responsibility for any errors and omissions. The views expressed in this paper are the authors' views and do not necessarily represent the views of their affiliated institutions.

References

Acosta, Pablo, and Andrés Loza. 2005. "Short and Long Run Determinants of Private Investment in Argentina." *Journal of Applied Economics* 8(2):389–406. DOI: https://doi.org/10.1080/15140326.2005.12040634

Aizenman, Joshua, and Nancy Marion. 1999. "Volatility and Investment: Interpreting Evidence from Developing Countries." *Economica* 66(262):157–69. DOI: https://doi.org/10.1111/1468-0335.00163

Alkhareif, Ryadh M., William A. Barnett, and John H. Qualls. 2017. "Has the Dollar Peg Served the Saudi Economy Well?" *International Finance and Banking* 4 (1): 145. DOI: https://doi.org/10.5296/ifb.v4i1.11189

Al Moneef, H. E., and Fakhri Hasanov. 2020. "Fiscal Multipliers for Saudi Arabia Revisited." *KAPSARC Discussion Paper*. No. ks--2020-dp21. DOI: https://doi.org/10.30573/ks--2020-dp21

Al-Shayaa, M. Shayaa, Mirza B. Baig, and Gary S. Straquadine. 2012. "Agricultural Extension in the Kingdom of Saudi Arabia: Difficult Present and Demanding Future." *Journal of Animal and Plant Sciences* 22(1):239–46.

Alyousef, Yousef, and Paul Stevens. 2011. "The Cost of Domestic Energy Prices to Saudi Arabia." *Energy Policy* 39(11):6900–05. DOI: https://doi.org/10.1016/j.enpol.2011.08.025

Balassa, Bela. 1964. "The Purchasing-power Parity Doctrine: A Reappraisal." *Journal of Political Economy* 72(6):584–96.

Bean, Charles R. 1981. "An Econometric Model of Manufacturing Investment in the UK." *The Economic Journal* 91(361):106–21.

Bolbol, Ali A., and Mohammad M. Omran. 2005. "Investment and the Stock Market: Evidence from Arab Firm-level Panel Data." *Emerging Markets Review* 6(1):85–106. DOI: https://doi.org/10.1016/j.ememar.2004.09.005

Callen, Tim, Reda Cherif, Fuad Hasanov, Amgad Hegazy, and Padamja Khandelwal. 2014. Economic Diversification in the GCC: Past, Present, and Future. International Monetary Fund. DOI: https://doi.org/10.5089/9781498303231.006

Campa, Jose, and Linda S. Goldberg. 1995. "Investment in Manufacturing, Exchange Rates and External Exposure." *Journal of International Economics* 38(3–4):297–320. DOI: https://doi.org/10.1016/0022-1996(94)01348-v

__________. 1999. "Investment, Pass-through, and Exchange Rates: A Cross-country Comparison." *International Economic Review* 40(2):287–314.

Clark, J. Maurice. 1917. "Business Acceleration and the Law of Demand: A Technical Factor in Economic Cycles." *Journal of Political Economy* 25(3):217–235.

Dickey, David A., and Wayne A. Fuller. 1979. "Distribution of the Estimators for Autoregressive Time Series with a Unit Root." *Journal of the American Statistical Association* 74(366a):427–31.

Dixit, Avinash K., and Robert S. Pindyck. 1994. Investment Under Uncertainty. Princeton, N.J.: Princeton University Press.

Doornik, Jurgen A. 2009. "Autometrics." In The Methodology and Practice of Econometrics: A Festschrift in Honour of David F. Hendry, edited by Jennifer L. Castle and Neil Shephard, 88–121. Oxford: Oxford University Press..

Doornik, Jurgen A., and David F. Hendry. 2009. Modelling Dynamic Systems: PcGive 13. London: Timberlake Consultants Press.

Doornik, Jurgen A., and David F. Hendry. 2018. Empirical Econometric Modelling, PcGive 15. London: Timberlake Consultants Ltd.

Dornbusch, Rudiger, Stanley Fischer, and Richard Startz. 2014. Macroeconomics. New York, N.Y.: McGraw-Hill Education.

Elheddad, Mohamed. 2019. "Foreign Direct Investment and Domestic Investment: Do Oil Sectors Matter? Evidence from Oil-Exporting Gulf Cooperation Council Economies." *Journal of Economics and Business* 103:1–12. DOI: https://doi.org/10.1016/j.jeconbus.2018.11.001

Fazzari, Steven M., R. Glenn Hubbard, and Bruce C. Petersen. 1988. "Financing Constraints and Corporate Investment." *Brookings Papers on Economic Activity* 1:141–95.

Fiscal Balance Program (FBP). 2017. "Fiscal Balance Program, Kingdom of Saudi Arabia Vision 2030." 2019 update. Accessed May 15, 2019. http://vision2030.gov.sa/en/bb2020.

General Authority for Statistics (GAStat). 2017. "National Accounts." *The Kingdom of Saudi Arabia*.

Goldberg, Linda S. 1993. "Exchange Rates and Investment in United States Industry." *The Review of Economics and Statistics* 75(4):575–88.

Government of Saudi Arabia. 2016. "Saudi Vision 2030." Accessed May 15, 2019. https://vision2030.gov.sa/en.

Grindle, Arani Kajenthira, Afreen Siddiqi, and Laura Diaz Anadon. 2015. "Food Security Amidst Water Scarcity: Insights on Sustainable Food Production from Saudi Arabia." *Sustainable Production and Consumption* 2:67–78.

Hall, Robert E., and Dale W. Jorgenson. 1967. "Tax Policy and Investment Behavior." *American Economic Review* 57(3):391–414.

Harchaoui, Tarek M., Faouzi Tarkhani, and Terence Yuen. 2005. "The Effects of the Exchange Rate on Investment: Evidence from Canadian Manufacturing Industries." *Bank of Canada Working Paper No*. 2005-22.

Harris, Richard, and Robert Sollis. 2003. Applied Time Series Modelling and Forecasting. West Sussex: Wiley.

Hasanov, Fakhri J., Nader AlKathiri, Saad Alshahrani, and Ryan Alyamani. 2020. "The Impact of Fiscal Policy on Non-oil GDP in Saudi Arabia." *KAPSARC Discussion Paper*. Doi: 10.30573/KS--2020-DP014.

Hasanov, Fakhri, Frederick L. Joutz, Jeyhun I. Mikayilov, and Muhammad Javid. 2020. "KGEMM: A Macroeconometric Model for Saudi Arabia." *KAPSARC Discussion Paper*. No. KS--2020-dp04. DOI: https://doi.org/10.30573/ks--2020-dp04

Hasanov, Fakhri J., and Sa'd Shannak. 2020. "Electricity Incentives for Agriculture in Saudi Arabia. Is That Relevant to Remove Them?" *Energy Policy* 144:111589. DOI: https://doi.org/10.1016/j.enpol.2020.111589

Hemrit, Wael, and Noureddine Benlagha. 2018. "The Impact of Government Spending on Non-oil-GDP in Saudi Arabia (Multiplier Analysis)." *International Journal of Economics and Business Research* 15(3):350–372. DOI: https://doi.org/10.1504/ijebr.2018.10011597

References

Hendry, David F., and Katarina Juselius. 2000. "Explaining Cointegration Analysis: Part 1." *The Energy Journal* 21(1):1–42.

International Monetary Fund (IMF). 2016a. "Economic Diversification in Oil-exporting Arab Countries." *Prepared for the Annual Meeting of Arab Ministers of Finance*. April.

__________. 2016b. "Investment and Growth in the Arab World: A Scoping Note." *Prepared for the Annual Meeting of Arab Finance Ministers*. April.

Johansen, Soren, 1991. "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models." *Econometrica* 59(6):1551–80.

Jorgenson, Dale W. 1963. "Capital Theory and Investment Behavior." *American Economic Review* 53(2):247–59.

Jorgenson, Dale W. 1965. "Anticipations and Investment Behavior." In The Brookings Quarterly Econometric Model of the United States, edited by James S. Duesenberry, Gary Fromm, Lawrence R. Klein, and Edwin Kuh. Chicago: Rand McNally.

Juselius, Katarina. 2006. The Cointegrated VAR Model: Methodology and Applications. Oxford: Oxford University Press.

Keynes, John Maynard. 1936. The General Theory of Employment, Interest and Money. London: Harcourt Brace Jovanovich.

Landon, Stuart, and Constance E. Smith. 2009. "Investment and the Exchange Rate: Short Run and Long Run Aggregate and Sector-Level Estimates." *Journal of International Money and Finance* 28(5):813–835. DOI: https://doi.org/10.1016/j.jimonfin.2008.07.009

MacKinnon, James G. 1996. "Numerical Distribution Functions for Unit Root and Cointegration Tests." *Journal of Applied Econometrics* 11(6):601–18.

Mann, Janelle, and Peter Sephton. 2015. "Revising Fiscal Policy and Growth in Saudi Arabia." *Journal of Reviews on Global Economics* 4:139–46. DOI: *https://doi.org/10.6000/1929-7092.2015.04.13*

Mensi, Walid, Syed Jawad Hussain Shahzad, Shawkat Hammoudeh, and Khamis Hamed Al-Yahyaee. 2018. "Asymmetric Impacts of Public and Private Investments on the Non-oil GDP of Saudi Arabia." *International Economics* 15:15–30. DOI: https://doi.org/10.1016/j.inteco.2017.10.003

Meyer, Daniel Francois, Tebogo Manete, and Paul-Francois Muzindutsi. 2017. "The Impact of Government Expenditure and Sectoral Investment on Economic Growth in South Africa." *Journal of Advanced Research in Law and Economics* 6(28):1843–55.

Modigliani, Franco, and Merton H. Miller. 1958. "The Cost of Capital, Corporation Finance and the Theory of Investment." *American Economic Review* 48(3):261–97.

Mousa, Hussein. 2018. "Grain and Feed Annual." GAIN Report No. SA1802. U.S. Embassy Riyadh: USDA Foreign Agricultural Service.

National Transformation Program (NTP). 2017. "National Transformation Program 2020." *Kingdom of Saudi Arabia Vision 2030*. Accessed May 15, 2019. https://vision2030.gov.sa/en/programs/NTP.

Newey, Whitney K., and Kenneth D. West. 1987. "A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix." *Econometrica* 55(3):703–8.

Park, Joon Y. 1990. "Testing for Unit Roots and Cointegration by Variable Addition." *Advances in Econometrics* 8(2):107–33.

Park, Joon Y. 1992. "Canonical Cointegrating Regressions." *Econometrica* 60(1):119–43.

Park, Joon Y., and Sang B. Hahn. 1999. "Cointegrating Regressions with Time Varying Coefficients." *Econometric Theory* 15:664–703.

Pesaran, M. Hashem, and Yongcheol Shin. 1999. "An Autoregressive Distributed Lag Modeling Approach to Cointegration Analysis." In Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium, edited by Steiner Strom, 371–413. Cambridge, U.K.: Cambridge University Press.

Pesaran, M. Hashem, Yongcheol Shin, and Richard J. Smith. 2001. "Bounds Testing Approaches to the Analysis of Level Relationships." *Journal of Applied Economics* 16(3):289–326.

Phillips, Peter C. 1995. "Fully Modified Least Squares and Vector Autoregression." *Econometrica* 63(5):1023–78.

Phillips, Peter C. B., and Pierre Perron. 1988. "Testing for a Unit Root in Time Series Regression." *Biometrika* 75(2):335–46.

Samuelson, Paul A. 1964. "Theoretical Notes on Trade Problems." *The Review of Economics and Statistics* 46(2):145–54.

Santos, Carlos, David. F. Hendry, and Soren Johansen. 2008. "Automatic Selection of Indicators in a Fully Saturated Regression." *Computational Statistics* 23(2):317–35.

Saudi Arabian Monetary Agency (SAMA). 2020. "Yearly Statistics." Accessed May 15, 2019.

http://www.sama.gov.sa/en-US/EconomicReports/Pages/YearlyStatistics.aspx.

Tobin, James. 1969. "A General Equilibrium Approach to Monetary Theory." *Journal of Money, Credit and Banking* 1(1):15–29.

Tuncalp, Secil, and Ugar Yavas. 1983. "Agricultural Development in Saudi Arabia: Present Status and Prospects." *Third World Planning Review* 5(4):333.

von Furstenberg, George M., Michael C. Lovell, and James Tobin. 1977. "Corporate Investment: Does Market Valuation Matter in the Aggregate?" *Brookings Papers on Economic Activity* 2:347–97.

Appendix A: A cursory review of the theory of investment

Keynes and classical economists emphasize different kinds of fluctuations within similar frameworks. Classical (and often modern) economists usually emphasize the effect of changes in real interest rates on investment. These effects occur as firms move along their downward-sloping investment demand curves. In contrast, Keynes focused on large fluctuations in investment. He believed that these changes were caused by shifts in the investment demand curve itself rather than by movements along the curve. The investment demand curve is volatile because it depends on firms' expectations regarding the profitability of investment. Keynes thought that investors' "animal spirits" tended to fluctuate wildly in waves of optimism and pessimism. He viewed the business cycle as a sequence of contagious spells of extreme optimism and pessimism.

Although appealing, the Keynesian theory of investment is not easily written as an equation that is amenable to empirical analysis. One of the earliest investment models for empirical analysis is the acceleration principle, or the accelerator model, which was first developed by Clark (1917). In this model, investment expenditures are triggered by changes in output levels. In most economies, the capital-output ratio is greater than one, and it is often greater than three in advanced economies. Thus, moderate expected changes in output can trigger relatively large changes in investment in the accelerator model. This aspect of the theory made it a particularly popular model of investment after the Great Depression. The model is also one of the two key components of the well-known multiplier-accelerator model. However, the multiplier-accelerator model is no longer commonly used as a theory of business cycles.

Investment is essentially a dynamic problem that involves changes to one fundamental factor of production. Thus, subsequent theoretical models of investment start with a representative firm that aims to maximize the present expected value of its future net cash flows. Optimality requires equating the firm's marginal product of capital to its marginal cost. The neoclassical theory of investment by Jorgenson (1963, 1965) provides a precise definition of this cost, called the user cost of capital. A key component of this cost is the interest rate, as the funds to finance investment expenditures are typically borrowed in financial markets. In empirical terms, investment can therefore be defined as a distributed lag function of changes in output and real user costs. This result led to the definition of the flexible accelerator model of investment. Hall and Jorgenson (1967) apply this model to the U.S. economy with careful consideration of the effects of various taxes on the cost of capital.

Tobin (1969) furthers this line of research by identifying a connection between the stock market and firms' investment decisions. Investments are often made by businesses, many of which are listed on the stock market. A firm's market value is the value that the stock market attributes to its assets. Tobin (1969) highlights the link between fluctuations in investments and fluctuations in the stock market. Share prices tend to be high when firms have good profit opportunities, implying that stock prices reflect firms' incentives to invest. Tobin proposes that firms base their investment decisions on the ratio between the market value and replacement cost of capital, which he calls 'Q'. If the numerator of this ratio is larger than the denominator (i.e., if $Q > 1$) then managers can increase the market value of a firm's stocks by investing. If $Q < 1$, managers will not replace the capital stock as it wears out. A prominent early application of the

Q model to aggregate investment data is the work of von Furstenberg, Lovell, and Tobin (1977).

More recent developments in the theory of investment behavior focus on the roles of financial constraints and of irreversibility and uncertainty. Indeed, most of the theories described above rest on the theorem proposed by Modigliani and Miller (1958). This theorem states that under perfect capital markets and no tax distortions, a firm's financial status and capital structure do not affect its investment decisions. Although this assumption usefully separates real and financial decisions, it is not very realistic. Asymmetric information in capital markets often limits access to credit, leading to financing or liquidity constraints on firms' investment spending (Fazzari, Hubbard, and Petersen 1988).

Another development in this literature stems from the observation that once a factory is built it cannot be un-built, meaning that investment is often irreversible. In the presence of uncertainty, firms that are unsure whether high levels of desired capital are permanent will be reluctant to undertake irreversible investments. Dixit and Pindyck (1994) describe the effects of irreversibility under uncertainty in great detail. They show that a firm gives up the option to have lower future capital stock when it invests in capital. The value of this option should therefore be included in the cost of capital and be valued using standard techniques from financial options analysis. The formulation of Jorgenson's user cost of capital changes as a result.

Finally, theoretical advances in international economics emphasize that exchange rate patterns can meaningfully affect industrial activities, including foreign and domestic firms' investments across markets. According to Goldberg (1993), three forces that influence domestic investment are triggered by exchange-rate movements. The first is changes in sectoral profits in response to exchange rate-induced changes in product demand and cost. The second is currency realignments and volatility that alter the relative attractiveness of domestic and foreign production locations, influencing overall and sectoral investment. The third is wealth or portfolio effects due to changes in exchange rates. Specifically, these changes can redistribute relative wealth across countries and shift patterns of asset demands for domestic and foreign investment. These forces suggest a direct link between investment and exchange rates.

Goldberg (1993) finds that a real depreciation (appreciation) of the U.S. dollar was likely to generate an expansion (reduction) in investment in the 1970s. However, she finds that the opposite pattern prevailed during the 1980s. Campa and Goldberg (1995) attribute this difference in investment's response to exchange rates between the 1970s and 1980s to the decline in industries' export exposure. U.S. firms progressively increased their reliance on imported inputs during this time.

Most empirical investigations of this topic are based on data from U.S. manufacturing industries. The literature provides very limited evidence on the relation between exchange rates and investments in other countries. A cross-country study by Campa and Goldberg (1999) compares investment sensitivity for the U.S., the United Kingdom, Japan and Canada for the period 1970–1993. Using industry-level data for 22 Canadian manufacturing industries, Harchaoui, Tarkhani, and Yuen (2005) examine the relationship between exchange rates and investment from 1981 to 1997. They show that the overall effect of exchange rates on total investment is not statistically insignificant. Finally, Landon and Smith (2009) analyze investment data disaggregated over nine sectors for 17 countries in the Organization for Economic Cooperation and Development. They account for both domestic and foreign output as other determinants and find significant effects of foreign exchange rate fluctuations on domestic investment.

Appendix B: Econometric specification of the investment function

Several specifications can be reasonably utilized in this context, including the accelerator and the flexible accelerator models and other empirical relations. We discuss these specifications in this section.

The first formulation is the naïve accelerator model, which assumes that investment is determined by the change in the level of output. If K is the capital stock and Y is output, this model can be written as:

$$K_t - K_{t-1} = \sigma(Y_t - Y_{t-1}). \quad \text{(B.1)}$$

By incorporating depreciation and some dynamics into (B.1), we obtain our first candidate specification:

$$I_t = \sum_{i=1}^{k} \gamma_i \Delta Y_{t-i} - \delta K_{t-1} \quad \text{(B.2)}$$

The simple basic specification given by (B.1) is a special case of (B.2) where $\gamma_1 = \sigma$ and $\gamma_i = 0$ for $i \neq 1$.

We obtain the second formulation of the investment equation from the flexible accelerator principle. This model assumes that the representative firm maximizes the present discounted value of its net cash flows. The optimality condition for the capital input requires the marginal product of capital to equal its user cost. To make the model operational, we assume a Cobb-Douglas production technology. Specifically, $Y = AK^{\alpha}L^{\beta}$, where Y is the value added and A is the level of technology (i.e., Hicks neutral technical change). If the markets are perfectly competitive, the optimality condition for capital is:

$$\alpha \frac{Y_t}{K_{t-1}} = \frac{u_t}{p_t} \qquad \Rightarrow \qquad K^*_{t-1} = \alpha\left(\frac{p_t Y_t}{u_t}\right). \quad \text{(B.3)}$$

Solving the first-order condition for the optimal capital stock leads to the expression on the right-hand side of (B.3). Note that $u_t = p_{I,t}(r_t + \delta)$ is the user cost of capital of Jorgenson (1963), assuming that there are no taxes or subsidies. p is the output price (i.e., a value added deflator). Taking first differences on both sides of (B.3) and allowing for a distributed lag adjustment, we obtain the second formulation of the investment function:

$$I_t = \sum_{i=1}^{k} \theta_i \Delta\left(\frac{pY}{u}\right)_{t-i} - \delta K_{t-1}. \quad \text{(B.4)}$$

The third formulation of the investment function is based on two components. The first is a general linear relation between investment and its main long-run determinants. The second is an error correction mechanism (ECM) accounting for short-run dynamics. In its log-linear representation, the long-run relationship between investment and its determinants is as follows:

$$inv_t = a_0 + a_1 gva_t + a_2 RI_t + a_3 rer_t + e_t. \quad \text{(B.5)}$$

Here, inv, gva and rer denote the logarithms of real fixed investment, real value added and the real exchange rate, respectively. RI is the real interest rate, and e_t is the error term. These regressors are included based on the literature review carried out in the main text.

In practice, actual investment may deviate from the right-hand side of (B.5) in the short run. To account for these short-run deviations, we assume that the discrepancies are corrected in each period. We model this dynamic process using an ECM as follows:

$$\Delta inv_t = b_0 + b_1(invx_{t-1} - a_0 - a_1 gva_{t-1} - a_2 RI_{t-1} - a_3 rer_{t-1}) + \sum_{i=1}^{n} c_i \Delta inv_{t-i} + \sum_{i=0}^{m} d_i \Delta gva_{t-i} + \sum_{i=0}^{p} f_i \Delta RI_{t-i} + \sum_{i=0}^{q} g_i \Delta rer_{t-i} + v_t. \quad \text{(B.6)}$$

Here, Δ is the first difference operator, and v_t is the error term.

Bean (1981) analyzes the empirical relation between investment and output using an ECM. He assumes that the economy's long-run growth rate is small relative to the capital stock's depreciation rate.

He favors this empirical approach because “the more conventional procedure in which estimation is based on a tightly specified model embodying a large number of untested overidentifying prior restrictions frequently requires ad hoc remedies such as flexible functional forms or the arbitrary addition of error processes to enable the model to describe the data- generation process satisfactorily” (Bean 1981, 119).

We use time series data in the estimation, meaning that we first the need to test the stationarity of the variables considered. For this purpose, we use the augmented Dickey-Fuller (ADF) unit root test (Dickey and Fuller 1979) and the Phillips-Perron (PP) semiparametric unit root test (Phillips and Perron 1988). The latter test statistics can be viewed as Dickey–Fuller statistics that are robust to serial correlation. This robustness is achieved using the Newey and West (1987) heteroscedasticity and autocorrelation consistent covariance matrix estimator.

Conditional on the outcome of the unit root tests, we next assess whether the variables under scrutiny have a long-run relationship. To do so, we adopt the autoregressive distributed lagged bounds testing (ARDL-BT) approach proposed by Pesaran and Shin (1999) and Pesaran, Shin, and Smith (2001). This approach is based on the assumption that the variables are either I(0) or I(1). Thus, before we apply the test, we must ensure that the variables are not I(2) so as to avoid spurious results. If any variables are integrated of order two, we cannot interpret the values of the F-statistics provided by Pesaran, Shin, and Smith (2001).

The ARDL-BT cointegration approach has three main advantages relative to traditional cointegration methods. First, this approach does not require all of the variables under study to be integrated of the same order. Instead, it can be applied when the underlying variables are integrated of order one, zero or a mixture of the two. Second, the ARDL-BT test is relatively more efficient for small samples. Third, this technique provides unbiased estimates of the long-run model (Harris and Sollis 2003; Pesaran and Shin 1999; Pesaran, Shin, and Smith 2001).

The ARDL-BT approach requires first estimating the following general ARDL model:

$$\Delta inv_t = b_0 + b_1 invx_{t-1} + b_2 gva_{t-1} + b_3 RI_{t-1} + b_4 rer_{t-1} + \sum_{i=1}^{n} c_i \Delta inv_{t-i} + \sum_{i=0}^{m} d_i \Delta gva_{t-i} + \sum_{i=0}^{p} f_i \Delta RI_{t-i} + \sum_{i=0}^{q} g_i \Delta rer_{t-i} + w_t, \quad \text{(B.7)}$$

where w_t is the error term. For each first-differenced variable, the preferred optimal lag lengths must be selected using a criterion, such as the Schwarz information criterion. Another advantage of the ARDL-BT method is that the optimal lag lengths can differ across the first-differenced variables in a given equation. The bounds test is based on a F-test of the joint significance of the coefficients of the lagged levels of the variables. In other words, we test H0: $b_1=b_2=b_3=b_4=0$, which amounts to testing the null hypothesis of no cointegration.

This test has a non-standard asymptotic distribution and relies on two sets of critical values for a given significance level (Pesaran, Shin, and Smith 2001). The first level is calculated on the assumption that all of the variables included in the ARDL model are integrated of order zero. The second level is calculated on the assumption that all of the variables are integrated of order one. The null hypothesis of no cointegration is rejected if the value of the test statistic exceeds the upper critical bound. It is accepted if the F-statistic is lower than the lower critical bound. If the F-statistic is between the upper and lower critical bounds, the cointegration test is inconclusive.

An alternative strategy for characterizing the long-run relationship between the variables is to estimate (B.5) using the canonical cointegration regression (vCCR) method. This method is first proposed by Park (1992). Relative to ordinary least squares (OLS), this method avoids the problems caused by the non-stationarity of the data (Park and Hahn 1999). Essentially, the CCR method transforms nonstationary data but maintains the same cointegration vector. The conventional OLS procedures are therefore valid when applied to the transformed data. To test the existence of a long-run relationship between the variables, Park and Hahn (1999) suggest using a variable addition test for cointegration. This test, proposed by Park (1990), requires adding extra trend variables and testing the joint significance of the appropriate trend coefficients.

Notes

1 Alternative estimation methods in this context include Johansen's system method and the fully modified ordinary least squares method (e.g., Pesaran, Shin, and Smith [2001], Phillips [1995]). As the unit root tests show that the real interest rate is a level stationary variable, however, the preferred method for empirical analysis is ARDL. ARDL is also preferable because we have a small sample size. However, the ARDL estimation results for the agriculture and transport and communication sectors are not theoretically interpretable. Thus, we use different methods for these two sectors. The canonical cointegration regression (CCR) and vector autoregression (VAR) methods produce more theoretically coherent and statistically significant results for the agriculture and transport and communication sectors, respectively. Rather than not modeling these sectors, we use alternative methods that can provide information on the determinants of private investment in these sectors. We do so because such information may be important for policymakers. We also model these sectors because we plan to incorporate all of the estimated sectoral investment equation into a macroeconometric model. Such a model can provide a holistic view of macroeconomic linkages.

2 We estimate a VAR model of investment, value added and the real interest rate in the transport and communication sector for the period 1992–2017. We choose three lags as the optimal lag order. The model has uncorrelated residuals with a normal distribution and homoscedastic variance. Additionally, the VAR model has no instability issues. The Johansen (1991) maximum likelihood cointegration test for the VECM transformation of the VAR indicates two cointegration relationships. This finding is reasonable. One of these relationships may be between investment and value added. The other may be established by the real interest rate, which is an I(0) variable, as the unit root test results indicate. To check this possibility, we exclude the real interest rate from the VECM and perform the cointegration test again. We find that investment and value added are still cointegrated for this sector. The VAR and VECM estimation and test results are not reported here to save space. However, they are available from the authors upon request.

3 We check the ratio of private investment in agriculture used in this study to the gross fixed capital formation of agriculture, forestry and fishing from FAOSTAT (http://www.fao.org/faostat/en/#data/CS). We measure both values in millions of 2010 riyals. The ratio is around 47% during 1996–2000 but declines significantly to 8% during 2006–2009. It then jumps tremendously from 7% in 2009 to 98% in 2010. More surprisingly, this ratio equals 106% and 103% in 2011 and 2012, respectively, which is nonsensical. These results cast some doubt on the accuracy of the data on private investment in agriculture.

About the Authors

Muhammad Javid

Muhammad Javid is a research fellow at KAPSARC. His research interests include but are not limited to economic development, the economics of energy and environment, and sustainable development. He holds a Ph.D. in applied economics from the Pakistan Institute of Development Economics (PIDE), Islamabad, Pakistan. Before joining KAPSARC, Muhammad worked as a senior research economist at PIDE. He has worked extensively in the areas of energy, environment, trade, and macroeconomics. He also has experience working for various research, academic and governmental organizations such as King Saud University, Saudi Arabia, the Benazir Income Support Program, Pakistan and PIDE.

Fakhri J. Hasanov

Fakhri Hasanov is a senior research fellow and the KAPSARC Global Energy Macroeconometric Model (KGEMM) project lead. Previously, he was an associate professor and director of the Center for Socio-Economic Research at Qafqaz University, Azerbaijan. He holds a Ph.D. in econometrics from Azerbaijan State University of Economics and completed his post-doctoral work and study at George Washington University. His research interests and experience span econometric modeling and forecasting, building, and the implementation of macroeconometric models for policy analyses, and energy economics, with a particular focus on countries rich in natural resources.

Carlo Andrea Bollino

Carlo Andrea is a visiting fellow at KAPSARC, a professor of economics at the University of Perugia, and a professor of energy economics at the University Luiss, Rome. He has been the president of the Italian Association for Energy Economics since 2014 and was the president of the International Association for Energy Economics in 2008. His other roles have included energy advisor to Italy's minister of industry, president of the Italian Electric Transmission Network, chief economist at Eni, economist at the Bank of Italy, research associate at United Nations' Project LINK, and lecturer and professor of economics at the universities of Pennsylvania (United States), Campobasso, Sassari and Urbino (Italy). Carlo Andrea's research investigates econometric modeling, consumer behavior, energy markets, sustainable and renewable energy, liberalization and regulation policy. He has authored over 200 scientific articles, is the chief editor of the Review of Economics and Institutions and a member of the editorial board of Energies.

Marzio Galeotti

Marzio is a visiting fellow at KAPSARC. He is currently Professor of Environmental and Energy Economics at the Università degli Studi di Milano. He holds an M.Phil. and a Ph.D. in Economics from New York University. He is also a research fellow at the Center for Research on Energy and Environmental Economics and Policy (IEFE) at the Università Bocconi of Milan. He is a member of the editorial board of lavoce.info, the Journal of Economic Policy (Politica economica) and Economics and Policy of Energy and the Environment. He has been an expert reviewer of the IPCC and is a review editor of the next Assessment Report.

About the Project

This study was part of the KGEMM Research and Policy Studies project. The project aims to leverage the work done for the KGEMM model development to produce policy and research studies that can inform Saudi Arabian decision-makers in enhancing their understanding of the Kingdom's domestic and international macroeconomic-energy relationships.

KAPSARC

مركز الملك عبدالله للدراسات والبحوث البترولية

King Abdullah Petroleum Studies and Research Center

www.kapsarc.org