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DRIVING ECONOMIC FLUCTUATIONS IN PERU: THE ROLE OF THE TERMS OF TRADE

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Abstract

This paper has four objectives. Firstly, to verify the existence of long-term relationships between the groups of variables analyzed (product, consumption, private investment, public investment, and terms of trade). Secondly, to analyze the role of public and private investment, as well as the role of the terms of trade in the Peruvian economy's economic fluctuations. Thirdly, to identify domestic and foreign shocks, as well as the degree of importance of both in the economy's fluctuations. Finally, to identify the role and the impact of permanent and transitory shocks in the economic fluctuations of an emerging economy such as Peru. To achieve these objectives, we follow the focuses of King et al. (1991), Mellander et al. (1992), and Warne (1993); additionally, the analysis disaggregates the total public and private investment. The primary result is that the permanent shocks of the terms of trade (foreign shocks) account for most of the fluctuations in product, consumption, private investment, and public investment. This result appears more pronounced as the time horizon approaches the long-term. The transitory shocks, for their part, explain the fluctuations of some variables only in the short term.

JEL Classification: E32, F41, F43, C32.

Keywords: Fluctuations, Output, Consumption, Private Investment, Public Investment, Terms of Trade, Permanent and Transitory Shocks, Domestic and Foreign Shocks, Developing Small Open Economy, Common Trends, Cointegration.

Resumen

Este trabajo tiene cuatro objetivos. En primer lugar, verificar la existencia de relaciones de largo plazo entre el grupo de variables analizadas (producto, consumo, inversión privada, inversión pública, y términos de intercambio). En segundo lugar, analizar el rol de la inversión pública y privada, así como el papel de los términos de intercambio en las fluctuaciones de la economía Peruana. En tercer lugar, identificar los choques domésticos y externos, así como su respectivo grado de importancia en las fluctuaciones de la economía. Por último, identificar el papel y el impacto de los choques permanentes y transitorios en las fluctuaciones económicas de una economía emergente como el Perú. Para lograr los objetivos, seguimos los enfoques de King et al. (1991), Mellander et al. (1992), and Warne (1993); además, el análisis desagrega la inversión pública y privada total. El resultado principal es que los choques permanentes de los términos de intercambio (choques foráneos) explican la mayor parte de las fluctuaciones en el producto, el consumo, la inversión privada y la inversión pública. Este resultado es más pronunciado a medida que se acerca el horizonte de tiempo al largo plazo. Los choques transitorios, por su parte, explican las fluctuaciones de algunas variables sólo en el corto plazo.

Clasificación JEL: E32, F41, F43, C32.

Palabras Claves: Fluctuaciones, Producto, Consumo, Inversión Privada, Inversión Pública, Términos de Intercambio, Choques Permanentes y Transitorios, Choques Domésticos y Foráneos, Pequeña Economía Abierta en Desarrollo, tendencias Comunes, Cointegración.

Driving Economic Fluctuations in Peru: The Role of the Terms of Trade¹

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1 Introduction

The recent experience of the Peruvian economy, marked by solid terms of trade, raw material price increases, and accelerated growth from mid-2000, suggests that terms of trade shocks are instrumental in explaining the fluctuations of emerging economies. The Gross Domestic Product (GDP) posted an average growth of 6.3% over the period 2002-2007, while the terms of trade enjoyed six years of sustained growth over the same period. In real terms, from 2000 until just before the international crisis, the terms of trade rose by 75%. The volume of exports, consumption, and the product grew at high rates: 7.5% in developing economies compared with 3.1% in advanced economies; see IMF (2008).

In theory, terms of trade shocks can explain both the cyclical and long term behavior of economies, depending on the duration of the shocks and the transmission mechanisms. According to Obstfeldt (1982) and Svensson and Razin (1983), the terms of trade affect purchasing power, which has impacts on the product and in consequence on consumption, which can be strongly affected insofar as the shock is more permanent. Another transmission mechanism is the fact that the gains in the terms of trade induce increased investment, especially in export-oriented industries. This is all the more evident when the export sector is related to raw materials, which is true for emerging economies such as Peru.

The relationship between terms of trade and economic fluctuations has been studied by authors such as Mendoza (1995), Easterly et al. (2001), and Becker and Mauro (2006). The dependence of developing economies on imported capital goods, and the high concentration of raw materials in the composition of their exports, render the terms of trade relevant to their fluctuations. In this regard, Blattamn et al. (2004) review the relationship between the terms of trade and the behavior of developing economies. Mendoza (1995) finds that prominent shocks to the terms of trade are liable to be long, persistent, and pro-cyclical, and that developing countries are more variable in terms of their macroeconomic aggregates.

Dancourt et al. (1997) evaluate the significance of external shocks in Peruvian macroeconomic history over the period 1950-1996. To this end, they construct an external shock indicator that is directly correlated to the development of the terms of trade, with the exception of the 1990s given the importance of capital flows to the period. The authors find that all of the economic recessions studied, except for that which began in 1987, coincide with adverse external shocks. Moreover,

¹This paper is drawn from the Thesis of Pierina Villanueva (2013) at the Department of Economics, Pontificia Universidad Católica del Perú. We thank useful comments of Paul Castillo (Central Reserve Bank of Peru). Helpful comments and conversations with Oscar Dancourt (PUCP) are especially appreciated.

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they find that the first half of the 1990s was marked by the biggest and longest-lasting favorable external shock experienced by the Peruvian economy in the 47 years of analysis. In this regard, the authors conclude that the role of external shocks cannot be overlooked when attempting to explain the long term behavior of the Peruvian economy.

Mellander et al. (1992) analyze macroeconomic fluctuations in a small and open economy such as Sweden. To this end, they make use of a common stochastic trends model, in which the terms of trade, consumption, gross domestic product, and aggregate investment are included. The authors find two cointegration relationships and propose two stochastic trends (domestic and foreign). The results show that both trends positively influence each of the series analyzed in the long term. On the other hand, the transitory shocks are significant for the case of the terms of change and aggregate investment in the short and medium term. Nonetheless, in the long term, both variables are explained by permanent foreign shocks. In the case of the product, transitory shocks are not significant, even in the short term. In the long term, the product is explained by permanent internal and external shocks of a similar magnitude. Moreover, the authors find that permanent domestic shocks have greater influence on consumption than on the long-term product; foreign shock influences consumption variability almost in its entirety. The results show that permanent shocks have an important role in economic fluctuations in the case of a small and open economy. At this respect, Kose and Riezman (1999) find that 45% of economic fluctuations are explained by shocks arising from international trade in a sample of African countries. Moreover, they find that these shocks explain around 90% of the aggregate investment variation and 80% of the consumption fluctuations; see also Kose (2002).

Misas et al. (2003), perform a study on the fluctuations of Colombia's main macroeconomic variables over the period 1950-2002. The authors employ a common stochastic trends model and two cointegration relationships, and find that the permanent shocks are important in explaining macroeconomic fluctuations, even though they do not display a variance decomposition.

Castillo and Salas (2010), perform an analysis on the Peruvian economy's economic fluctuations for the quarterly period 1992-2007. The variables studied are the terms of trade, gross domestic product, consumption, and aggregate investment. The authors estimate a stochastic trends model to identify the role of economic shocks on macroeconomic variables. Previously, they find two cointegration relationships and pose the existence of two common trends -one foreign and the other domestic. The results show that both trends have a positive effect on each of the variables for the long-term. The authors show that the permanent shocks significantly influence the economy, and the result increases in pertinence in the medium- and long-term. Moreover, they find that permanent foreign shocks account for the greatest proportion of fluctuations in product, consumption, and total investment in the Peruvian economy.

Other studies that find significant influence of external shocks on the fluctuations of a small, open economy include Canova (2005), Aguiar and Gopinath (2007), Justiniano and Preston (2008), and Izquierdo et al. (2008). See also recent works in IMF (2014a, 2014b). Studies that find the reverse include Ahmed and Murphy (1994), Hoffmaister and Roldós (1997), Hoffmaister et al. (1998), and Lubik and Teo (2005).

This paper has four objectives. Firstly, to verify the existence of long-term relationships between the group of variables analyzed (GDP, consumption, private investment, public investment, and terms of trade). Secondly, to analyze the role of public and private investment, as well as the role of the terms of trade in the Peruvian economy's economic fluctuations. Thirdly, to identify domestic and foreign shocks, as well as the degree of importance of both in the economy's fluctuations.

Finally, to identify the role and the impact of permanent and transitory shocks in the economic fluctuations of an emerging economy such as Peru's. To achieve the objectives, we follow the focuses of King et al. (1991), Mellander et al. (1992), and Warne (1993), Misas et al. (2003) and Castillo and Salas (2010); additionally, the analysis disaggregates the total public and private investment. The primary result is that the permanent shocks of the terms of trade (foreign shock) account for most of the fluctuations in product, consumption, private investment, and public investment. This result appears more pronounced as the time horizon approaches the long-term. The transitory shocks, for their part, explain the fluctuations of some variables only in the short term.

The paper is structured as follows. Section 2 presents Johansen's cointegration methodology (1988, 1991, 1995) and the common stochastic trends of Stock and Watson (1988), Mellander et al. (1992), and Warne (1993). Section 3 presents and discusses the empirical results of both approaches. Section 4 presents the main conclusions.

2 Methodology

This study makes use of the cointegration methodology put forward by Johansen (1988, 1995) and the stochastic trends proposed by Stock and Watson (1988), King et al. (1991), Mellander et al. (1992), and Warne (1993). The methodology consists of estimating a VAR model with common stochastic trends. To this end, cointegration restrictions are identified and imposed with the aim of identifying the relevant parameters and shocks, to then perform a variance decomposition based on permanent and transitory, as well as foreign and domestic, shocks.

Consider y_t a vector that contains n variables, expressed by way of a $VAR(k)$ as follows:

$$y_t = \sum_{i=1}^k \Pi_i y_{t-i} + \Phi D_t + \epsilon_t, \quad (1)$$

where D_t refers to the deterministic part and ϵ_t to the Gaussian residuals, which follow a Normal distribution with mean 0 and variance Ω . The equation (1) may also be expressed as a vector error correction model (VECM), as follows:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \Phi D_t + \epsilon_t, \quad (2)$$

where $\Pi = -I + \sum_{i=1}^k \Pi_i$, $\Gamma_i = \sum_{j=i+1}^k \Pi_j$. Cointegration exists when the matrix Π has reduced rank; that is, $r < n$ and in this case, the matrix Π can be factorized and expressed as $\Pi = \alpha\beta'$; where α and β are full rank matrices $n \times r$. On the one hand, the matrix α contains the adjustment coefficients and, on the other hand, the matrix β contains the cointegration vectors. To find the cointegration vectors, first the vectors of dimension $n \times 1$ of residuals r_{0t} and r_{1t} of auxiliary residuals are obtained; that is, regressions of Δy_t and y_{t-1} taking into account ΦD_t and the lagged variables, represented by $\{\Delta y_{t-1}, \Delta y_{t-2}, \dots, \Delta y_{t-k+1}\}$. Thus, the product of residuals is obtained: $S_{ij} = (1/T) \sum_{i=1}^T r_{it} r'_{jt}$, going on to resolve the problem of eigenvalues $|\lambda S_{11} - S_{10} S_{00}^{-1} S_{01}| = 0$. From there, the eigenvalues $\hat{\lambda}_1 \geq \hat{\lambda}_2 \geq \dots \geq \hat{\lambda}_n$ and the cointegration values corresponding to the corresponding cointegration vectors $\hat{\beta}_1, \hat{\beta}_2, \dots, \hat{\beta}_n$ are obtained. The proposed statistics are denominated: (i) *Traza* = $-T \sum_{i=r+1}^n \log(1 - \hat{\lambda}_i)$, which verifies the null hypothesis that cointegration does not exist, $r = 0$, versus the hypothesis that at least one vector exists, $r > 0$, and so on until the

null hypothesis is not rejected; and (ii) the $\lambda_{\max} = -T \log(1 - \hat{\lambda}_i)$ that contrasts the null hypothesis that $r = r_0$, in contrast to the alternative hypothesis that $r = r_0 + 1$ where $r_0 = 0, 1, \dots, n - 1$, until the null hypothesis is not rejected.

Given the existence of n variables in the model, $n - r = g$ stochastic trends exist. The basic idea behind the common trends representation is that if a system of non-stationary variables exists, where there are one or more cointegration relationships, it can be decomposed into two components: one of a permanent nature, and another of a transitory nature. In this case it is said that the system admits a common trends representation. Mellander et al. (1992) and Warne (1993) represent the model as follows; see also Stock and Watson (1988):

$$y_t = y_0 + \mathfrak{S}\tau_t + \Phi(L)v_t, \quad (3)$$

where L is the lag operator and the vector v_t satisfies $E[v_t] = 0$, $E[v_t v_t'] = I_n$, $E[v_t v_j'] = 0$ for $s \neq j$ and $\Phi(L)v_t = \sum_{i=0}^{\infty} \Phi_i L^i$. Moreover, y_0 is assumed to be stationary and $\Phi(L)v_t$ jointly stationary. On the other hand, $\mathfrak{S}\tau_t$ is the trend component, with \mathfrak{S} being of dimension $n \times g$. Let τ_t be a random walk vector of dimension g , represented by: $\tau_t = \mu + \tau_{t-1} + \eta_t$ where innovation η_t is white noise with $E[\eta_t] = 0$ and $E[\eta_t \eta_t'] = I_g$. Given that a common stochastic trends model is made up of a vector of trends and a vector of stationary variables, both unobservable as individual factors, the vector y_t can be represented by way of the sum of one permanent component and one transitory component: $y_t = y_t^p + y_t^s$, where $y_t^p = \mathfrak{S}[\mu + \tau_{t-1} + \eta_t] = \mathfrak{S}[\tau_0 + \mu t + \sum_{i=1}^t \eta_i]$ and, on the other hand, $y_t^s = y_0 + \Phi(L)v_t$. Given that the number of common trends is $g < n$, there are $r = n - g$ linearly independent cointegrated vectors, which are orthogonal to the columns of the matrix \mathfrak{S} ; that is $\beta' \mathfrak{S} = 0$, $z_t = \beta' y_t$ is stationary and conforms with $\beta' y_t^p = 0$. The trends include stochastic elements that are consistent with the idea that some shocks in the economy are permanent, represented by y_t^p , while y_t^s contains those shocks that are transitory³.

The estimation of the common trends model starts off with the assumption that $\{y_t\}$ follows a VAR generating process of order k , represented by: $A(L)y_t = \rho + \epsilon_t$ with $\{\epsilon_t\}$ being white noise, while the polynomial matrix of an order of $n \times n$ $A(L) = I_n - \sum_{i=1}^p A_i L^i$ satisfies $\det[A(L)] = 0$, if $|L| > 1$ or $L = 1$. If the series that comprises $\{y_t\}$ are first-order cointegrated; that is, $\{y_t\} \sim CI(1, 1)$, with r cointegration vectors, Granger's Representation Theorem establishes that $\text{rank}[A(1)] = r$, $A(1) = \alpha \beta'$. In this sense, the previous VAR can be rewritten as a vector of error correction model (VECM) represented by $A(L)^* \Delta y_t = \rho - \alpha z_{t-1} + \epsilon_t$, where $z_t = \beta' y_t$ is jointly stationary and the polynomial matrix $A(L)^* = I_n - \sum_{i=1}^{k-1} A_i^* L^i$ is related to $A(L)$ through $A_i^* = -\sum_{j=i+1}^k A_j$. On the other hand, according to Wold's Representation Theorem, there is a moving average representation for the previous equation: $\Delta y_t = \delta + C(L)\epsilon_t$, where $\{\Delta y_t\}$ is jointly stationary, $C(L) = I_n + \sum_{j=0}^{\infty} C_j L^j$ and, given that $C(1) \neq 0$, $\{y_t\}$ is not stationary. Moreover, it is found that $\{y_t\} \sim CI(1, 1)$, $C(1)$ has a rank $n - r$ and $\beta' C(1) = 0$. In this sense, the representation of moving averages together with the cointegration process imply the existence of an unrestricted VAR representation and of the VECM representation⁴. For the estimation of the common trend model parameters, an analysis is conducted of whether $\{y_t\}$ exhibits g common stochastic trends,

³The restrictions of cointegration determine the number of common trends and the way that the y_t vector is related to these.

⁴As an equivalent, Johansen (1991) holds that if $\{y_t\}$ is generated by (2), $A(1) = \alpha \beta'$, and the matrix of dimension $(n - r) \times (n - r)$: $\alpha'_\perp [\sum_{j=1}^p j A_j] \beta_\perp$ is not singular, so $\{y_t\} \sim CI(1, 1)$ with r vectors of cointegration, leading him to conclude that there is a representation of moving averages. The necessity for nonsingularity of the matrix mentioned is important so as to eliminate the possibility that $\{y_t\}$ is integrated of an order greater than one.

which allows the matrix \mathfrak{S} to be rewritten as the product of the matrices $\mathfrak{S} = \mathfrak{S}_0 F$ where \mathfrak{S}_0 is a $n \times g$ matrix of known parameters, ensuring that $\beta' \mathfrak{S}_0 = 0$ and that the trend innovations have an economic interpretation.

In summary, the common trends model given by (3) has g independent stochastic trends (τ_t) . This vector τ_t of dimension g has drifts μ and innovations η_t . These innovations have a permanent effect on the stochastic trends, with the result that they are known as permanent shocks. The matrix \mathfrak{S} determines the long-term effect of these shocks on the variables y_t . Just as occurs with the structural vector autoregression model, an important aspect in this context is the identification of the structural shocks; that is, restrictions need to be imposed on the matrix \mathfrak{S} . In practice, as in this paper, the approach taken is to estimate the cointegration vectors β , identify them in accordance with economic theory, and then identify and estimate the matrix \mathfrak{S} . An evident restriction is the fact that the permanent shocks are orthogonal to the transitory shocks. In our case we need a further restriction to identify \mathfrak{S} . In the following section we detail the restrictions imposed on the cointegration space and the common trends.

3 Results

3.1 The Data

Following on from Mellander et al. (1992), we define the vector of variables as $y_t = [y_{td_t}, y_{gdp_t}, y_{c_t}, y_{pri_t}, y_{pub_t}]'$, where y_{td_t} denotes the terms of trade (export price index/index price index), y_{gdp_t} is the real gross domestic product, y_{c_t} is real consumption, y_{pri_t} is real private investment, and y_{pub_t} is real public investment. All variables are in logarithms. This is a small open economy model that is an extension of the closed economy model of King et al. (1991), and is very similar to that proposed and analyzed by Castillo and Salas (2010). The difference is that we include the total investment divided into its two components (private and public), with which our model factors in five variables. We would judge the decomposition of total investment to be important not only due to the different behaviors of these variables, but also because the role of private investment has been instrumental to the growth of the Peruvian economy through the favorable development of the terms of trade. To the best of our knowledge, there is no empirical analysis that analyses the two investment types separately. This analysis has been performed on the quarterly database published by the Central Reserve Bank of Peru for the period 1992:01-2007:04^{5,6}.

Figure 1 shows the evolutions of the variables and Figure 2 shows the respective growth rates. The GDP variable shows a clear positive trend from the start to the end of the period analyzed. It should be mentioned that the start of the analysis coincides with the beginning of the term of office of the then President Fujimori. The beginning of the economic growth of the Peruvian economy was favored by two important events: the end of hyperinflation period and the capture of the leader of the terrorist movement called *Shining Path*. These facts were crucial to form a context of trust and momentum of a series of structural reforms characterized by a drastic shift to neoliberal policies, fiscal correction, an aggressive privatization of firms and trade liberalization. This growth benefitted even more from the rise in international metal prices, which meant that in 2008, a period of international crisis, the GDP grew by 9%. Mining is the main activity that underpins the

⁵The series were seasonal adjusted using the tramo/seats method developed by Gómez and Maravall (1996). This procedure was carried out for all variables with the exception of the terms of trade.

⁶Castillo and Salas (2010) perform their analysis from 1996 up to 2007.

Peruvian primary export model, as an increase in the price of metals raises an economy's income levels.

Private investment also shows a positive trend throughout the period of analysis. The price growth of raw materials implies an increase in aggregate demand component being private investment one of the most favored. This can be termed as the channel of the private investment. Furthermore, the privatization process that took place in Peru from 1991 constituted a key incentive for the development of this variable. Moreover, the economy's indicators showed a clear improvement, as did the economy itself, which encouraged private investment. González de Olarte (1996) holds that the adjustment policy rolled out from the start of the 1990s, as well as the reforms of the institutional and legal framework, created a new platform for private investment. Equal opportunities for investors, the free movement of factors, goods and services within and outside the country, legal stability, tax stability agreements for foreign investment, limitations on the economic role of the state, and free competition constituted a new framework to promote private investment. It should be noted that throughout the period of study, private investment was largely drawn from foreign capital. From 1990, the minimization of uncertainty regarding the country's course in response to economic, political and social instability allowed investors' trust to be regained, and had positive repercussions on their interest in investing in Peru.

As with the product and private investment, public investment follows a positive trend during the period under analysis. In fact, the other channel of aggregate demand is on the side of public investment. This component increases when commodity prices increase because tax revenues increase. This is evident since tax revenues are a function of the earnings of the companies which are subject to the income tax and it is higher when the price of raw materials is higher. On the other hand, public investment has the peculiarity of being closely linked to the decision-making of the government of the day relating to the country's course, its priorities, budget level, and the fiscal policy it undertakes to pursue during its term. Insofar as terms of trade shocks are favorable, in the long term, both private and public investment will increase⁷. This result is consistent with the responsible policy-making decision to increase government spending in the face of a permanent rise in the terms of trade, whether due to a rise in the price of export goods or a fall in the price of import goods, or to maintaining a policy of saving if the shock is perceived to be transitory.

Private investment grew by 21.0% during the final quarter of 2007, after maintaining a path of continuous growth from the start of 2002. Moreover, figures higher than 40.0% in the growth of this variable in the mid-1990s are observed. In this study's total period of analysis, private investment went from 6.2% growth over the period 1992-2000 to 10.5% over the period 2001-2007.

On the other hand, public investment achieved 26.8% growth in the final quarter of 2007, as a result of the set of executions carried out by local governments and the central government. Nonetheless, in comparison with private investment, its development posted isolated periods of high growth, represented by figures in excess of 20%, followed by periods of sudden slowdown. Moreover, this latter variable posted a decrease in its average growth from the period 1992-2000 to the period 2001-2007, dropping from 6.1% to 2.9%.

Private investment retained an important role in the dynamics of Peru's economy over the

⁷It is important to mention that there may be other channels through which the terms of trade can affect the economy. One is through the balance of payments, i.e. through availability of international reserves. The other mechanism is through capital flows although the literature is not clear whether there is independence between these two variables. However, it is important to note that these mechanisms are not modeled in this paper but can be significant.

period 1992-2007. In comparison with public investment, private sector investment has accounted for, on average, more than 17% of GDP, while public investment has only amounted to 4%. In addition, over the same period of analysis private investment has constituted more than 70% of the total investment in the country. Moreover, the analysis of private investment from 2000 to 2007 records a figure in excess of 80% with respect to the total value of investment in the country, as well as a growing trend of sustained growth, increasing from an average quarterly growth of 1.5% in the years 2000-2004 to 18% over the period 2005-2007.

Finally, the terms of trade series presents a positive trend from 2000, from a previous stage of slowdown and with the exception of a sharp fall in this series in 2007. It is worth mentioning that in 2007 the symptoms of the financial crisis occasioned in the United States began to be felt, which caused an imbalance in the country's import and export prices.

3.2 Cointegration

As a preliminary stage to the application of the methodology formulated in the previous section, the stationarity of the variables is examined using the ADF statistic proposed by Said and Dickey (1984), the statistics ADF^{GLS} , P_T^{GLS} and M^{GLS} put forward by Elliott, Rothenberg and Stock (1996), and Ng and Perron (2001), respectively. For the selection of lags, the Modified Akaike Information Criteria (MAIC), proposed by Ng and Perron (2001), is employed. All results support non-rejection of the null hypothesis of the unit root in all of the model's variables⁸.

After an examination of the lag structure, a VAR(6) is estimated, with good results related to the behavior of the residuals⁹. Table 1 shows the results obtained from Johansen's cointegration tests (1988, 1995). According to the Trace statistic and the λ_{\max} , the results show three cointegration relationships; restrictions were imposed to identify these three relationships. The first equation normalized with respect to y_{gdp_t} , while the second and third equations normalized with respect to y_{pri_t} . The statistic calculated with the restrictions is equal to 8.369, which is less than the critical value at a level of significance of 5% (p-value=0.592). In consequence, the long-term relationships between the variables proposed are not rejected. In this regard, the three equations have the following representation:

$$\beta' y_t = \begin{bmatrix} 0.0 & 1.0 & -1.16 & 0.0 & 0.0 \\ -1.5 & -0.4 & 0.0 & 1.0 & 0.0 \\ 0.0 & -0.80 & 0.0 & 1.0 & -1.0 \end{bmatrix} \begin{bmatrix} y_{td_t} \\ y_{gdp_t} \\ y_{c_t} \\ y_{pri_t} \\ y_{pub_t} \end{bmatrix}. \quad (4)$$

The first cointegration relationship displays a positive relationship of y_{gdp_t} with respect to y_{c_t} . On the other hand, the second cointegration relationship assumes a positive relationship of y_{pri_t} together with y_{gdp_t} and y_{td_t} . Finally, the third equation again shows a positive relationship, but of a greater magnitude, between y_{pri_t} and y_{gdp_t} . In this final relationship, the terms of trade are not present but y_{pub_t} is. The investment made by the public sector shows a positive relationship

⁸Results available on request.

⁹A variable dummy is used for the fall in consumption (1998:4). All results of the evaluation of residuals are available.

with respect to private investment; that is, a complementary relationship between both investments is observed. This complementary relationship may be justified for different reasons. On the one hand, the government's decision to execute an economic policy in which an investment plan for infrastructure is put forward, means that the interested parties regard it attractive to place their investments at the same time as those of the government. Moreover, the state's economic impulse is perceived as a guarantee over the country's political stability. On the other hand, the investment made by the government turns out to be an incentive to private investment, as new projects are launched that had not previously been considered due to high risks of economic loss in the event of failure. Moreover, the increase in the promotion of joint projects -known as public-private projects- in the last three years, in which the state and the private sector participate, supports this result.

Figure 3 shows the three cointegration relationships specified in (4). Some further restrictions on the adjustment coefficients in the cointegration model are imposed. The first set of restrictions are associated with the fact that the terms of trade do not respond to domestic imbalances. These restrictions are commonly used. The other restriction is that the y_{c_t} does not respond to the imbalance of the second cointegration relationship. Given that this relationship is made up of y_{dgp_t} , y_{pri_t} and y_{td_t} , this assumption seems reasonable.

3.3 Common Trends

In addition to the restrictions imposed thus far, we need a further restriction in order to identify the matrix \mathfrak{S} given that the model presents two common trends ($n - r = g = 5 - 3 = 2$). It is assumed that the shocks to one of the trends (called shocks to the domestic trend) does not have long-term effects on the terms of trade. This is equivalent to saying $\mathfrak{S}_{12=0} = 0$, which allows us to identify the stochastic trends as one foreign ($\tau_{f,t}$) and the other domestic ($\tau_{d,t}$).

The results of the matrix for the estimation of the common trend parameters is represented by:

$$\begin{bmatrix} y_{td_t} \\ y_{dgp_t} \\ y_{c_t} \\ y_{pri_t} \\ y_{pub_t} \end{bmatrix} = \hat{\rho} + \begin{bmatrix} 0.051 & 0.000 \\ (0.024) & (0.000) \\ 0.022 & 0.004 \\ (0.011) & (0.001) \\ 0.019 & 0.004 \\ (0.009) & (0.001) \\ 0.084 & 0.002 \\ (0.041) & (0.000) \\ 0.067 & -0.002 \\ (0.032) & (0.000) \end{bmatrix} \begin{bmatrix} \hat{\tau}_{f,t} \\ \hat{\tau}_{d,t} \end{bmatrix} + \hat{\Phi}(L)v_t. \quad (5)$$

The estimation of the parameters shows that both trends, foreign (τ_f) and domestic (τ_d), possess long-term positive effects on all of the variables analyzed, except for the effect of domestic shock on y_{pub_t} and the null effect of the domestic trend on y_{td_t} (by assumption). All coefficients estimated have a level of significance of 5%.

In the long-term, the response of y_{td_t} to a deviation of the permanent external shock is positive and equal to 5.1%. On the other hand, because of the assumption of the model as regards the small size of the economy, the common trend has no influence on this variable, so the effect of the domestic trend on y_{td_t} is null. The effect of a terms of trade shock on y_{gdp_t} is 2.2%. Likewise, y_{c_t} is positively altered by almost the same extent (1.9%) in response to a deviation of foreign shock. This result is also found by Castillo and Salas (2010) and supports economic theory, which suggests the small change to the savings rate. For the case of the effect of the foreign trend on y_{pri_t} , the result shows a positive change of 8.5%. The effect is higher than that reported by the domestic trend, which is very close to zero (0.2%). The price growth of raw materials implies an increase in aggregate demand component being private investment one of the most favored. This can be termed as the channel private investment. Finally, the matrix also indicates a positive effect of 6.7% of the foreign trend for the case of y_{pub_t} . This is the other channel of aggregate demand (on the side of public investment). This component increases when commodity prices move up because increase in tax revenues. This is because tax revenues are a function of the earnings of the companies which are subject to the income tax and it is higher when the price of raw materials is higher. Nonetheless, a disturbance in the domestic trend on y_{pub_t} possesses a negative effect equal to 0.2%. The returns of y_{pri_t} are usually quantitatively greater and the incentives of public policy-makers are not usually well-defined, which supports the result that public investment is displaced by private investment in those years in which the total productivity of factors has increased, all other things being equal. The matrix of the parameters of the common trends indicates that the parameter found in this estimation for the case of the effect of the domestic trend on both investments is exactly the same, but with opposite signs. That is, in the long term, the productivity shock explains, to the same degree, the change in private and public investment, but with opposite signs¹⁰. In summary, what is found is a strong long-term impact of foreign factors on private and public investment, respectively.

Figure 4 shows the transitory components obtained as the difference between the variable observed and its permanent component. Meanwhile, Figure 5 shows the permanent components, together with the development of each of the variables in the system. The variables y_{gdp_t} and y_{c_t} have very closely followed the behavior of their permanent components. Nonetheless, a deviation of both series during the five-year period of study is observed, leaving both below their permanent component, which indicates the presence of transitory factors. Likewise, the private investment series displays behavior similar to the path of its permanent component during the period of analysis, and a deviation over the last five years. Moreover, another similar five-year period is observed, 1996-2001, in which the behavior of private investment is above its permanent component, which again indicates the presence of transitory factors during both five-year periods in mention. For the case of the terms of trade, it can be seen that the accelerated growth of the series, from 2004 to 2006, is clearly explained by the permanent component of the series. Finally, public investment posts the largest deviations, whether above or below, with respect to its permanent component, with which a greater presence of transitory factors can be inferred.

¹⁰ Another plausible explanation for the opposite sign between the two types of investment is the fact that since 1992 and particularly since 1994 strong structural reforms among which was a major privatization of state enterprises were established. This caused a shift or reduction in public investment.

3.4 Variance Decomposition

Table 2 displays the variance decomposition of different time horizons, ranging from the short term to a medium-term horizon (horizons $h = 1, 4, 8, 12, 20, 40$). It can be seen that the set of transitory (and domestic) shocks under any time horizon minimally explains the behavior of the terms of trade, which is assumed and consistent with the behavior of a small open economy. With respect to the other variables, the transitory components, even if they possess significant weight, continue to display decreasing behavior as the medium-term is reached.

In the very short-term (less than one year), a significant proportion of private consumption is explained by the set of transitory shocks, determining 68% of its total variability. Nonetheless, the proportion decreases significantly from the year of analysis. In the same way, the effect of the set of transitory shocks on the product shows a value greater than 20% in the short-term, dropping to a value close to zero in the medium-term. Likewise, the effects of the set of transitory shocks on both investments are significant at the start of the period analyzed, and are later reduced in the medium-term. It is worth noting that the reduction of the proportion explained by the transitory public investment shocks displays gradual behavior, remaining at 10% after 20 quarters, while the same effect on private investment loses significance after eight quarters, which represents less than half of the time elapsed in the case of public investment, dropping to less than 10% after having accounted for almost 40% of this investment over the first four quarters.

With respect to the impact of permanent shocks on the variables studied, Table 2 shows that permanent foreign shocks account for almost all terms of trade variability. The percentage value of the external shock on the terms of trade fluctuates between 97.1% and 99.5% in the short- and medium-term. This shows that a fluctuation in the terms of trade in the short- and medium-term is primarily explained by a foreign shock, which makes sense in the case of a small open economy such as Peru's.

As regards private consumption, it is seen that the permanent foreign shock went from being insignificant (below 5%) in the beginning, to taking a value in excess of 50% after four quarters and finally reaching 96% in the medium-term.

For the case of the product, the permanent foreign shock displays almost null effect in the first quarter of analysis. Nonetheless, a significant increase is observed in the importance of the effect in the determination of the product during subsequent periods, accounting for 51% of its variability during the short term, and going on to 95% in the medium term.

Finally, the effect of permanent shocks on the behavior of disaggregated investment in public and private investment can be seen. Foreign shock has a leading role in determining both levels of investment. Specifically, the proportion of this effect is relatively high in the case of private investment. The value observed for this latter investment is greater than 90% from the eighth quarter, while the effect of permanent foreign shock on public investment only takes a similar value several quarters later. Domestic shock, for its part, has a no role in either level of investment in the short- and medium-term. In particular, this is significant, with 13% for private investment in the very short-term, but later loses significance in the medium-term.

Table 3 shows the long-term variance decomposition. The components that comprise the Table correspond to the response to the variables analyzed given some of the permanent shocks encountered. In this case, only permanent shocks are taken, as in the long term the fluctuation of the variables are no longer explained by transitory shocks. The results found are similar to those presented by Castillo and Salas (2010). The estimation shows that in the long term, the fluctuation

of the product, private consumption, and public and private investment is explained, almost entirely, by foreign shocks. In the case of all variables, the foreign shock on the fluctuation of these corresponds to more than 95%. Public and private investments post a bigger role for foreign shock, followed by the product and consumption. This had already been observed in the coefficients of the matrix \mathfrak{S} .

On the other hand, Table 3 points out that, in general, the long-term impact of domestic shock on the variables is insignificant, attaining a participation of only 3% in the case of the product and private consumption. The results found are not surprising for an emerging economy such as Peru's. The weak development of internal industry and, thus, the dependence on primary activity render the country more vulnerable to external shocks. The economy's revenues have the production of primary goods as their main source; as a result, the variations of the terms of trade maintain a direct effect on the country's economic vulnerability. Even more so, the Peruvian economy is characterized by a high concentration of raw material exports, which means that a variation in the prices of its goods causes instability on the revenues received.

3.5 Historical Decomposition

Finally, we perform a decomposition of the historical development of the Peruvian economy's main macroeconomic variables. Unlike the analysis of the variance decomposition, which is based on the estimation of the shocks, the historical decomposition is based on the current performances of the shocks. In this regard, the historical decomposition enables an alternative measurement of the relative importance of foreign and domestic shocks in the development of the estimated permanent components of each variable $(y_{gdpt}, y_{ct}, y_{pri_t}, y_{pub_t})$ ¹¹. The analysis was carried out for the entire sample, and the period of study was also disaggregated into two sub-periods: 1994-2000 and 2001-2007, in which the second period was characterized by favorable terms of trade for Peru.

The results of this analysis, presented in Table 4, show an increase in the trend product between the 1990s and 2000s, from 2.7% to 4.9%, respectively. Its development is explained primarily by the development in the terms of trade, which went from contributing -0.4% of the trend product in the 1990s to 1.9% in the 2000s. The domestic trend factors, which reflect the development of total domestic factor productivity, remained stable in the two sub-periods, at around 3%.

The analysis for the case of potential consumption shows results similar to those obtained for the product. Thus, it is estimated that the trend growth of consumption rose from 2.3% in the 1990s to 4.3% in the 2000s. As in the case of the product, the change in the terms of trade, from -0.3% in the 1990s to 1.6% in the 2000s, was a determinant for the trend increase in consumption. Moreover, the domestic trend factors stayed at around 2.7%.

In the case of the trend growth in private investment, this grew from 0.3% in the 1990s to 8.5% in the 2000s. The increase of 8.2 percentage points from one sub-period to another is primarily explained by a trend growth associated with the development of the terms of trade (7.3%), while the participation of the domestic factors remained at around 1.3%. It is worth mentioning that the participation of external factors in the private consumption trend development amounts to approximately one-fifth of such participation in the private investment trend development, while in the case of the participation of domestic factors, the relationship between both is almost double.

Unlike the other variables, the public investment trend development is the only series in which the domestic factors have a negative effect, increasing from -1.0% in the 1990s to -1.2% in the

¹¹This will be known as the potential components of the variables.

2000s. That is, in those years in which the total productivity of factors increased (all other things being equal), public investment fell. Nonetheless, the trend growth of public investment, as in the case of the other variables, is primarily explained by external factors, rising from a participation of -0.9% in the 1990s to 5.8% in the 2000s.

On the other hand, it can be seen that the contribution of domestic factors remained stable during the second sub-period, while the contribution of foreign factors to the development of all variables increased significantly for the second period. It is worth mentioning that the contribution of foreign factors was more pronounced for the case of public and private investment, with increases from -0.9% to 5.8% and from -1.1% to 7.3%, respectively.

The analysis of historical decomposition also allows the observation that the average participation of foreign factors in the development of all variables went from being negative over the period 1994-2000 to positive over the period 2001-2007. That is, during the first sub-period, foreign factors -rather than contributing positively to the growth of the variables- contributed negatively on average, stalling the economy's growth to a certain degree. Nonetheless, during the second sub-period, on average the external factors contributed positively to the growth of economic variables, accentuating their contribution to the development of both investments. In this sense, the results highlight that the volatility of the variables studied is highly related to external factors.

The greatest positive contribution of the terms of trade shocks to the permanent component of the product, consumption, private investment and public investment was posted in 2006, a period in which Peru constituted a favorable stage for foreign trade. On the other hand, the greatest negative contribution of foreign shocks to all variables mentioned was recorded one year later, in 2007, the period that marked the start of the international subprime crisis.

The observations of historical decomposition obtained may seem contradictory in comparison to those obtained of the variance decomposition. In effect, Table 4 suggests that domestic factors have been the most important in explaining the average growth rate in the potential of each of the variables under analysis. Nonetheless, Table 4 also suggests that the volatility of the potential of the four variables is dependent on foreign factors. In other words, the potential level of the four domestic variables is highly dependent on the external factors in the sense that their volatilities depend much on the movements in the terms of trade. The domestic component, we can affirm, has been more stable.

4 Conclusions

This document has four objectives. Firstly, to verify the existence of long term relationships between the group of variables analyzed. Secondly, to analyze the role of private investment and public investment, as well as the role of terms of trade in the economic fluctuations of the Peruvian economy. Thirdly, to identify the domestic and foreign shocks, as well as the degree of importance of both in the economy's fluctuations. Finally, to identify the role and impact of permanent and transitory shocks in the academic fluctuations of an emerging economy such as Peru's.

The results indicate the existence of three long term relationships between the set of variables and two stochastic trends, which are comprised of domestic and foreign shocks. With respect to the relationship existing between private and public investment, the analysis of cointegration proposes a complimentary effect between both, which is corroborated with the results obtained from the analysis of common stochastic trends in response to the presence of permanent foreign shocks (terms of trade). That is, insofar as the shocks in the terms of trade are favorable, in the

long term, both private and public investment will increase, which is consistent with responsible policy-making behavior on increasing fiscal spending in the face of a permanent increase in the terms of trade and, on the other hand, maintaining a savings policy if the shock is perceived to be transitory. Likewise, in the face of a permanent fall in the terms of trade, both private and public investment will also fall to the same extent. Nonetheless, a domestic shock (productivity) suggests a substitution relationship (or crowding out effect) between both investments, which is consistent with the observation in the period of structural reforms (1990-1996) in the country, in which private investment played an important role in the growth of the economy, while the role of the state was historically reduced.

Moreover, the analysis of stochastic trends indicates the role of permanent shocks in the medium- and long-term on all variables analyzed, while the transitory shocks explain, to a very limited degree, the behavior of the variables in the very short-term. In this sense, it is concluded that the high growth in the main macroeconomic principles of an emerging country such as Peru, in the scenario of a small open economy, is significantly linked with external factors, such as the rise in the prices of raw materials. Complimentarily, the decomposition of the historical development of the main variables is analyzed, for the periods 1994-2000 and 2001-2007, as another way of measuring the relative importance of external factors versus domestic factors in the development of each variable. The results also indicate the high sensitivity of the Peruvian economy's main macroeconomic variables in the face of external factors.

The study shows that the behavior of all variables analyzed is primarily explained by the permanent foreign shocks in the long-term. This result took on great importance in the behavior of the two investment series, led by private investment. In this sense, the effect of the permanent domestic shocks in the behavior of the variables studied is insignificant. This indicates the Peruvian economy's high vulnerability to external factors due to greater international economic exposure, which is exacerbated by the relatively small size of the domestic economy compared to the worldwide economy.

The conclusions set out here show the effects experienced by a small and open economy characterized by the production of primary goods as the main economic activity, which are directly related to the international market and where a price variation has direct repercussions on the economy's terms of trade. Moreover, the concentration of exports in the Peruvian economy is another key factor in understanding the depth of economic vulnerability with respect to external factors. A small concentration would enable greater stability in the final revenues received by the economy and, in turn, the country's economic activity would be less vulnerable.

Policy-makers face a considerable task based on the desire to cushion the effects of foreign shocks on the economy. The monetary policy, exercised by the each country's Central Bank, is an important tool in tackling the adverse consequences of external shocks. The role of each Central Bank in the absorption or amplification of shocks arising from outside the country, directly intervening through its policy instruments and indirectly on exchange rate volatility, will be decisive in the rise or fall of internal economic vulnerability.

The results are consistent with the favorable scenario of the terms of trade and its effects on a small open economy such as Peru's. The best external conditions have been conducive to significant growth in private investment in mining and the exportation of raw materials associated with that sector. At present, the terms of trade are unfavorable to the Peruvian economy and the effects on the main macroeconomic variables has quickly gained in prominence through a reduction in various private investment projects related to mining, as well as problems in executing private investment.

All of this has contributed to the Peruvian economy leaving behind high growth levels (6% to 8% annual) to return to growth rates of 2% or less.

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Table 1. Cointegration Tests

H_0	value	critical value at 5%	p-values
Traza (5%)			
$r = 0$	146.60	69.82	0.000
$r = 1$	79.64	47.86	0.000
$r = 2$	37.62	29.80	0.005
$r = 3$	13.82	15.50	0.088
$r = 4$	2.10	3.84	0.147
$\lambda_{\max}(5\%)$			
$r = 0$	66.96	33.88	0.000
$r = 1$	42.02	27.58	0.000
$r = 2$	23.81	21.13	0.021
$r = 3$	11.72	14.26	0.122
$r = 4$	2.10	3.84	0.147

Table 2. Decomposition of Variance

Variable	Innovation	$h = 1$	$h = 4$	$h = 8$	$h = 12$	$h = 20$	$h = 40$
y_{td_t}	τ_f	0.971 (0.076)	0.964 (0.036)	0.980 (0.024)	0.985 (0.019)	0.991 (0.013)	0.995 (0.007)
	τ_d	0.004 (0.064)	0.005 (0.022)	0.002 (0.012)	0.002 (0.013)	0.001 (0.005)	0.001 (0.003)
	transitory	0.026 (0.046)	0.031 (0.028)	0.018 (0.019)	0.013 (0.012)	0.008 (0.010)	0.004 (0.005)
y_{gdp_t}	τ_f	0.001 (0.018)	0.507 (0.277)	0.834 (0.321)	0.914 (0.233)	0.942 (0.214)	0.955 (0.212)
	τ_d	0.646 (0.941)	0.278 (0.301)	0.104 (0.291)	0.058 (0.221)	0.044 (0.211)	0.039 (0.210)
	transitory	0.353 (0.939)	0.215 (0.109)	0.062 (0.055)	0.028 (0.025)	0.013 (0.012)	0.006 (0.007)
y_{c_t}	τ_f	0.021 (1.006)	0.579 (0.943)	0.845 (0.595)	0.916 (0.401)	0.945 (0.311)	0.957 (0.277)
	τ_d	0.301 (0.400)	0.304 (0.885)	0.129 (0.563)	0.072 (0.384)	0.049 (0.303)	0.040 (0.273)
	transitory	0.677 (0.656)	0.117 (0.159)	0.026 (0.043)	0.011 (0.020)	0.005 (0.009)	0.002 (0.004)
y_{pri_t}	τ_f	0.032 (0.053)	0.534 (0.212)	0.900 (0.063)	0.964 (0.026)	0.985 (0.023)	0.993 (0.002)
	τ_d	0.134 (0.143)	0.056 (0.079)	0.012 (0.017)	0.004 (0.009)	0.002 (0.017)	0.001 (0.019)
	transitory	0.834 (0.149)	0.410 (0.166)	0.088 (0.056)	0.031 (0.023)	0.013 (0.011)	0.005 (0.006)
y_{pub_t}	τ_f	0.122 (0.205)	0.173 (0.537)	0.490 (0.434)	0.719 (0.226)	0.881 (0.124)	0.945 (0.071)
	τ_d	0.016 (0.058)	0.011 (0.059)	0.052 (0.199)	0.046 (0.218)	0.018 (0.087)	0.009 (0.053)
	transitory	0.863 (0.171)	0.815 (0.550)	0.458 (0.507)	0.235 (0.189)	0.100 (0.063)	0.046 (0.034)

Standard Errors are in parentheses

Table 3. Long-Run Decomposition of Variance

variable	τ_f	τ_d
y_{td_t}	1.000 (0.000)	0.000 (0.000)
y_{gdp_t}	0.966 (0.036)	0.339 (0.036)
y_{c_t}	0.966 (0.036)	0.034 (0.036)
y_{pri_t}	0.999 (0.000)	0.000 (0.000)
y_{pub_t}	0.999 (0.001)	0.001 (0.001)

Standard Errors are in parentheses

Table 4. Historical Decomposition (%)

Variable	Total	Foreign	Domestic	Total	Foreign	Domestic	Total	Foreign	Domestic
	1994-2007			1994-2000			2001-2007		
y_{gdp_t}	3.8	0.8	3.1	2.7	-0.4	3.1	4.9	1.9	3.0
y_{c_t}	3.3	0.6	2.7	2.4	-0.3	2.7	4.3	1.6	2.6
y_{pri_t}	4.4	3.1	1.3	0.3	-1.1	1.4	8.5	7.3	1.2
y_{pub_t}	1.4	2.5	-1.1	-1.9	-0.9	-1.0	4.6	5.8	-1.2

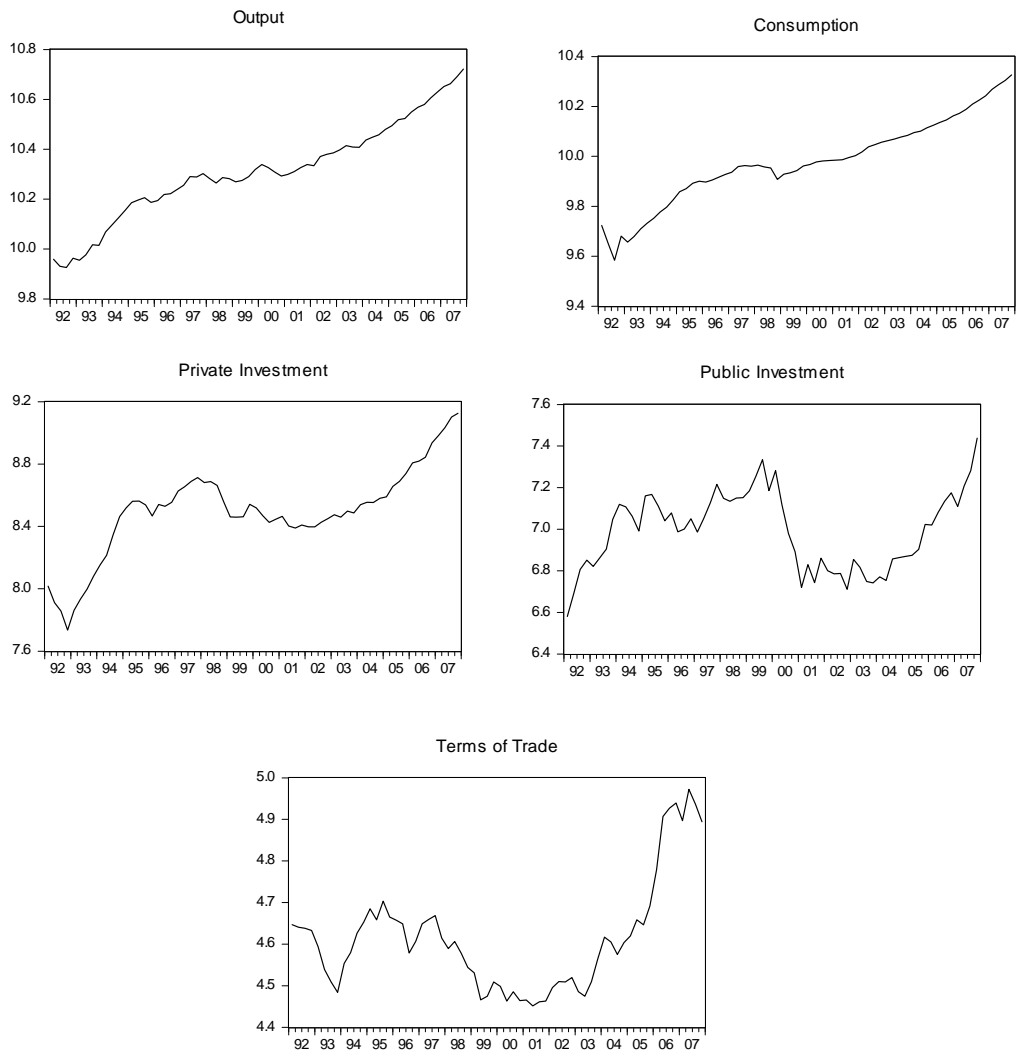


Figure 1. Seasonal Adjusted Variables

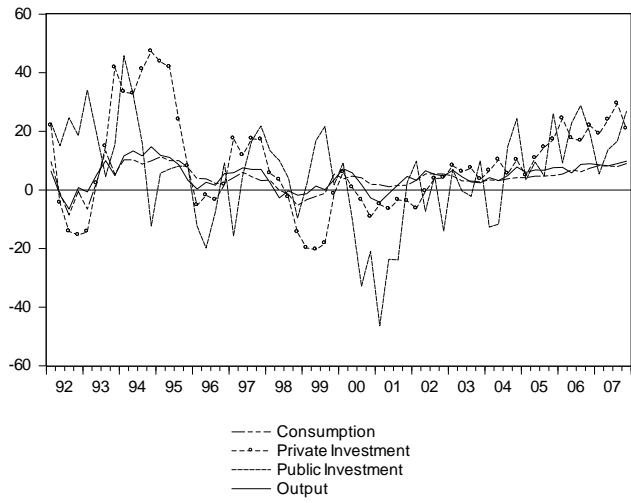
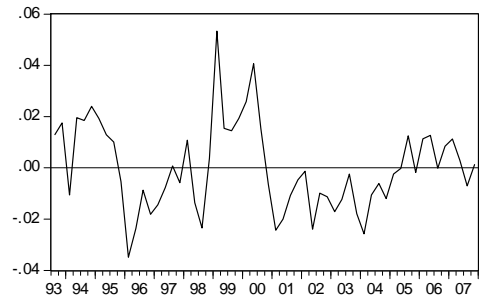


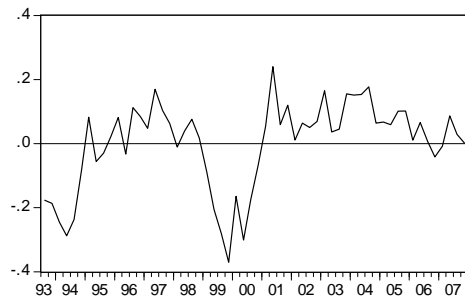
Figure 2. Growth Rates of Variables



— Cointegrating Relation 1



— Cointegrating Relation 2



— Cointegrating Relation 3

Figure 3. Estimated Cointegrated Relations

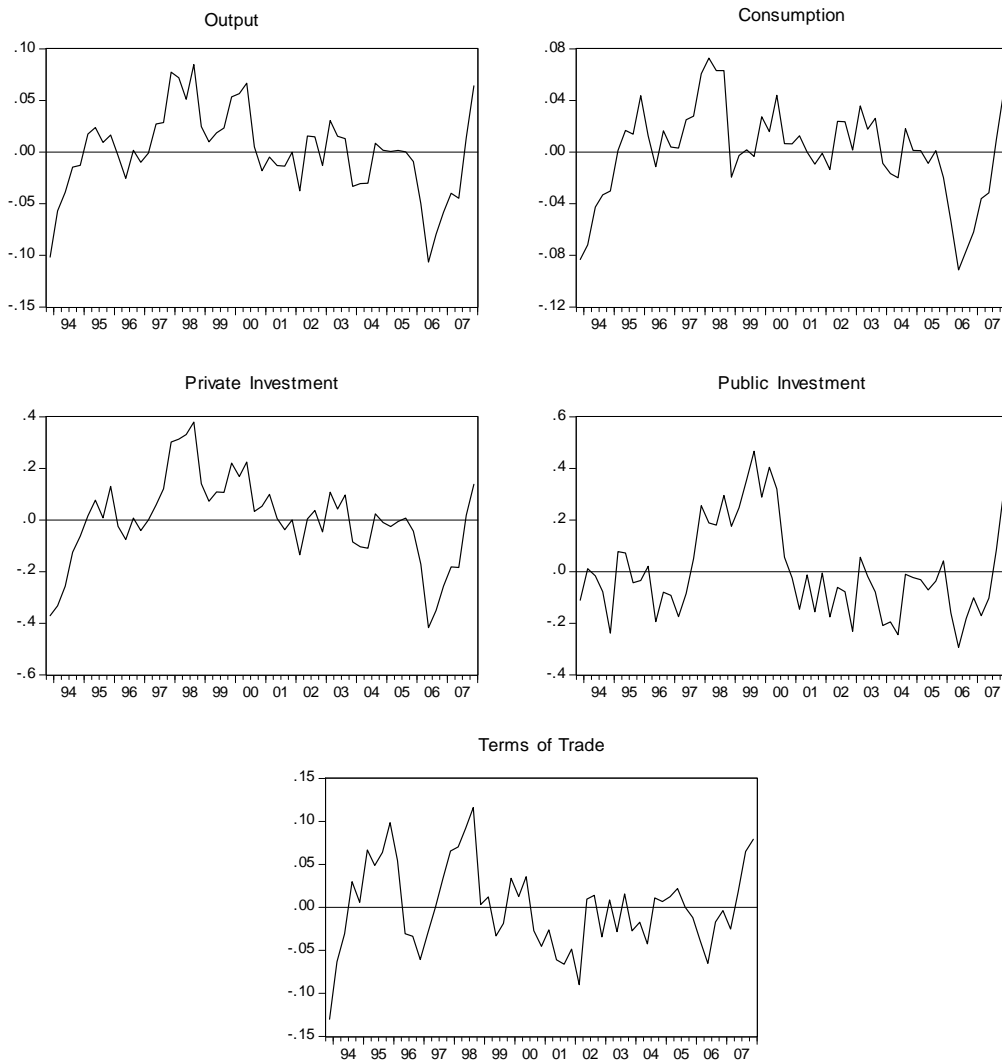


Figure 4. Transitory Components



Figure 5. Series and Permanent Components

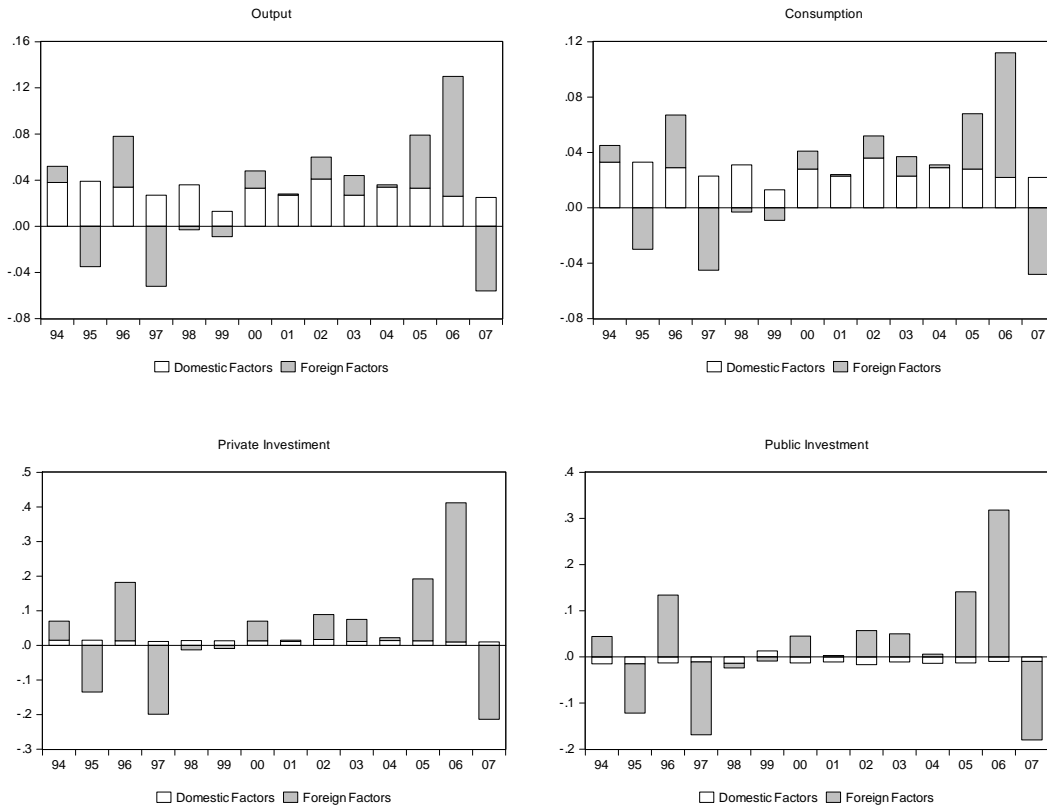


Figure 6. Historical Decomposition of Growth Rates

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