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# Terms of Trade and Current Account Fluctuations: a Vector Autoregression Approach

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# Terms of Trade and Current Account Fluctuations: a Vector Autoregression Approach*

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**Abstract**

This paper provides evidence on the Harberger-Laursen-Metzler (HLM) effect for the case of Peru. The HLM effect is the deterioration in the savings level of an economy due to a decline in their terms of trade for a given level of investment. This deterioration is caused by lower revenues which worsen the current account. We estimate VAR models that match up the following variables: terms of trade, export prices, import prices, current account, investment and saving. The results show that an unanticipated-permanent increase in the terms of trade (or export prices) improves the current account and saving rises. However, this effect disappears as investment grows faster than saving. On the other hand, an increase in the price of imports negatively affects the current account.

**JEL Classification:** F32
**Keywords:** Current account, terms of trade, HLM effect, vector autoregression.

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# 1 Introduction

According to the traditional interpretation, the saving level is negatively affected by a reduction of the terms of trade, through the lowering of the income level. For a given level of investment, this lowering deteriorates the current account. The previous reasoning is known as the Harberger-Laursen-Metzler (hereafter HLM) effect, proposed by Harberger (1950) and Laursen and Metzler (1950). Such effect has subsequently been examined within a deterministic, intertemporal utility-maximizing framework to explain the responses of saving and income along time for a given terms-of-trade shock. Therefore, other theoretical approaches explain the relationship considering an intertemporal framework and conclude that (besides the persistence of shocks) the net effect is determined by the interaction between income and substitution effects. See, for example, Sachs (1981), Svensson and Razin (1983), Obstfeld (1982), Persson and Svensson (1985) and Edwards (1989).

In this regard, this paper investigates the empirical relationship between the terms of trade and the current account for the case of Peru, a typical small open economy. Both the theory and the empirical studies provide a diversity of answers. Therefore, it is important to carry out empirical research and examine whether there exists convergence within this area. From a vector autoregression (VAR) viewpoint, both the impulse-response functions and the variance decomposition are analyzed. The impulse-response functions are interpreted as resulting from *unanticipated-permanent* shocks. Specifically, we estimated nine bivariate VAR models resulting from the combination of the current account, saving and investment GDP ratios[1] as the endogenous variable and terms of trade, price of exports and price of imports as the exogenous variable. However, at this point it is worth to emphasize that, although attention is devoted to the bivariate VAR relating terms of trade and current account, the remaining eight models are also analyzed in an attempt to identify the current account dynamics as the result of saving and investment decisions[2] (for given positive and negative terms of trade shocks). Annual observations covering the period from 1950 to 2009 were employed for this task.

Results suggest that *unanticipated-permanent* shocks to the terms of trade and price of exports improve the current account through an increase of saving, but then the effect vanishes as investment increases at a faster rate. A similar shock to the price of imports negatively impacts the current account through a deterioration of saving. Therefore, there is preliminar evidence supporting the HLM effect in Peru since a deterioration of the current account is observed through a decrease in saving, for a given investment level, due to a negative shock (for example, an increase of the price of imports). On the other hand, shocks to the terms of trade, price of exports and price of imports modestly contribute to the variance of current account, saving and investment (i.e. each of the latter GDP ratios is explained by their own shocks rather than by price shocks).

[1] For a sake of simplicity, any reference to this three variables should be understood in these terms.

[2] This informal "identification" process is intended to be complementary and suggestive rather than conclusive. Additional comments will be provided in Section 3.

The remaining of this paper is organized as follows. Section 2 provides a literature review. Section 3 describes both the dataset employed and the econometric model. Section 4 discusses the results and their policy implications. Section 5 concludes.

# 2 Literature Review

The references for the relationship between the terms of trade and the current account are Harberger (1950) and Laursen and Metzler (1950), which lead to the Harberger-Laursen-Metzler (HLM) effect. These authors assert that the savings level is negatively affected by a reduction of the terms of trade through the deterioration of income which (for a given level of investment) deteriorates the current account. Such approach assumes a stable relationship between income and saving, and naturally the main critique relies on the lack of an intertemporal utility-maximizing framework to explain the responses of saving and income along time for given terms of trade shocks.

For instance, Sachs (1981) points out that the modern theory of saving and investment emphasizes that their responses to several disturbances crucially depend on expectations about the way current shocks will affect the key economic variables in the future. The author analyzes the determinants of the current account and the exchange rates within a two-period model and distinguishes between permanent and transitory terms of trade shocks: permanent shocks have a small effect on the current account while transitory fluctuations may have larger effects.

Svensson and Razin (1983) emphasize the difference between responses of trade balance due to temporary and permanent terms of trade deteriorations. A temporary terms of trade deterioration generates both a temporary fall in real income and a change in the real interest rate while a permanent shock has an ambiguous effect. Specifically, the authors distinguish three effects: (i) a direct effect consisting of a revaluation of net exports, (ii) a wealth effect on consumption (since a terms of trade deterioration reduces it) and (iii) a pure substitution effect on consumption due to relative price changes within and between periods. The summation of the three aforementioned effects exhibits an ambiguous sign. However, the direct effect plus the wealth effect remains unambiguously negative for a temporary terms of trade deterioration.

Obstfeld (1982) argues that the HLM effect constitutes a particular case. Under an intertemporal utility-maximization framework, the author asserts that a permanent worsening of the terms of trade leads to a current account surplus rather than a deficit, a conclusion derived from the fact that aggregate spending (measured in units of the domestic good) should fall when net claims on future units of the foreign good are zero. In this sense, the HLM relationship predicting a downfall in saving and therefore a current account deficit no longer holds.

Persson and Svensson (1985) emphasize the difference between transitory/permanent and anticipated/unanticipated terms of trade shocks affecting the dynamics of saving and investment. They employ an overlapping generations (OLG) model to explain the behavior of saving in a small open economy and show that the reaction of saving to a terms of trade downfall can have any sign for plausible parameters values, both for temporary

and permanent disturbances.

Edwards (1989) analyzes how transitory and permanent terms of trade shocks affect the current account by employing a dynamic general equilibrium model that incorporates optimizing consumers and producers. The author asserts that the terms of trade shocks affect the current account through the real exchange rate mechanism and distinguishes between internal terms of trade shocks (generated by tariff changes) and shocks to the external terms of trade. The results show that a temporary import tariff worsens the current account only during the period it is imposed.

To summarize, the effect of a terms of trade shock on the current account depends on their persistence (transitory or permanent) and their predictability (anticipated or unanticipated), as well as on the interaction between income and substitution effects: the income effect goes in the same direction of the terms of trade shock, while the substitution effect goes in the opposite direction through intratemporal (related to the substitution of goods by cheaper ones in the same period) and intertemporal (related to the substitution of currents goods by goods in the future) substitution effects.

Several empirical studies have previously focused on the topic. For instance, Backus, Kehoe, and Kydland (1994) analyze some properties of the short term fluctuations in trade balance and the terms of trade for 11 developed countries. The authors find that the trade balance is uniformly countercyclical and negatively correlated, in most of the cases, to current and future movements in the terms of trade but it is positively correlated to past movements of the latter variable. Mendoza (1995) studies the link between terms of trade shocks and business cycles within a dynamic, small open economy, stochastic model for G-7 and 23 developing countries. Results show that net exports and terms of trade correlations are low and positive. That is, the HLM effect holds. Cashin and McDermott (1998) summarize their findings by stating that the terms of trade shocks induce both large and significant intratemporal and intertemporal substitution effects, which offset any associated income effect on saving decisions and the current account position. That is, the HLM effect does not hold.

Calderón, Chong, and Loayza (1999) estimate the determinants of the current account position for 44 developing countries and find that temporary shocks that increase terms of trade are linked to higher current account deficits, but permanent shifts do not have significant effects. Kent and Cashin (2003), by following a current account model that incorporates both the consumption-smoothing and investment effects, estimate a panel data model for 128 countries and find that the higher (lower) the persistence of terms of trade shocks, the higher (lower) the extent in which the investment effect dominates the consumption-smoothing effect on saving. Therefore, the current account moves in the opposite (same) direction to those of shocks. Otto (2003) estimates the effect of terms of trade shocks on the trade balance for 15 small OECD economies and 40 developing countries (Peru is included as well) within a structural vector autoegression (SVAR) framework. After considering terms of trade shocks (permanent and transitory), the author finds that the HLM effect holds in most of the cases.

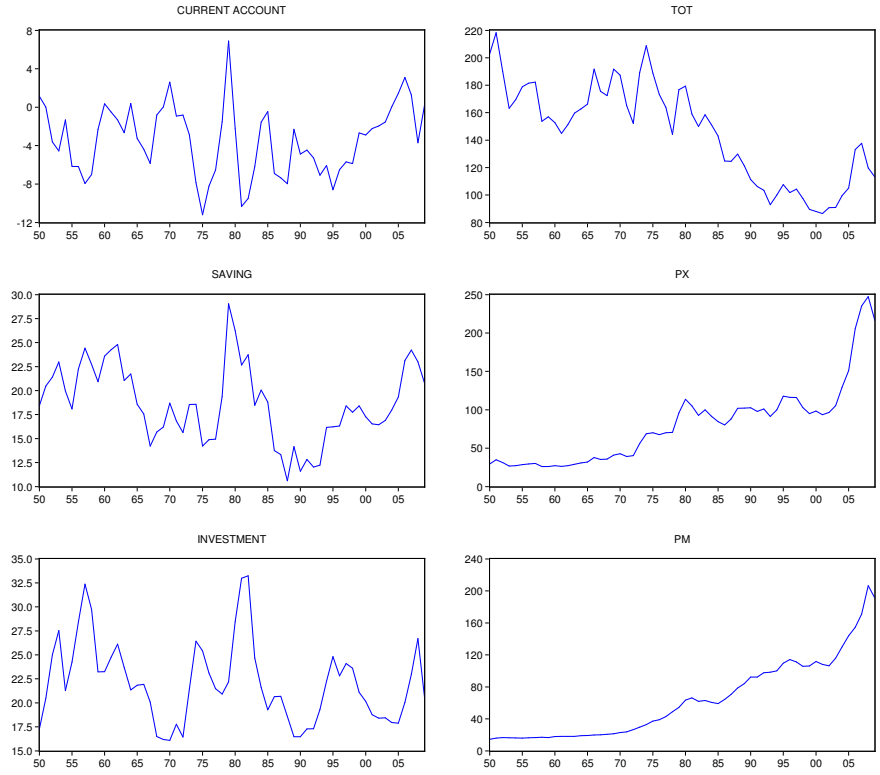
# 3 Empirical Strategy

In this section, the data and the econometric model are described. The data reflects the evolution of a typical small open economy and the econometric framework aims to model *unanticipated-permanent* shocks to the terms of trade and the corresponding current account response.

## 3.1 Data

The economy under study is Peru, a small open economy, during the period 1950-2009. Since the aim is to explore the current account and the terms of trade dynamics, annual data is considered for saving, investment and current account and terms of trade (TOT), price of exports (PX) and price of imports (PM) indexes[3] (see Figure 1).

Figure 1: Peru, relevant series (1950-2009)




[3]Terms of trade is defined as the ratio of export to import price indexes. They are estimated by the Fisher index formula, chained index weighting annually, which takes into account the weight of the goods according to their trade through time. By doing this, substitution effect is avoided and the corresponding measure is independent of the base year.

## 3.2 Econometric Model

As previously noticed, theoretical considerations suggest that the net effect depends on the persistence of shocks. Therefore, a simple econometric model is proposed in order to find out whether some intuitive results can be obtained and according also to prior empirical studies. Particularly, the vector autoregression (VAR) is helpful for modeling shocks mentioned in literature.

According to Sims (1980), the framework starts with a structural model for the endogenous variables contained in the $2 \times 1$ vector $y_t = [\Delta tot_t \; ca_t]'$[4], where the variables are functions of both its own lagged values and other contemporaneous variables

$$y_t = c + \sum_{i=0}^{q} A_i y_{t-i} + u_t. \tag{3.1}$$

In the above equation, $c$ is a $2 \times 1$ vector of constants, $q \geq 1$ is the number of lags in the system (to be determined according to the Schwarz criterion), each $A_i$ is a $2 \times 2$ matrix of coefficients ($i = 0, \ldots, q$) and $u_t$ is a $2 \times 1$ vector of innovations with distribution $N(0_{2\times 1}, I_2)$. Some algebra in (3.1) allows for writting

$$By_t = c + \sum_{i=1}^{q} A_i y_{t-i} + u_t, \tag{3.2}$$

where $B = I_2 - A_0$. Equation (3.2) can be written as

$$y_t = \tilde{c} + \sum_{i=1}^{q} \tilde{A}_i y_{t-i} + e_t \tag{3.3}$$

where $\tilde{c} = B^{-1}c$, $e_t = B^{-1}u_t$ and $\tilde{A}_i = B^{-1}A_i$ for each $i$. It must be noticed that the matrix $B$ allows for finding the effects of structural shocks $u_t$ on the behavior of the endogenous variables contained in $y_t$. Equation (3.3) can also be rewritten as

$$R(L)y_t \;\; = \;\; \tilde{c} + e_t, \tag{3.4}$$

where $R(L) = I_2 - \sum_{i=1}^{q} \tilde{A}_i L^i$ ($L$ is the lag operator) or, equivalently, as the following reduced vector moving-average representation

$$y_t \;\; = \;\; \bar{c} + F(L)e_t, \tag{3.5}$$

where $F(L) = R(L)^{-1} = \sum_{i=0}^{\infty} F_i L^i$ ($F_0 = I_2$), $\bar{c} = F(1)\tilde{c}$ and $e_t \sim N(0_2, \Omega_{2\times 2})$.

The identification is performed by employing the Cholesky decomposition, which makes use of the inverse of the Cholesky factor of the residual covariance matrix to orthogonalize the impulses, in order to impose an ordering of the variables in the VAR[5]. This allows for the derivation of both the impulse-response functions and the variance

[4] In a similar fashion, estimations are performed for the other combinations of GDP ratios and price indexes. The inclusion of the first component as a differenced variable anticipates the results of unit root tests, which are shown below.

[5] The problem of identification arises from the fact that the reduced form estimates less parameters than the structural model posesses. Therefore, it is necessary to impose a restriction on the structural form in order to identify the VAR. See Enders (2004) for further details.

decomposition. By analyzing these results, several economic implications can be inferred for policy design. Specifically, since the interest is focused on studying the relationship between the terms of trade and the current account, eight complementary bivariate VAR models were estimated[6] (see Table 1) resulting from the combination of terms of trade, price of exports and price of imports (as the exogenous variable) with the current account, savings and investment (as the endogenous variable). The nine VAR systems provide suggestive insights about the effects of positive and negative terms of trade shocks through innovations on the price of exports and imports[7] and to explore their dynamics along with those corresponding to current account, savings and investment[8].

Table 1: Bivariate VAR Models

| | Terms of Trade | Price of Exports | Price of Imports |
|---|---|---|---|
| Current Account | **VAR 1** | VAR 2 | VAR 3 |
| Savings | VAR 4 | VAR 5 | VAR 6 |
| Investment | VAR 7 | VAR 8 | VAR 9 |

# 4 Results

## 4.1 Data Analysis

The sample period, 1950-2009, is characterized by many economic changes, such the degree of openness of the economy. During the period 1970-1980 the international trade was restricted by law. In addition, during the period 1987-1990 the economy suffered the greatest economic crisis ever experienced. Economic adjustments (trade openness) and structural reforms involving the main sectors are characteristics of recent years. However, it is assumed that these events should not have changed the intrinsic relationship between the variables of interest.

As it is customary, the detection of unit roots becomes relevant for the specification of any VAR model. For this reason, unit root tests due to Dickey and Fuller (1979), Said and Dickey (1984) and Phillips and Perron (1988) are reported in Table 2. In summary,

[6]There are many authors that have employed bivariate VAR models along empirical studies. For example, Blanchard and Quah (1989), in the case of identification of real demand and real supply shocks.

[7]Indeed, positive (negative) terms of trade shocks can be explained by an increase (decrease) of export prices or a decrease (increase) of import prices, or the combination of both.

[8]It is worth to mention that a formal analysis of the dynamic linkage among the variables in $[\Delta tot_t \ \Delta px_t \ \Delta pm_t \ ca_t \ s_t \ i_t]'$ would naturally involve a six-variable VAR. However, such VAR imposes no restriction on the variables to be included and therefore it will neglect the identities $ca_t = s_t - i_t$ and $\Delta tot_t = \Delta px_t - \Delta pm_t$. In addition, although prices variables can be regarded as exogenous relative to GDP ratios, the complete ordering (required for identification) remains unclear. An alternative approach would consist on studying the dynamics of the vector $[\Delta px_t \ \Delta pm_t \ s_t \ i_t]'$ as a state equation and treating the two identities as measurement equations in a state-space fashion. However, such methodology significantly differs from the approach adopted in this paper.

Table 2: Unit Root Tests[a]

| Augmented Dickey-Fuller Tests | | | | |
|---|---|---|---|---|
| | | No drift or trend | Drift, no trend | Drift and trend |
| Current Account (as % of GDP) | | -2.674638*** | -4.792746*** | -4.765023*** |
| Savings (as % of GDP) | | -0.403615 | -2.610687* | -2.662239 |
| Investment (as % of GDP) | | -0.641021 | -4.176514*** | -4.598290*** |
| Price of Exports (in logs) | | 1.325737 | -0.289779 | -3.199061* |
| Price of Imports (in logs) | | 2.665482 | 0.176192 | -2.634267 |
| Terms of Trade (in logs) | | -0.918419 | -1.580339 | -2.231735 |
| Critical values[b] | 1% | -2.604746 | -3.546099 | -4.121303 |
| | 5% | -1.946447 | -2.911730 | -3.487845 |
| | 10% | -1.613238 | -2.593551 | -3.172314 |
| **Phillips-Perron Tests** | | | | |
| | | No drift or trend | Drift, no trend | Drift and trend |
| Current Account (as % of GDP) | | -2.633122*** | -3.713525*** | -3.700268*** |
| Savings (as % of GDP) | | -0.325484 | -2.704680* | -2.774746 |
| Investment (as % of GDP) | | -0.058193 | -3.124696** | -3.333739* |
| Price of Exports (in logs) | | 2.127509 | -0.086635 | -2.261052 |
| Price of Imports (in logs) | | 4.331633 | 0.299845 | -2.090575 |
| Terms of Trade (in logs) | | -1.135519 | -1.491102 | -2.238418 |
| Critical values[b] | 1% | -2.604746 | -3.546099 | -4.121303 |
| | 5% | -1.946447 | -2.911730 | -3.487845 |
| | 10% | -1.613238 | -2.593551 | -3.172314 |

[a] *, ** and *** indicate rejection of the unit root hypothesis at the 10%, 5% and 1% level of significance, respectively.

[b] MacKinnon (1996).

results therein suggest that the current account is a stationary series but the terms of trade, price of exports and price of imports contain a unit root. For the case of savings and investment ratios, results are sensible to the specification employed for testing, a tipical caveat of initial tests[9].

In order to overcome a series of well known limitations involving the power loss of unit root tests, Table 3 reports statistics due to Ng and Perron (2001) that attempt to increase the power of inference against local alternatives. In this case, not only price variables are sistematically classified as integrated but also the current account (again, results for the remaining aggregate ratios remain mixed). However, there exist both theoretical and practical reason to consider aggregate ratios, and therefore current account, as stationary variables. First, over a long time span, ratios involving savings and investment should orbitate around a *steady state* value. Second, saving (expressed as a ratio) is required to

[9]For an analitical study on recent developments, see Aquino and Rodríguez (2011).

Table 3: Ng-Perron Unit Root Tests[a]

| | | Intercept | | |
|---|---|---|---|---|
| | | $MZ_\alpha^{GLS}$ | $MZ_t^{GLS}$ | $MSB^{GLS}$ |
| Current Account (as % of GDP) | | -4.73775 | -1.53334 | 0.32364 |
| Savings (as % of GDP) | | -11.3729** | -2.36955** | 0.20835** |
| Investment (as % of GDP) | | -7.34393* | -1.91369* | 0.26058* |
| Price of Exports (in logs) | | 0.76343 | 0.42642 | 0.55856 |
| Price of Imports (in logs) | | 1.52339 | 1.47655 | 0.96925 |
| Terms of Trade (in logs) | | -0.81378 | -0.45360 | 0.55739 |
| Asymptotic critical values | 1% | -13.8000 | -2.58000 | 0.17400 |
| | 5% | -8.10000 | -1.98000 | 0.23300 |
| | 10% | -5.70000 | -1.62000 | 0.27500 |
| | | Trend and intercept | | |
| | | $MZ_\alpha^{GLS}$ | $MZ_t^{GLS}$ | $MSB^{GLS}$ |
| Current account (as % of GDP) | | -2.72077 | -1.06788 | 0.39249 |
| Savings (as % of GDP) | | -11.7578 | -2.39767 | 0.20392 |
| Investment (as % of GDP) | | -11.9161 | -2.43802 | 0.20460 |
| Price of Exports (in logs) | | -6.39943 | -1.74492 | 0.27267 |
| Price of Imports (in logs) | | -8.47709 | -2.04896 | 0.24171 |
| Terms of Trade (in logs) | | -7.33863 | -1.87894 | 0.25603 |
| Asymptotic critical values | 1% | -23.8000 | -3.42000 | 0.14300 |
| | 5% | -17.3000 | -2.91000 | 0.16800 |
| | 10% | -14.2000 | -2.62000 | 0.18500 |

[a] *, ** and *** indicate rejection of the $I(1)$ null hypothesis at the 10%, 5% and 1% level of significance, respectively. Modified or $M$-tests are described in Ng and Perron (2001). In the case of $MZ_\alpha^{GLS}$, $MZ_t^{GLS}$ and $MSB^{GLS}$ tests, a statistic lower than the critical value leads to a rejection of the $I(1)$ null hypothesis.

lie between between 0 and 1.

Nevertheless, it can be noticed in Figure 1 that all variables seem to exhibit abrupt shifts which, according to Perron (1989), distort conventional tests and lead to an over acceptance of the unit root hypothesis. For this reason, Table 4 reports the unit root tests proposed by Perron and Rodríguez (2003) which allow for the presence of a structural change. That is, abrupt shift are allowed and "controlled" in a robust fashion while testing for unit roots. A conservative 90% confidence level allows to characterize aggregate ratios as stationary and prices as integrated series. For this reason, terms of trade (as well as prices of exports and imports) are introduced in the bivariate VAR in first differences and the current account is introduced in levels (and no cointegration test is required).

For each one of the nine VAR models, the Schwarz criterion was employed to select the number of lags to be included (see Table 5). As it can be noticed, most of the selected

Table 4: Perron-Rodríguez Unit Root Tests[a]

| | | $\sup MZ_{\alpha}^{GLS}$ | $\sup MZ_{t}^{GLS}$ | $\sup MSB^{GLS}$ |
|---|---|---|---|---|
| Current account (as % of GDP) | | -49.5158*** | -4.9751*** | 0.1005*** |
| Savings (as % of GDP) | | -24.1972** | -3.4749** | 0.1436** |
| Investment (as % of GDP) | | -21.1400* | -3.2511* | 0.1538* |
| Price of Exports (in logs) | | -8.3603 | -2.0329 | 0.2432 |
| Price of Imports (in logs) | | -12.5783 | -2.5066 | 0.1993 |
| Terms of Trade (in logs) | | -7.2138 | -1.8897 | 0.2620 |
| Critical values[b] | 1% | -27.0000 | -3.6600 | 0.1340 |
| | 5% | -22.9000 | -3.3500 | 0.1450 |
| | 10% | -20.7000 | -3.1900 | 0.1540 |

[a] *, ** and *** indicate rejection of the $I(1)$ null hypothesis at the 10%, 5% and 1% level of significance, respectively. Modified or $M$-tests under structural change are described in Perron and Rodríguez (2003). In the case of $\sup MZ_{\alpha}^{GLS}$, $\sup MZ_{t}^{GLS}$ and $\sup MSB^{GLS}$ tests, a statistic lower than the critical value leads to a rejection of the $I(1)$ null hypothesis.

[b] Perron and Rodríguez (2003), Table 2.

models exhibit only one lag.

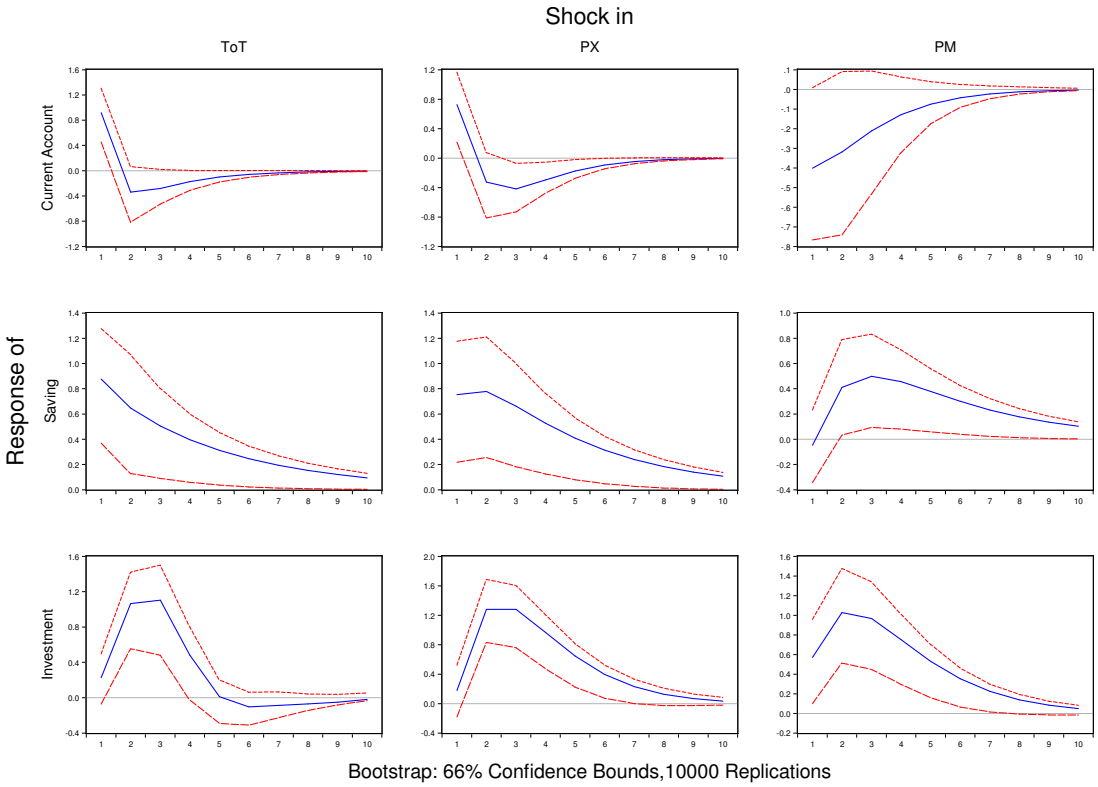
## 4.2 Impulse Responses

Figure 2 displays the nine impulse-response functions, which can be interpreted in two ways. First, as the extent in which the current account reacts to different terms of trade shocks (either positive or negative). Second, as a tentative description about the component of the current account that explains its response for a given terms of trade shock. In particular, it suggests that *unanticipated-permanent* shocks to the terms of

Table 5: Lag-Lenght Selection

| | Lag | Schwarz criterion |
|---|---|---|
| VAR 1: ToT - Current Account | 1 | 12.52895 |
| VAR 2: PX - Current Account | 1 | 12.93093 |
| VAR 3: PM - Current Account | 1 | 11.64488 |
| VAR 4: ToT - Saving | 1 | 12.12742 |
| VAR 5: PX - Saving | 1 | 12.54588 |
| VAR 6: PM - Saving | 1 | 11.31139 |
| VAR 7: ToT - Investment | 2 | 12.20688 |
| VAR 8: PX - Investment | 1 | 12.40413 |
| VAR 9: PM - Investment | 1 | 11.11400 |

Figure 2: Impulse-response function (permanent shock)

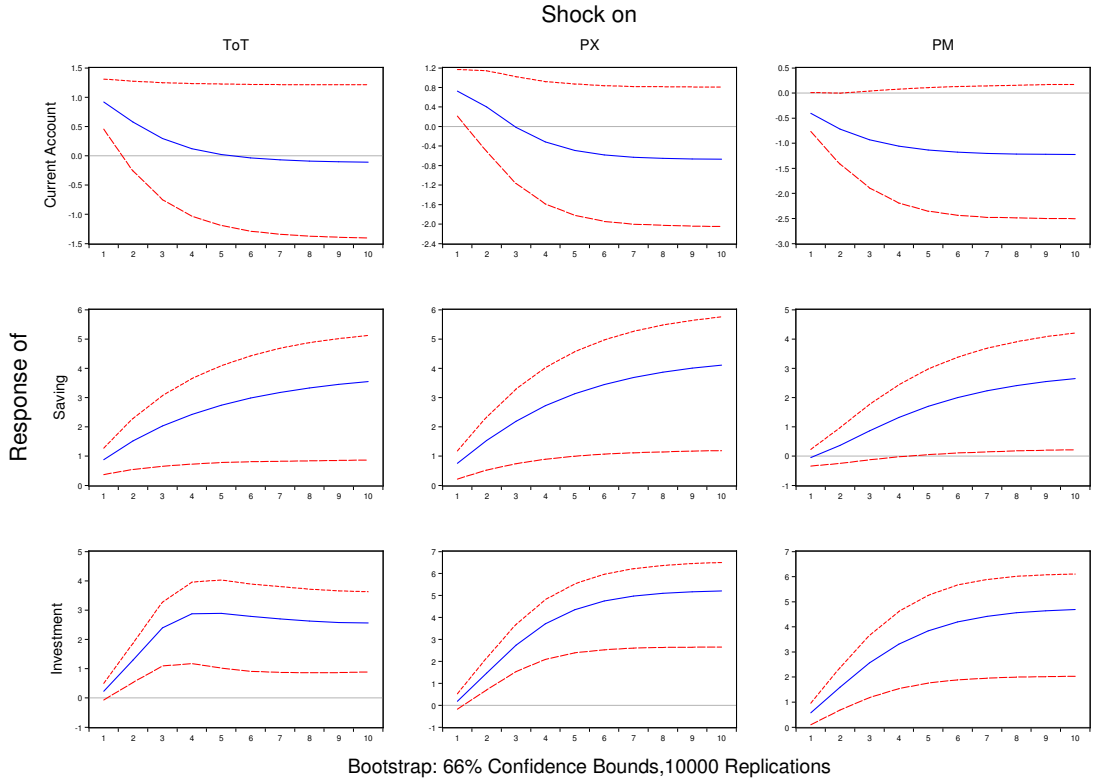



trade and the price of exports improve the current account during the first year, they both are followed by a decrease during the second year and by a smooth transition to the steady state in subsequent years. Also, a shock to the price of imports deteriorates the current account in subsequent years until the latter approaches to its corresponding steady state value.

The response of saving to an *unanticipated-permanent* shock to the terms of trade and price of exports is positive and smoothly vanishes as long as the steady state remains closer. In the case of a shock to the price of imports, saving reacts negatively during the first year and then positively approaches the steady state. The last fact provides a clue that the HLM holds in the case of Peru, since a current account deterioration is observed through a decrease on saving (for a given level of investment) due to an adverse shock (in the exercise, a positive shock to the price of imports).

As it can be noticed in Figure 2, *unanticipated-permanent* shocks to the terms of trade, price of exports and price of imports improve the investment rate during the second and third years and then the effect slowly vanishes. First and second results are intuitive, since the main economic sector along the sample is mining sector, which favorable reacts to positive shocks to the price of exports like gold or copper. The third result can be interpreted as a puzzle since a deterioration of investment is meant to be expected due to a positive shock on the price of imports (mainly oil). However, the oil sector becomes

Figure 3: Cumulative impulse-response function (permanent shock)




relevant for the investment accountability and therefore the increase in the price of imports can boost the investment in such sector, but further research is needed in order to support this argument.

In summary, *unanticipated-permanent* shocks to the terms of trade and price of exports improve the current account through an increase on the saving rate, but then the effect goes down as long as the investment rate increases faster than saving rate. A similar shock to the price of imports does negatively affect the current account through a deterioration in the saving rate and an increase on the investment rate, although, the latter is not clearly the channel of transmission since a deterioration of investment ratio is expected due to a positive shock on price of imports, mainly oil price. Additionally, cumulative impulse-response are shown in Figure 3.

## 4.3 Variance Decomposition

For variance decomposition, the patterns displayed in Table 6 can be roughly summarized as follows: *unanticipated-permanent* shocks to the terms of trade, price of exports and price of imports slightly explain the variance of the current account, saving and investment. That is, the latter is explained by their idiosyncratic shocks rather than those corresponding to price variables.

Table 6: Variance decomposition

| Current Account | | | | | | |
|---|---|---|---|---|---|---|
| | Terms of Trade | | Price of Exports | | Price of Imports | |
| Step | % | 90% CI | % | 90% CI | % | 90% CI |
| 1 | 10.04 | [26.91,0.56] | 6.17 | [22.56,0.09] | 1.76 | [12.74,0.02] |
| 2 | 8.07 | [23.14,3.39] | 5.24 | [19.88,1.97] | 2.15 | [16.99,0.24] |
| 3 | 7.91 | [23.25,3.50] | 6.04 | [22.26,2.35] | 2.33 | [19.22,0.30] |
| 4 | 7.88 | [23.41,3.51] | 6.51 | [23.40,2.49] | 2.40 | [20.11,0.32] |
| 5 | 7.87 | [23.53,3.50] | 6.68 | [23.71,2.52] | 2.43 | [20.29,0.32] |
| 6 | 7.87 | [23.58,3.50] | 6.73 | [23.84,2.53] | 2.44 | [20.36,0.32] |
| 7 | 7.87 | [23.59,3.50] | 6.74 | [23.87,2.54] | 2.44 | [20.40,0.32] |
| 8 | 7.87 | [23.59,3.50] | 6.75 | [23.88,2.54] | 2.44 | [20.43,0.32] |
| 9 | 7.87 | [23.59,3.50] | 6.75 | [23.89,2.54] | 2.44 | [20.43,0.32] |
| 10 | 7.87 | [23.59,3.50] | 6.75 | [23.89,2.54] | 2.44 | [20.43,0.32] |
| Saving | | | | | | |
| | Terms of Trade | | Price of Exports | | Price of Imports | |
| Step | % | 90% CI | % | 90% CI | % | 90% CI |
| 1 | 11.82 | [30.77,0.37] | 8.78 | [27.15,0.12] | 0.04 | [6.20,0.01] |
| 2 | 11.34 | [33.50,0.92] | 11.05 | [33.37,0.71] | 1.65 | [13.00,0.32] |
| 3 | 11.17 | [34.90,0.95] | 12.24 | [37.12,0.83] | 3.25 | [19.58,0.41] |
| 4 | 11.09 | [35.52,0.92] | 12.87 | [38.93,0.89] | 4.34 | [23.28,0.44] |
| 5 | 11.04 | [35.79,0.92] | 13.21 | [39.87,0.91] | 5.01 | [25.26,0.45] |
| 6 | 11.02 | [35.93,0.90] | 13.40 | [40.23,0.92] | 5.41 | [26.33,0.46] |
| 7 | 11.01 | [36.10,0.91] | 13.51 | [40.46,0.92] | 5.64 | [26.87,0.46] |
| 8 | 11.00 | [36.12,0.90] | 13.57 | [40.55,0.92] | 5.77 | [27.20,0.47] |
| 9 | 10.99 | [36.15,0.90] | 13.60 | [40.59,0.92] | 5.85 | [27.40,0.47] |
| 10 | 10.99 | [36.16,0.90] | 13.62 | [40.61,0.92] | 5.89 | [27.50,0.47] |
| Investment | | | | | | |
| | Terms of Trade | | Price of Exports | | Price of Imports | |
| Step | % | 90% CI | % | 90% CI | % | 90% CI |
| 1 | 0.85 | [8.44,0.01] | 0.48 | [9.20,0.01] | 4.20 | [18.46,0.05] |
| 2 | 8.40 | [24.23,1.09] | 13.35 | [31.86,4.10] | 10.49 | [30.65,1.17] |
| 3 | 12.89 | [33.52,1.61] | 20.46 | [41.79,5.98] | 14.23 | [37.61,1.59] |
| 4 | 13.43 | [35.54,1.93] | 23.71 | [45.88,6.76] | 16.19 | [41.05,1.77] |
| 5 | 13.41 | [35.75,2.07] | 25.06 | [47.42,7.05] | 17.13 | [42.25,1.84] |
| 6 | 13.44 | [36.00,2.07] | 25.57 | [47.92,7.17] | 17.55 | [42.67,1.88] |
| 7 | 13.44 | [36.16,2.07] | 25.74 | [48.11,7.25] | 17.72 | [42.78,1.91] |
| 8 | 13.44 | [36.22,2.07] | 25.80 | [48.16,7.27] | 17.79 | [42.82,1.92] |
| 9 | 13.44 | [36.23,2.08] | 25.81 | [48.19,7.27] | 17.81 | [42.85,1.93] |
| 10 | 13.44 | [36.24,2.08] | 25.82 | [48.19,7.28] | 17.82 | [42.87,1.94] |

On average, terms of trade shocks account for about 8%, 11% and 13% of the variability of the current account, saving and investment ratios, respectively. The price of exports accounts for about 7%, 14% and 26% of the corresponding variances whereas the price of imports does for about 2%, 6% and 18% of the variation in the current account, saving and investment ratios, respectively. We observe that shocks to the terms of trade tend to affect investment in a higher extent (in comparison to saving) due to the dependence of the economy of Peru on the evolution of the commodities prices through the mining sector, which primarily sets the investment path.

These results differ from other studies. For example, Otto (2003) found that shocks to the terms of trade account for about 33% of the variation for the balance of trade in the case of Peru[10]. On the other hand, Mendoza (1995) found that a large variance of trade of balance in the G-7 countries can be attributed to the estimated size of productivity shocks and their positive correlation with the terms of trade. A possible interpretation of the results states that the effects of terms of trade on current account could be measured as the sum of the effects of terms of trade on saving and investment, since they are its components whose effects go in opposite directions from macroeconomic accountability. Therefore, terms of trade, price of exports and price of imports should account for 24%, 39% and 24% of the variation of the current account, respectively. These results are closer to those found in prior empirical studies.

The omission of feasible transmission channels of terms of trade shocks, such as the real exchange rate, the degree of openness or the GDP per capita, could be explaining the variance decomposition estimated in the study. In fact, there are other factors that explain terms of trade fluctuations that must be affecting the relationship between the terms of trade and current account, as Galor and Lin (1994) claim: "(...) a comprehensive discussion of current account dynamics should be based on changes in the fundamentals of the world economy that lead to changes in the relative prices, rather than on changes in endogenous variables." However, the results display relevant features for the relationship between the terms of trade and the current account for the peruvian economy and they might be taken into account in the design of policies aimed to preserve macroeconomic stability.

# 5 Concluding Remarks

This paper performed an empirical study on the relationship between the terms of trade and the current account in the case of Peru, a small open economy, for the period 1950-2009. According to the traditional interpretation, the level of saving is negatively affected by a reduction in the terms of trade, through the deterioration of the income level; and,

[10]The author makes use of the balance of trade as a measure of current account, while herein the current account is employed since it better reflects the dynamic process regarding optimal decissions adopted by agents. In addition, Otto (2003) relies on a three-variable SVAR model (terms of trade, output and trade balance), and identifies supply shocks and real demand shocks through long-run restrictions. However, the author implicitly claims that shocks to the terms of trade affect output in the long-run, which cannot be sustained from theory as in the case of real supply and real demand shocks restrictions.

for a given level of investment, this will deteriorate the current account. This result is known as the Harberger-Laursen-Metzler (HLM) effect, attributed to Harberger (1950) and Laursen and Metzler (1950). Other theoretical frameworks explain the relationship considering an intertemporal framework and conclude that the net effect depends on the persistence of the shocks where both the income effect and substitution effect completely determine it, as shown by Sachs (1981), Svensson and Razin (1983), Obstfeld (1982) and Persson and Svensson (1985).

From the perspective of the vector autoregression (VAR) framework here adopted, the impulse-response functions are interpreted as resulting from *unanticipated-permanent* shocks. The results show that *unanticipated-permanent* shocks to the terms of trade and price of exports improve the current account through an increase on the saving rate, but such effect vanishes as investment increase faster than saving does. A similar shock to the price of imports negatively affects the current account through the deterioration of saving. Therefore, there is evidence the HLM holds in the case of Peru, since a deterioration of the current account is observed through a decrease in saving, for a given level of investment, due to a negative shock (in the exercise a positive shock on the price of imports). On the other hand, similar shocks to the terms of trade, price of exports and price of imports slightly explain the variance of the current account, saving and investment. That is, the latter is explained by their idiosyncratic shocks rather than by innovations in terms of trade, price of exports and price of imports.

Despite the nature of results, it is worth to mention that a VAR model imposes restrictions on the parameters and the distribution of data. A non-linear VAR model would improve results obtained in this paper, since different patterns of shocks can be estimated. Additionally, a Bayesian VAR approach might improve the results since different priors about the distribution of the data can be imposed.

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