A Revisitation of the Savings-Growth Nexus in Mexico

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Abstract

Through employing tests for long-term causality that are not dependent upon pretests of cointegration rank and unit roots, we find evidence in favour of the savings-growth relationship for Mexico over the period 1960-1996. While growth can be shown to be a stimulus for savings, contrary to Sinha and Sinha ({Economics Letters}, 1998), the influence of savings on growth cannot be ruled out totally, especially over the short run. We further explore the complex dynamics of the functional inter-relationships and attempt to clarify this nexus.

Key Words/Phrases: Savings-growth, long-run relationship, cointegrating VARs, generalized impulse response functions.

JEL: E21, O11, C32, C52

The views expressed in this paper are strictly those of the authors.

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Introduction

The neoclassical models inspired by Solow (1956) suggest a connection between higher savings and economic growth in the short run as the economic transitions between alternative steady-states (see, Kaldor, 1961). In fact, the mainstream empirical literature on growth theory, founded on Solow's model, is substantiated by numerous empirical studies (Barro and Sala-i-Martin, 1992, 1995; Levine and Renelt, 1992; Mankiw et al., 1992; Nonneman and Vanhudt, 1996). Recent models based on endogenous growth theories like those developed by Romer (1986); Lucas (1988) and Reynolds (1983) establish a connection between higher savings and growth rates. These works coincide with the conventional belief that higher savings lead to higher economic growth, and thus lead to macroeconomic policies to stimulate growth. However, Jones (1995) criticizes the endogenous AK models' prediction that permanent changes in government policies affecting investment rates lead to permanent changes in growth rates. In contrast, McGrattan (1998) supports the AK models' prediction with evidence that investment rates and growth rates have a strong positive relationship. In this sense, development theory assigns a dominant role to internal savings and investment for economic growth and development (see Mackinnon and Shaw, 1973; Wheeler, 1980; Douglas North, 1989; T.M. Steger, 2000 and Hammer, 1998).

The socio-political and economic context is highly relevant for applying appropriate policy instruments to achieve economic growth. Policy instruments do not have the same effect in heterogeneous experiences and different stages of economic development achieved by countries. Nonetheless, the strong causal relationship between savings and growth should not be underestimated (see specially the study of Schmidt-Hebbel and Serven, 1995; Liu and Xu, 1996; Cardenas, 1998; Krieckhaus, 2002). The fast growing Asian economies (the newly industrializing economies) had maintained the highest savings rates in the world, ranging from 30% to 50% of GDP for several decades prior to the Asian crisis. This causal link between savings and growth between the NIE's is explained by large domestic and foreign savings to finance domestic investment, which subsequently have contributed to high growth, amongst other positive effects (Kim, 2001).

However, empirical work by Gavin, Hausmann and Tavli (1997) suggests that, contrary to conventional wisdom, higher economic growth precedes higher savings rates. Thus, Gavin et al's results indicate that the strongest determinant of savings is economic growth over the long run. Furthermore, recent work by Sinha and Sinha (1998) support Gavin et al's results on a data series for Mexico from 1960 to 1996. In addition, they confront the main criticisms of Gavin et al in the case of Mexico by (i) increasing the time span of data, (ii) studying the problem of unit roots, cointegration and granger causality and (iii) separating the effects of public and private savings. Similar results on saving dynamics in Asian countries have been highlighted more recently by Baharumshah, Thanoon and Rashid (2003). They show that the casual link between savings and economic growth is weak in every country studied from 1960 to 1997, except Singapore, thus adding to the burgeoning literature (Lahiri, 1989; Jappellelli and Pagano, 1994; Collins, 1989; Paxson, 1996; Muradoglu and Taskin, 1996; Morande, 1998), which questions the conventional wisdom of savings being a leading determinant of economic growth.

Moreover, the empirical evidence from several of the studies mentioned reveals that causation need not necessarily go in the opposite direction either, with higher growth leading to higher savings, as in the case of Hong Kong, Malaysia, Myanmar and Singapore, according to Sinha (2001). Hence, in some instances, the relationship between these two variables is shown to be spurious (see Kim, 2001). In this sense, how can apparent paradoxes such as the differences in recent economic performance of Japan and US be explained, if one relies strictly on savings as the key determinant of economic growth? While the US economy has demonstrated remarkably high economic growth, in spite of recording one of the lowest savings rates during the 1990's, Japan, with one of the highest savings rates, has experienced very low GDP growth for the same period (see Suto and James, 1999). The answer in this paradoxical case is that productivity improvement is more important than domestic savings as a source of growth (Makin, 2002). In other words, total factor productivity (TFP) translates into more efficient use of the entire capital shock (see the importance of low TFP in Hsieh and Klenow, 2003). Vanhoundt (1998), however, maintains that the Solow model is more prone to witness negative granger causality between growth and savings rates in the medium run and no causality in the granger sense between savings and long-run rates of growth. Therefore, there seems no valid reason to dismiss the causal relationship between savings leading to growth, which is commonly associated with the Solow model and neoclassical growth theory.

Distinct methodological approaches to address the same question lead researchers to arrive at completely conflictive and sometimes empirically flawed results (see, Gonzales, 1988). We maintain that the apparent paradox in the absence of growth with high savings in Mexico is due to methodological limitations in the study carried out by Sinha and Sinha (1998). The main focus of this research will thus be to address these perceived limitations.

We apply recently developed vector autoregression (VAR) techniques on tests for Granger non-causality to the same data set used by Sinha and Sinha (1998). We show that, contrary to their findings, there does exist a significant role for savings in driving long-run economic growth in Mexico. We argue that tests for Granger non-causation that are dependent upon pretests of cointegration rank, particularly in small samples, may seriously contaminate estimates and lead one to make misleading inferences. In such cases it is appropriate to apply testing procedures that are free of pretest bias. Such tests are over-parameterized level VARs prescribed by Toda and Yamamoto (1995), and in independent work, by Dolado and Lutkepohl (1996). Further, we augment the evidence based on these tests by estimating generalized impulse response and generalized variance decompositions like Koop, Pesaran and Potter (1996), in order to quantify what proportion of shocks to GDP growth are explained by public and private savings in Mexico.

Methodology

Consider a (*k-1*)- vector random process $\{\mathbf{z}_t\}_{t=1}^{\infty}$ whose data generating process is given by

$$\Lambda z_t = a_0 + a_1 t + \sum_{i=1}^{k-1} \Gamma_i \Lambda z_{t-i} + \Pi z_{t-1} + e_t, t = 1,2\ldots T$$

where $\Delta \equiv 1 - L$ is the difference operator

$$\Pi = -\left(I_m - \sum_{i=1}^{p} \Phi_i\right); \Gamma_i = -\sum_{j=i+1}^{p} \Phi_j, i = 1,\ldots, p-1$$

Note that the short-run response matrices $\{\Gamma_i\}_{i=1}^{p-1}$ and the long-run multiplier matrix Π are defined above. Along with $\mathbf{z}_t$, the error term $\mathbf{e}_t$ is also partitioned as $\mathbf{e}_t = (\mathbf{e}'_{yx}, \mathbf{e}'_{xt})$ with a variance-covariance matrix specified as:

$$\Omega = \begin{pmatrix} \Omega_{yy} & \Omega_{yx} \\ \Omega_{xy} & \Omega_{xx} \end{pmatrix}$$

This framework allows structural modelling of the vector of $\mathbf{y}_t$ conditional upon historical or lagged values of $\mathbf{y}_t$ as well as contemporaneous and past values of random variables $\mathbf{x}_t$. Both Pesaran; Smith and Shin (2000), as well as Harbo, Johansen, Nielsen and Rahbak (1998), consider the problem of structural modelling and inference using this framework.

Suppose that in equation ref. 1 we redefine the m-vector of random variables given by $\mathbf{z}_t$ as $\mathbf{z}_t = (\mathbf{z}'_{1t}, \mathbf{z}'_{2t}\ \mathbf{z}'_{3t})$ and we are interested in whether the first m_1 elements of $\mathbf{z}_t$ are Granger caused by the last m_3 elements of, where $\mathbf{z}_{it}$ is of dimension m_i, $i = 1,2,3$ and we partition Γ_i conformably with $\mathbf{z}_t$. The null hypothesis of non-causality can then be formulated in equation ref. 1 as:

$$H_0 : \Gamma_{1,13} = \ldots = \Gamma_{p-1,13} = 0,\ \Pi_{13} = 0$$

against the alternative

$$H_1 : \Gamma_{1,13} \neq \ldots \neq \Gamma_{p-1,13} = 0,\ \Pi_{13} \neq 0$$

where $\Gamma_{1,13}$ and Π_{13} are the $m_1\ x\ m_3$ upper-right submatrices of $\Gamma_{1,13}$ and Π_{13}, respectively. As causality tests are frequently constructed from least squares estimates of the VAR, these tests implicitly use an unrestricted estimated of Π.

More recently, Toda and Yamamoto (1995), and in independent work, Dolado and Lutkephol (1994), proposed a complementary integrated procedure which allows casual inference to be conducted in level VARs that many contain integrated processes, but does not involve scrutiny and strict dependence upon integration and cointegration properties of any or all variables in the system. In essence, this procedure circumvents some of the pre-test biases that practitioners may be confronted with in a VECM and other modelling formulations involving unit root and cointegration pre-testing. Furthermore, the Toda-Yamamoto procedure is simple and convenient to apply and permits linear as well as non-linear tests of restrictions. These restrictions themselves would then imply long-run casual inference since, unlike ordinary difference VARs, this formulation involves only variables appearing in their levels.

Toda and Yamamoto and Dolado and Lutkepohl (TYDL) show that standard Wald tests can be applied to the coefficient matrices up to the correct lag order, when the system in level is artificially augmented by including at least as many extra lags of each variable as the highest order of integration of any variables in the system. Suppose we consider the VAR (p, l) model but now augment this with an extra lag, i.e. we fit a VAR (p+1, l) model. The hypothesis of non-causality can now be tested using a conventional Wald statistic since the additional lag, for which $\Gamma_{p,13} = 0$, by assumption, permits valid standard asymptotic inference to be used. The reason for this property is that all non-standard asymptotes will apply with respect to the coefficient matrices up to the correct lag order, and standard asymptotes will apply with respect to the coefficient matrices up to the correct lag order. Choi (1993) uses similar arguments to show that standard asymptotes can be applied to unit root tests which are suitably augmented. If one assumes that the elements of $\mathbf{z}_t$ are at most $I(1)$, the inclusion of one extra lag in the estimation process is sufficient. However, for more general orders of integration, a VAR($p+d_{\max}$, l) model should be fitted, where d_{max} is the maximum order of integration of the elements. Therefore, knowledge of the precise orders of integration or cointegration rank is not needed. Overall, the method of surplus lags provides a very tractable, and hence appealing, way to deal with many of the non-standard distribution problems associated with so many economic variables.

While knowledge of the cointegration properties of the system is not necessary, it should be pointed out, not surprisingly, that the TYDL approach is less powerful as well as more inefficient, in the sense that the order of the VAR is intentionally set too large. Overparameterizing VARs and the deficiencies associated with lack of parsimony are well established in the literature. Since the procedure is valid asymptotically, efficiency will also be affected in particular cases where the true lag-length may be as small as one, and augmenting additional lags in a small-sample VAR may prove to be costly in terms of parsimony. This, though, will not occur frequently in applied work using data with a frequency greater than annual and orders of integration not exceeding two. There is thus the tradeoff between inefficiency arising from overparameterization and the pre-test biases associated with cointegration tests. Some will argue that the avoidance of the latter at the cost of the former is more warranted in applied work.

Another feature of the TYLD approach is that we are not limited to just short-run causality like differenced VARs. Long-run causality is directed tested for as we are dealing with the levels. Swason, Ozyildirim and Pisu (1996) note that it is also reasonable to apply the TYDL approach to purely differenced data by including an extra lag of the level regressor. In this way, with a suitably modified version of the levels, a Wald test could be used as a test for solely short-run non-causality. However, the gains in undertaking such an approach are questionable, since the VECM allows for short- and long-run causality to be tested in the same model. As economic theory lends itself more to long-run equilibrium relationships, the relevance of purely short-run linkages in isolation seems limited, if not undesirable.

Estimation Results

We use annual data spanning the sample 1960 to 1996 sourced from Banco de Mexico, where $\boldsymbol{Y}_t$ is real *GD*P at time *t*, *PUB*, is public savings ratio and PRV_t is private savings ratio. All variables were transformed to their natural logs. Standard augmented Dickey-Fuller and Phillips-Perron test revealed that we could not reject the null of a unit root. Based on this evidence we concluded that the maximal order to integration was one. We also tested for cointegration among these three variables with the procedure advocated in Johansen (1991). Based on this procedure we found at most a single cointegrated vector, allowing for an intercept and restricted trends.

Estimated VEC models are presented in table 1. Interestingly, each of the error-correction terms are significant and of the correct sign. This implies that none of the variables is weakly exogenous, meaning that there are active channels of causality running from public and private savings to long-run GDP. Standard diagnostic checks reveal no violations of assumptions regarding residual correlation, functional from misspecification or heteroskedasticity. However, non-normal error terms are present in two of the error correction models. Turning to the TY procedure, we determined the optimal lag to be of order k = 2. As we find that the maximal order of integration is $d(max)$ = 1, we estimate a VAR(3) model using the levels of all variables but conduct inference on lags up to 2. Results from the estimation of VAR levels appear in table 2 and show clear evidence of a feedback long-run casual relationship between public savings and GDP. We also find evidence of public savings having leading information for private savings; however, there is no significant long-run causality running from private savings to GDP.

In this analysis we employ a recently prescribed technique known as generalized variance decomposition (GVDC), defined as the proportion of the n-step ahead forecast error variance of variable i which is accounted for by the innovations in variable j in a VAR model analysis as prescribed by Koop, Pesaran and Potter (1996). An attractive feature of this approach is that it does not suffer from the "compositional" effect inherent in standard VAR analysis. As is well known, variance decomposition and impulse response functions derived from standard VAR analysis depend on the particular ordering of the variables used to obtain orthogonal shocks. This dependence reflects the fact that changing the ordering changes the implicit linear combination of the VAR innovations used to obtain the orthogonal shock. GVDCs are based on an alternative approach and in part on a rethinking of what is actually "retrieved" from the estimated VAR model. GVDC measures do not pretend to measure the percentage of the variance attributed to pure shocks. In the context of our example, the percentage of the variance of GDP attributable to public/private savings would also capture the historically observed information regarding shocks in the data.

Results from GVDC appear in table 3 and show that a good proportion of the variance in GDP shocks is attributable to shocks in both public and private savings. GDP also accounts for shocks in public savings, but not nearly as much in private savings. The importance of *PUB* shocks to *PRV* is also apparent in contrast to the reverse case where shocks to *PUB* shocks are almost negligible in explaining shocks to *PRV*. These results largely corroborate the findings based on the VAR model tests for Granger non-causation.

Similar to GVDCs, generalized impulse response functions build upon the same idea and propose to look instead at a typical historical shock. GIRFs compares the average dynamic responses of the model given a typical historical shock and the history of the model, compared with the average baseline model that is not subject to the shock, conditional upon the history of the model. Specially, GIRFs compares the conditional expectation of a variable in the model given an arbitrary current shock *v* and history *w*, to the conditional expectation of that variable given history:

$$GIR(x_{t+k}, v,w) = E(X_{t+k} \backslash v,w) - E(X_{t+k} \backslash w)$$

GIRFs emanating from standard deviation shocks to *PUB* and *PRV* with the response in GDP are traced out in figures 1 and 2. Responses from shocks in both variables provide resoundingly similar paths for GDP: increasing sharply and then climaxing in the case of the *PUB* shock after 3 years and exhibiting a long and pronounced cyclical effect. The time profiles of these responses illustrate the positive and persistent impact shocks to savings have on GDP.

Conclusions

In this note we have re-examined the savings-led growth hypothesis for the case of Mexico using a set of annual data spanning 1960-96. Unlike previous work done on this very issue by Gavin, Hausmann and Tavli (1997) and Sinha and Sinha (1998), we find fairly compelling evidence supporting the role of savings as a driver of long-run Mexican GDP. We attribute the different findings, among other factors, to the application of alternative, more robust procedures of testing Granger non-causality, particularly procedures that are not subject to pretest bias for cointegration rank and unit roots. Moreover, a deeper examination of the long-run dynamics reveals evidence corroborating our earlier findings.

We argue that Mexico presents a good example of the relationship between savings and growth as it has undergone a number of economic cycles lasting six years – a period roughly coinciding with presidential transitions – during the last 24 years. The most recent recession occurred in 1995, after the devaluation of the Mexican peso on December 19, 1994. The presidential transition on that occasion took place early in December of 1994. Ex-post analyses of Mexico's financial crisis of 1994, popularly known as the Tequila, indicate that the country was more vulnerable to international capital shifts as a result of moderate levels of domestic savings (see Feldstein, 1999). The aftermath of the financial crisis in 1994 and 1995 demonstrated that capital movements can rapidly reduce the total amount of savings in a country, thus leaving it short of production financing requirements. In a country with an open capital market such as Mexico, domestic capital can also be subject to rapid capital flows to other countries. As a result, Mexico has changed to a pay-as-you go social security system with mandatory individual pension accounts. The broad purpose of such an initiative is to promote capital accumulation in the long-term and to deepen domestic financial markets. Our empirical conclusions support such initiative by the government as we conclude that the savings-growth relationship holds in Mexico.

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Table 1. VEC Model Estimates

Equation	ΛY_t	ΛPUB_t	ΛPRV_t
ξ_{t-1}	**-0.045** (0.025)	**-0.16** (0.031)	**-0.042** (0.027)
α	**-0.164** (0.109)	**1.077** (1.321)	**0.171** (0-159)
ΛY_{t-l}	**0.342** (0.170)	**0.551** (0.206)	**-0.057** (0.248)
ΛPUB_{t-l}	**0.010** (0.015)	**0.191** (0.181)	**0.013** (0.022)
ΛPRV_{t-l}	**0.142** (0.036)	**-1.714** (1655)	**0.194** (0.198)
$\overline{R}_2$	**12.48**	**0.52**	**0.19**
$\hat{\sigma}$	**0.03**	**0.43**	**0.05**
RSS	**0.04**	**0.05**	**0.08**
$\chi^2_{SC}[1]$	**0.743**	**1.43**	**3.41**
$\chi^2_{FF}[1]$	**0.146**	**0.07**	**0.001**
$\chi^2_{NOR}[1]$	**12.62*** **	**69.10*** **	**0.04**
$\chi^2_{HET}[1]$	**0.36**	**0.10**	**0.25**

Notes ξ_{t-1} is the lagged error-correction term and Λ is the first difference operator. The underlying VAR model is of order 2 and contains unrestricted intercepts and restricted trend coefficients. Lag order was selected by Schwarz Bayesian Criterion (SBC). Standard errors are given in parentheses. *, ** and *** indicate statistical significance at the 10, 5 and 1 per cent levels. The diagnostics are chi-squared χ^2 [degrees of freedom] statistics for serial correlation (SC), functional form misspecification (FF), non-normal error terms (NOR) and heteroskedastic error variances (HET). $\hat{\sigma}$ is the standard error of estimate.

Table 2. Summary of Long-Run Causality Results Based on Toda-Yamamoto *[k+d(max)]th*-Order Level VAR Procedure

	Joint Lagged Levels		
Dep. Variable	*Y*	*PUB*	*PRV*
Y	-	**5.726** (0.057)	1.128 (0.569)
PUB	**7.379** (0.025)	-	0.931 (0.627)
PRV	0.006 (0.997)	**4.537** (0.103)	-

Notes: The VAR was estimated in levels with $d(max) = 1$ as evidence indicated the maximum order of integration was unambiguously equivalent to one. The selection of the lag-length ($k = 3$) was determined through a Wald statistic as prescribed by Toda and Yamamoto [(1995), pp. 243-245]. Reported above are significance levels associated with asymptotic Wald statistic ω [see ext] for testing exclusion restrictions. Figures in bold denote significance at least at the 10% level.

Table 3. Generalized Variance Decompositions

Horizon (Yrs)	**GDP**	**Public Savings**	**Private Savings**
Shock to GDP *(Y)* Explained by Innovations in:			
1	0.956	0.014	0.026
2	0.770	0.102	0.091
5	0.726	0.109	0.127
Shock to Public Savings *(PUB)* Explained by Innovations in:			
1	0.022	0.961	0.078
2	0.111	0.832	0.096
5	0.234	0.715	0.088
Shock to Private Savings *(PRV)* Explained by Innovations in:			
1	0.009	0.259	0.636
2	0.036	0.359	0.496
5	0.098	0.486	0.309

Note: GVDCs will not add up to 1 like orthogonalized variance decompositions.

Figure 1. Response of GDP to Single Standard Deviation Shock to Public Savings

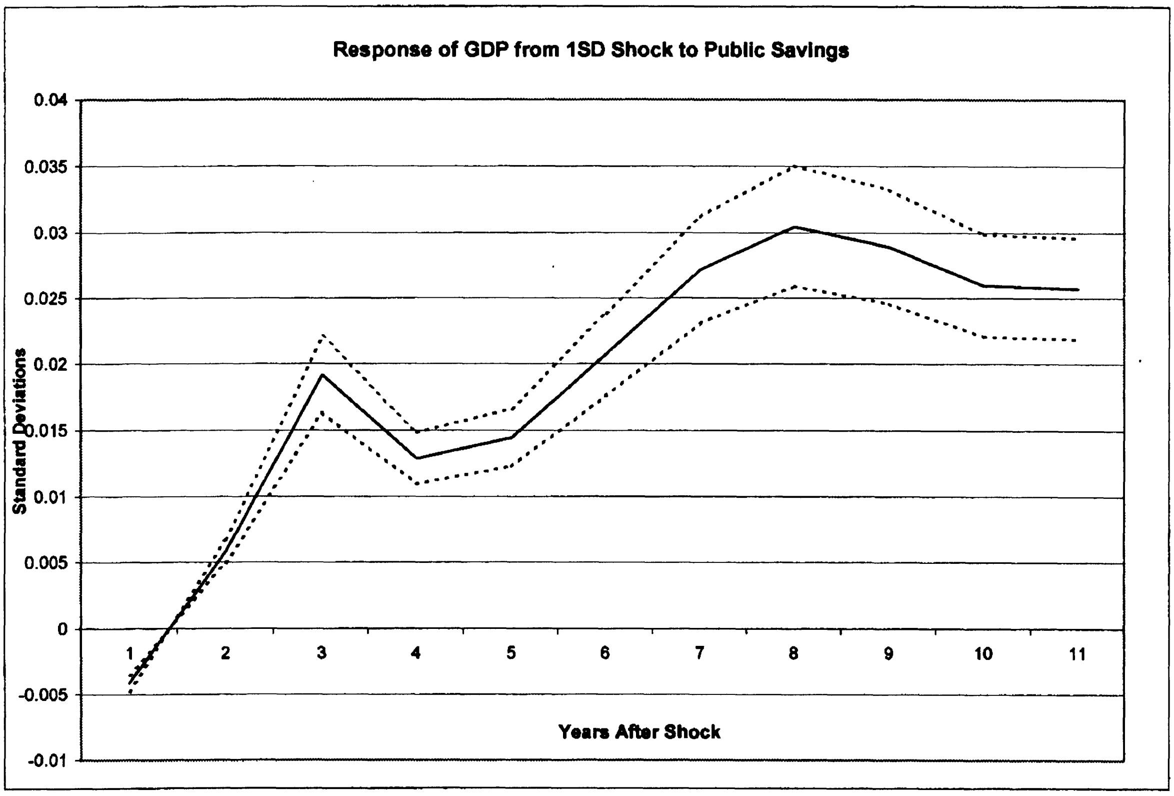

Figure 2. Response of GDP to Single Standard Deviation Shock to Public Savings