



EconoQuantum

ISSN: 1870-6622

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Universidad de Guadalajara

México

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EconoQuantum, vol. 3, núm. 2, 2007, pp. 7-32

Universidad de Guadalajara

Zapopan, Jalisco, México

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Endogenous growth in México: The role of US economic activity and balance of payments transfers

ALEJANDRO RODRÍGUEZ ARANA¹

- **Abstract:** This paper calibrates an AK model of growth for México. Investment financing is modeled considering the domestic savings ratio as well as net factorial income and capital inflows of the balance of payments. According to this model, actual parameters determining growth in México are compatible with a long run rate of growth of about 3.6%. Under these circumstances, the ratio of the Mexican GDP to US GDP grows in time. Sustained growth depends heavily upon balance of payments transfers, which nowadays are conformed mainly by family remittances and the US economic growth, variables that nobody in México can control. This fact implies that the domestic savings rate is very low. The paper concludes that to assure a positive growth that improves standards of living and the relative size of México with respect to the US, policies to increase the domestic savings rate and productivity are necessary.
- **Resumen:** Este artículo realiza un ejercicio de calibración de un modelo del tipo AK para el caso de México. El financiamiento a la inversión se modela considerando tanto la razón de ahorro doméstico al PIB como los ingresos netos por servicios factoriales y los flujos de capital de la balanza de pagos. De acuerdo con el modelo planteado, los parámetros actuales que determinan el crecimiento económico del país son compatibles con una tasa de crecimiento de largo plazo cercana a 3.6%. En estas circunstancias, la razón entre el PIB de México y el de Estados Unidos crecería moderadamente en el tiempo. El crecimiento de largo plazo de México depende fuertemente de las transferencias netas de la balanza de pagos, las cuales se conforman hoy en día principalmente por remesas familiares y por el crecimiento económico de Estados Unidos. Estas variables están fuera de control para nuestro país. La

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situación muestra claramente que el ahorro doméstico es muy limitado. El artículo concluye que para asegurar un crecimiento positivo que mejore los niveles de vida y el tamaño relativo de México con respecto a Estados Unidos, es necesario implementar políticas que incrementen el ahorro doméstico y la productividad.

■ **Key words:** Growth, remittances, savings.

■ **JEL classification:** O41, O47, O57.

■ *Introduction*

The last years have seen a very important development in growth theory. Differently from the traditional models by Solow (1956) and Swan (1956), in the eighties, Romer (1986) and Lucas (1988) proposed models where long run growth depends upon economic policy and other variables. The following years witnessed considerable research in endogenous growth theory due to people like Jones and Manuelli (1991), Rebelo (1992) and Barro and Sala I. Martin (1995).

While there has been quite a lot of research in the new growth theory based in the experience of large economies like the US, Japan or the European Union, less research has been advocated to small or less developed economies. Applying the traditional Solow model to a small country under perfect capital mobility the result is that, in a very open context, the growth of the small country will be independent of growth in large economies. When observing real experiences, it is clear that the link between growth in small and large economies is strong, nonetheless, presumably because the latter influence small ones deeply.²

Neoclassical economics has been quite successful establishing how savings and investment interact to generate growth. It has also been very successful to model preferences and their influence on growth, but the success has been relatively low when trying to explain growth in small open economies. Post Keynesian economics have established why through the balance of payments equilibrium growth in developed econ-

² Growth in small open economies become independent of growth in large economies under perfect capital mobility because in a Solow's type model there is a negative relation between the exogenous foreign rate of interest and the capital-labor ratio. Therefore, in order to maintain this relation, capital grows at the exogenous rate at which labor grows and in absence of growth in exogenous productivity, all the small economy finishes growing at the rate of growth of labor.

omies affects growth in developing countries (see for example Kaldor, 1970, and Thirlwall, 1979). However, the link between savings, investments and the balance of payments equilibrium do not seem to be analyzed quite properly in this approach.

The aim of this work is to try to fill a gap explaining how savings, investment and the balance of payments equilibrium interact to generate growth in a small open economy. The motivation is based in the existent strong relation between México and the US generated by different factors:

México is the third trade partner of the US. On the other hand, the US is by far the most important trade partner of México since more than 70% of Mexican trade takes place with that country. At the same time, most of the foreign direct investment (FDI) that enters México comes from the US; hundreds of thousands of Mexican workers immigrate to the US yearly. The remittances these people send to its original country accounts for more than 2% of Mexican GDP; finally, the majority of total Mexican debt outstanding was contracted with US private and public agencies.

These facts seem to be intuitively very consistent with the observed simple correlation between Mexican GDP and the correspondent figure for the US, which between 1980 and 2003 was near to 97%.³ Nonetheless, they seem to be in accordance neither with a traditional kind of Solow's growth model with perfect capital mobility, nor with a macroeconomic model where there is a natural rate of unemployment.

To explain the determinants of Mexican growth, as well as its relation with US growth, this paper sets a simple endogenous growth model of the AK type (see Rebelo, 1992, 1992a). Assuming the absorption approach through the balance of payments equilibrium, investment is financed by domestic plus foreign savings.

The model is calibrated and projected to the future. To do that, we use historical data for the domestic savings ratio and actual data for remittances from Mexican workers in the US and foreign debt as a proportion of US GDP. Total productivity of capital (A) and the rate of depreciation of physical capital are estimated econometrically.

Perhaps the main result of the paper is that actual parameters of the Mexican economy seem compatible with a sustained trajectory of future Mexican growth. However, the sustained trajectory is based in the permanence of worker remittances from the US. If this income disappeared,

³ The Johansen cointegration test for the log of Mexican GDP and the correspondent figure for the US cannot reject the existence of one cointegrating vector at 95% of confidence from 1980 to 2003.

the other actual parameters would become incompatible with a long run growth trajectory. To solve this problem, either US growth or domestic savings should increase quite above its forecasted figure. Since México can do nothing to generate higher US growth, it has to work in increasing the domestic savings rate.

According to the simulations of the paper, the size of the Mexican economy relative to the size of the US economy will grow slightly in time if actual parameters remain. The Mexican economy will continue being very small for a long time, however.⁴

The paper is divided in four different sections: section I sets the AK model; section II solves analytically the model for a small open economy; section III calibrates the model for México and performs long run growth simulations; section IV reflects on the role of balance of payments transfers and remittances on growth; The last section concludes.

■ *The Model*

We start from the very simple AK model of growth (see Rebelo, 1992, 1992a) in continuous time. In the small open economy output is a linear function of physical capital. If there is a Leontief type of production function and labor is abundant, it is also redundant (see Hussein and Thirlwall, 2000).⁵

$$(1) \quad Y_t = AK_t$$

Where Y is output, K capital and A the productivity of capital

This equation can be transformed in

$$(2) \quad g_{yt} = A \frac{dK_t}{dt} \frac{1}{Y_t}$$

Equation (2) states that output growth (g_y) is a linear function of net investment (dK/dt) as a proportion of output.

At the same time, the trade balance is simply, by the national accounts identity, the difference between output and domestic expenditure

⁴ According to the model, convergence between México and the US would take almost thousand years.

⁵ Rebelo (1992) (1992a) assumes that labor is embedded in factorial productivity A. Theoretically, that would not cause any problem if it is supposed that labor is constant. Nonetheless, empirically for the case of México it cannot be assumed a constant labor in the near future.

$$(3) \quad X_t - m_t = Y_t - C_t - \frac{dK_t}{dt} - \delta K_t - G_t$$

Where X are exports, m imports, C is domestic consumption and G is government consumption, $dk/dt + \delta K$ is gross capital formation and δ is the rate of depreciation of capital. All relative prices are assumed constant.

The balance of payments identity can be described as

$$(4) \quad X_t - m_t + T_t - r^* D = \frac{-dD}{dt}$$

Where T are net transfers to the domestic economy r^* is the foreign interest rate and D is the foreign debt stock outstanding net of international reserves. The left hand side term is the domestic current account and $-dD/dt$ is the net capital account. dD/dt is net indebtness, which includes new debt minus the accumulation of international reserves.

Equation (4) simply states that the net result of a current account surplus is a reduction of foreign net debt.

Substituting (3) in (4) and rearranging terms

$$(5) \quad Y_t - C_t - G_t + T_t - r^* D_t = \frac{dK_t}{dt} + \delta K_t - \frac{dD_t}{dt}$$

(5) is the absorption approach version of (4). Higher domestic savings $Y-C-G$ plus net transfers from abroad minus interest payments of the debt are resources employed to increase gross investment and/or to reduce the foreign debt stock.

Dividing (5) by Y_t and using equation (2)

$$(6) \quad g_{yt} = A \left(s + \frac{T_t}{Y_t} - r^* \frac{D_t}{Y_t} + \frac{dD_t}{dt} \frac{1}{Y_t} \right) - \delta$$

The rate of growth of output will be higher the higher is productivity A , the domestic savings rate $= (1-(C/Y)-(G/Y))$, remittances as a proportion of GDP and indebtness also as a proportion of GDP. Higher interest payments will reduce the rate of growth, however.

If technology were the one described by (1), (6) would be an identity. To convert an identity in a model it is necessary to assume some behavioral equations. The first one is that the domestic saving rate is constant. Secondly, transfers, especially if they are remittances, are related more

to foreign output than to domestic output. This seems logical since those who remit resources live abroad. We assume a linear relation between remittances and foreign output:

$$(7) \quad T = \tau Y^*$$

The third assumption is that debt as a proportion of foreign output remains constant, which means that debt is supplied, constrained and linked to the capacity of lending abroad. This is relatively a plausible assumption in some cases, especially when foreign public debt is huge and governments last for a short period of time. If that is the case, the demand for higher indebtedness is very high because the short term government can increase growth in its period without paying the interest payments of that new debt. Instead, in any case they have to pay interest payments for old debt.

The third assumption means then that

$$(8) \quad \frac{1}{Y_t} \frac{dD_t}{dt} = D_{y^*} g_{y^*} \frac{Y_t^*}{Y_t}$$

Where D_{y^*} is the size of public debt as a proportion of foreign output and g_{y^*} is the rate of growth of foreign output.

Substituting (7) and (8) in (6) and rearranging

$$(9) \quad g_{y^*} = A \{ s + [\tau - (r^* - g_{y^*}) D_{y^*}] \frac{Y_t^*}{Y_t} \} - \delta$$

Equation (9) is the long run dynamic equation for growth, which depends positively on productivity, the domestic savings rate, the rate of transfers and the rate of growth of foreign output. It depends negatively on the foreign rate of interest and in the rate of depreciation of capital. The sign of the levels of foreign output and domestic output on growth is ambiguous. If the term $[\tau - (r^* - g_{y^*}) D_{y^*}]$ is positive, then higher foreign output will affect positively the rate of growth of domestic output and the level of domestic output will affect negatively its rate of growth. If instead that sign is negative, it will be the other way around.

■ *Long run solutions and the stability of the model*

If the rate of growth of foreign output is constant, equation (9) can be transformed in the following exact differential equation:

$$(10) \quad \frac{dY}{dt} = (As - \delta) Y_t + A[\tau - (r^* - g_{y^*}) D_{y^*}] Y^*(0) \exp(g_{y^*} t)$$

After tedious calculations, (10) can solve for the trajectory of output $Y(t)$ in the form (see Chiang, 1992:480-482):

$$(11) \quad Y(t) = H \exp(As - \delta)t + Z \exp(g_{y^*} t)$$

Where

$$(12) \quad H = \left\{ Y(0) - \frac{A[\tau - (r^* - g_{y^*}) D_{y^*}] Y^*(0)}{(g_{y^*} + \delta - As)} \right\}$$

$$(13) \quad Z = \frac{A[\tau - (r^* - g_{y^*}) D_{y^*}] Y^*(0)}{(g_{y^*} + \delta - As)}$$

The reduced form for the rate of growth of output is

$$(14) \quad g_{y_t} = \frac{dY}{dt} \frac{1}{Y_t} = \frac{(As - \delta) H \exp(As - \delta)t + g_{y^*} Z \exp(g_{y^*} t)}{H \exp(As - \delta)t + Z \exp(g_{y^*} t)}$$

Equation (14) can be restated in the two following ways

$$(15) \quad g_{y_t} = \frac{(As - \delta) H \exp(As - \delta - g_{y^*})t + g_{y^*} Z}{H \exp(As - \delta - g_{y^*})t + Z}$$

$$(16) \quad g_{y_t} = \frac{(As - \delta) H + g_{y^*} Z \exp(g_{y^*} - (As - \delta))t}{H + Z \exp(g_{y^*} - (As - \delta))t}$$

When $As - \delta < g_{y^*}$ the limit when t approaches infinity in (15) implies that the rate of growth of domestic output converges to the rate of growth of foreign output

$$(17) \quad \lim_{t \rightarrow \infty} [As - \delta < g_{y^*}] g_{y_t} = g_{y^*}$$

Instead, when $As - \delta > g_{y^*}$ the limit when t approaches infinity in (16) implies that the rate of growth of domestic output converges to a measure of net domestic savings as a percentage of total capital.

$$(18) \quad \lim_{t \rightarrow \infty} [As - \delta > g_{y^*} g_{y^*t} = As - \delta$$

Though the general solution for the problem is this, there are cases where the small economy collapses. Eventually, this happens always when $g_{y^*} > As - \delta$ and net factorial income plus capital inflows are negative, namely $\tau \cdot (r^* - g_{y^*}) D_{y^*} < 0$, but it can also happen sometimes when $As - \delta > g_{y^*}$ and $\tau \cdot (r^* - g_{y^*}) D_{y^*} < 0$. Instead, if net factorial income plus capital inflows are positive the domestic economy never collapses.

To show this we propose:

Proposition: If net factorial income plus capital inflows are negative: $\tau \cdot (r^* - g_{y^*}) D_{y^*} < 0$, then the small open economy will always collapse at some future if $g_{y^*} > As - \delta$ and will collapse sometimes when $As - \delta > g_{y^*}$. The economy will never collapse when net factorial income plus capital inflows are positive ($\tau \cdot (r^* - g_{y^*}) D_{y^*} > 0$).

Proof:

If $g_{y^*} > As - \delta$ and $\tau \cdot (r^* - g_{y^*}) D_{y^*} > 0$, then: $Y(0) - Z = H$ may be greater, equal or smaller than zero (see (12)) but $Z > 0$.

Therefore, the trajectory of output in the small open economy can be rewritten as (see (11), (12) and (13)):

$$(19) \quad Y(0) \exp(As - \delta)t - Z \exp(As - \delta)t + Z \exp(g_{y^*}t) > 0$$

This expression has to be always positive for every period t , since $Y(0) > 0$ and $As - \delta < g_{y^*}$.

If $g_{y^*} < As - \delta$ and $\tau \cdot (r^* - g_{y^*}) D_{y^*} > 0$, then $Z < 0$ and $Y(0) - Z = H > 0$, but this implies rewriting (11)

$$(20) \quad Y(0) \exp(As - \delta)t - Z (\exp(As - \delta)t - \exp(g_{y^*}t)) > 0$$

Which happens because $Z < 0$ and since $As - \delta > g_{y^*}$, the term $\exp(As - \delta)t - \exp(g_{y^*}t)$ is necessarily greater than zero for every positive t .

If $g_{y^*} > As - \delta$ and $\tau \cdot (r^* - g_{y^*}) D_{y^*} < 0$ the economy collapses eventually. In this case $Z < 0$, which means that $H > 0$, but because the rate of growth of foreign output is large, (11) implies that at some point the term $Z \exp(g_{y^*}t)$ must go above the term $H \exp(As - \delta)t$ in absolute value, which means that Y becomes negative and the economy collapses.

If $g_{y^*} < As - \delta$ and $\tau \cdot (r^* - g_{y^*}) D_{y^*} < 0$ the economy may or may not collapse. The economy will not collapse if the initial output $Y(0)$ is sufficiently high. In this case $Z > 0$, which means that H may be greater, equal or smaller than zero. If $H \geq 0$ because $Y(0)$ is sufficiently high,

the economy never collapses (see 11). However, if $H < 0$ the economy definitely collapses since $Y = H \exp (As - \delta)t + Z \exp(g_y * t)$ with $As - \delta > g_y *$ implies that at some point the term $H \exp (As - \delta)t$ overpass the term $Z \exp (g_y * t)$ in absolute value, generating a negative value for Y .

An economy subject to a high debt overhang may face a situation where its parameters are inconsistent with sustainability in the long run. In a strict sense economies do not collapse, but inconsistent parameters indicate that, at some point, there must be an enormous effort to increase domestic savings in order to survive. These efforts may include a strong fiscal adjustment or high increases in interest rates to generate higher savings. In monetary environments, adjustments can include high inflation to produce forced savings through the inflation tax.

■ *Mexican growth: stability and the influence of United States growth in the AK model*

The previous model may be calibrated to check for stability and long run solutions in particular small open economies. We do that for the case of México, where we take the growth and the level of output of the US as the relevant parameters of reference of the large partners. This is quite consistent with the fact that more than 70% of the total Mexican trade takes place with the US, but also because almost all remittances proceed from the US and a very high proportion of the Mexican debt outstanding comes also from the same country.

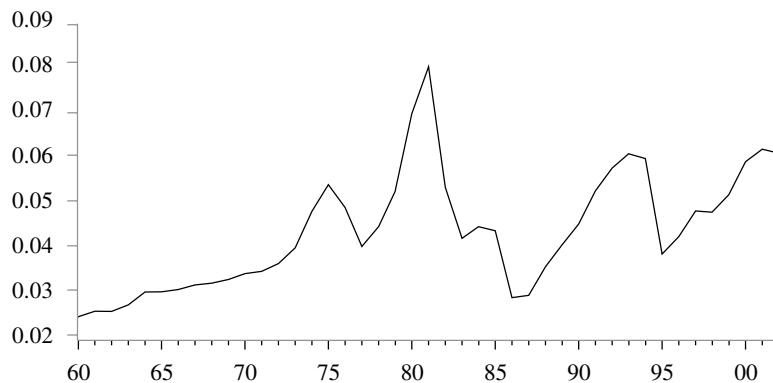
a) The behavior of the ratio of the Mexican GDP over the US GDP

Through time, the US has been a much larger economy than México. The relation between Mexican GDP and US GDP shows a moderate upward trend since 1960. However, starting in the mid seventies there is quite a lot of variance in that ratio.

Graph 1 shows the relation between the nominal GDP in current dollars of México with respect to the same figure in the US. Starting in the sixties, the Mexican GDP was just about 2.5% of the total US GDP. The figure reached a first maximum of 5.4% in 1976, year in which México experienced the first macroeconomic crisis of the new era. The recovery of the second half of the seventies took the Mexican economy to a new maximum of 8% of the US GDP in 1982, year of the second large macroeconomic crisis.

During the 1980's period, the growth of the Mexican economy was lower than the correspondent figure in the US and Mexican GDP be-

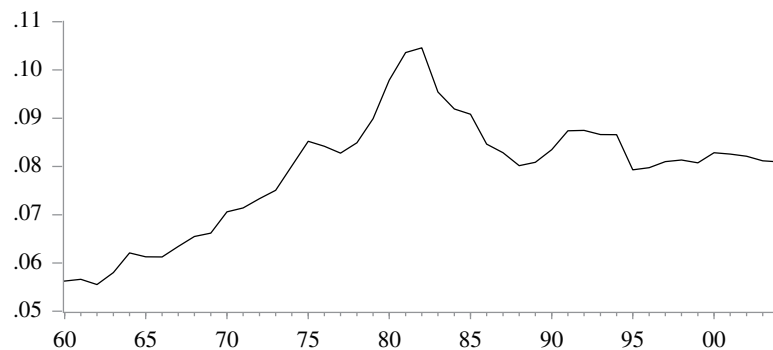
Graph 1
Ratio of Mexican current GDP/US current GDP



The ratio is referred to Mexican current GDP in current dollars divided by US GDP in current dollars.

Source: World Development Indicators 2004. The World Bank.

Graph 2
Mexican GDP/US GDP at Purchasing Power Parity (PPP)



The ratio is referred to real Mexican GDP at PPP converted over US GDP in the same terms.

Source: Heston, Summers and Aten (2006) Penn World Table.

came smaller with respect to the US economy. This situation changed since 1988. In 1994, the Mexican economy reached another local maximum of 6% of the US economy. The 1995 crisis changed this pattern but the economy recovered fast and in 2002 was 6% of the US again.

The strong adjustment between the Mexican GDP and the same figure for the US is quite influenced by the adjustment of the real exchange rate. In periods of crisis in México (1976, 1982, 1995), the nominal devaluation has been accompanied by a sharp real exchange rate depreciation, which immediately reduces the nominal level of the Mexican GDP in dollars and produces the strong movement on the ratio of the GDP's. Measuring the GDP in constant US dollars theoretically eliminates this problem.

Graph 2 shows the ratio of Mexican GDP to US GDP converted in real purchasing power parity dollars of 2000. The figure suggests that from 1960 to 1982, and except for 1976, the Mexican economy was systematically growing at higher rates than the US economy. From that point, the ratio of GDP's has been much more volatile showing cyclical patterns. If there is some trend in this ratio starting in the eighties, this is negative.

The Dickey-Fuller test for the ratio of graph 2 rejects stationarity even when a linear trend is included. Adding a quadratic trend implies that the non-deterministic part of the process is quite possibly stationary.

This augmented Dickey-Fuller test can be set in the following way:

$$(21) \quad r_t - r_{t-1} = a_0 + a_1 t + a_2 t^2 + a_3 r_{t-1} + a_4 (r_{t-1} - r_{t-2}) + e_t$$

Where r is the ratio of Mexican GDP to US GDP in PPP, t is time (year) and e is a stochastic white noise. The results for this regression can be seen in table 1.

The Dickey-Fuller test is the t-statistic of the a_2 parameter, which is barely significant at the 90% confidence level. The regression fits very well the data, however. The coefficient of correlation between the actual ratio and the estimated ratio by the regression is 0.88. The fact that there is a quadratic trend with a negative sign implies a maximum estimated ratio in 1988. The forecast in the following years is a further deterioration for the ratio.

Graphs 1 and 2 suggests that while possibly in the sixties and seventies there was a trend for convergence between México and the US, starting in the eighties that phenomenon is absent at least in output levels.

Table 1
Dickey-Fuller Test (t statistic in parentheses)

	OLS
a_0	0.005 (1.9)
a_1	0.0007 (2.1)
a_2	-1.01×10^{-5} (-2.1)
a_3	-0.21 (-2.8)
a_4	0.44 (3.2)
R ²	0.32
D.W.	1.92
F	4.8
Q(12)	6.9
LM(2) F	0.15
ADF(1) for residuals	-6.4
JB	1.9
CUSUM	Inside the 5% confidence intervals
CUSUMSQ	Slightly below the 5% confidence limits between 1976 and 1984

Source: Own calculations.

R₂: Coefficient of determination.

D.W. Durbin-Watson statistic.

F: Fisher statistic for goodness of fit.

Q(12): Box-Ljung statistic of the correlogram.

LM(2)F: F statistic of the LM test for serial correlation.

ADF(1): Augmented Dickey-Fuller statistic with one lag. It includes intercept but not trend.

JB: Jarque-Bera statistic to check for normality of residuals.

CUSUM: CUSUM Test for stability of the parameters.

CUSUMSQ: CUSUMSQ test for stability of the parameters.

*b) Savings, transfers and US growth in the determination
of Mexican long run growth.*

The statistical behavior of the Mexican GDP over the US GDP may be well modeled by equation (21). The projection of that equation suggests

that México could become even smaller with respect to the US in the next future. Nonetheless, that equation is just a description of how the Mexican economy has been growing with respect to the US economy. If we want to know what we could expect in the future, it is better to attend to the structural behavior of the determinants of the Mexican growth.

Using the theoretical model shown in sections I and II, we performed an exercise to check whether actual and historical parameters of the Mexican economy are, first, consistent with the existent of the economy in the long run; second, sufficient to create convergence between México and the US either in growth rates or even in output levels. The exercise is also useful to show the sensibility of growth and long run levels of output to small changes in parameters.

Data consistent with the model described in sections II and III is presented in table 2

Table 2
Assumptions for simulations of the Mexican case (basic scenario)

Net external debt/US GDP (D_y^*) (2003)	0.00916
Remittances/US GDP (τ) (2004)	0.00145
Implicit interest rate for net foreign debt (r^*) (2003) (%)	10.8
Domestic savings rate (s) (Average 1980-2004) (%)	0.19
Initial US GDP ($Y^*(0)$) (billions of US dollars) (2004)	11728
Initial Mexican GDP ($Y(0)$) (billions of US dollars) (2004)	667.1
US GDP long run growth (%)	3.5
Productivity A	0.7786
Rate of depreciation δ (%)	11.2
Parameter H	4074.5
Parameter Z	-3407.4

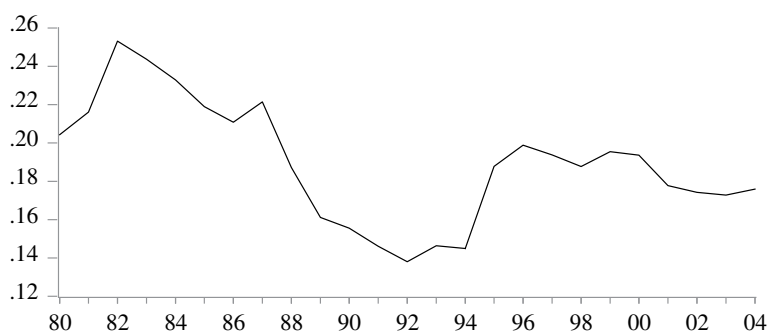
Source: For the Mexican net foreign debt: Informe Anual del Banco de México 2003; for the US GDP: Bureau of Economic Analysis (www.bea.gov); for remittances: Banco de México (www.banxico.org.mx); for the implicit interest rate of foreign debt: own calculations based on information of Informe Anual del Banco de México 2003; For the domestic savings rate: own calculations based on information of Instituto Nacional de Estadística, Geografía e Informática (www.inegi.gob.mx); For the other parameters own calculations.

Net foreign debt is calculated as foreign debt reported by Banco de México minus international reserves owned also by that institution. Remittances are calculated as the net result of the balance of transfers in the

current account of the balance of payments. The domestic saving rate is calculated as the difference between Mexican GDP total consumption (public and private) and accumulation of inventories divided by GDP.

The domestic savings ratio shows quite a lot of volatility through time. On average its value has been between 19% to 20% of GDP. This value is small compared with several countries in Asia. For instance, in China and Korea, the domestic savings ratio is above 35% of GDP. Instead, in countries like Argentina or Brazil, the savings ratio is even lower than in México.

Graph 3
Domestic savings ratio in México as a percentage of GDP



Source: Instituto Nacional de Estadística, Geografía e Informática (INEGI).

To calculate productivity A and the rate of depreciation of capital δ we assume the original AK model. Data on the size of the physical capital in México is either inexistent or very partial and without a long history. Equation (1) in discrete time and in the presence of random shocks can then be transformed in:

$$(22) \quad g_{yt} = A(I_{byt} - \delta \frac{K_{t-1}}{Y_{t-1}}) + e_t$$

Where I_{byt} is gross investment in time t divided by GDP in the previous period. e_t is a random shock normally distributed with zero mean. Also, since theoretically A is Y/K , (22) may be written in econometric terms as:

$$(23) \quad g_{yt} = \pi_0 + \pi_1 I_{byt} + j_t$$

In this case π_0 is an estimator of $-\delta$ and π_1 is an estimator of A . j represents the residuals of the regression.

We run regression (23) in annual terms for the period 1980-2003. The results estimated by ordinary least squares (OLS) and by the generalized method of moments (GMM) are presented in table 3.

Table 3
Estimation of productivity and the depreciation rate
(t-statistic in parenthesis)

	OLS	GMM
π_0	-0.129 (-3.6)	-0.112 (-7.4)
π_1	0.83 (4.2)	0.78 (9.3)
R^2	0.46	0.42
D.W.	1.7	1.65
F	18.0	-
Q(12)	6.6	6.5
LM(2) F	0.3	-
ADF(1) for residuals	-3.2	-3.2
JB	1.6	1.6
CUSUM	Inside the 5% confidence limits	-
CUSUMSQ	Inside the 5% confidence limits	-
J statistic	-	0.25
ADF(1) for gy^*	-3.7	-3.7
ADF(1) for lby^1	-3.6	-3.6

Source: Own calculations.

J-statistic: Statistic to show the validity of overidentified restrictions in a GMM model.

Instruments for the GMM regression: GDPUS, GDPMEX t-1, Ipriv t-1, Ipub t-1, X t-1 (Ipriv is private investment, Ipub is public investment, X represents non oil exports).

The calculated regression shows a good performance. The rate of growth of GDP and the ratio of total gross investment to GDP are both stationary variables according to the Dickey-Fuller tests. Endogeneity might be present in the real life since changes in the error term can be correlated with the ratio of total investment to GDP. For that reason we run the regression by OLS and also by GMM. In this last case we use

instruments that should not be correlated with the contemporaneous error term.

It is surprising that according to the CUSUM and CUSUMSQ tests in the OLS estimation the parameters of the regression are, apparently, stable. This finding supports the original assumption of perfect complementarity between labor and capital. It is also consistent with Kaldor (1957) findings that the capital output ratio of many different economies is quite stable.

The results of the model show that the productivity factor A is around 0.8 and that the rate of depreciation of capital is between 11% and 13%. For the simulation coming next we use the parameters estimated by the GMM technique, which should be free from endogeneity problems.

We projected equations (13) and (14) as well as the ratio of Mexican GDP to US GDP starting in 2005. Basic assumptions are shown in table 1. We use the historical domestic saving rate measured as the average of the years 1980-2004. This figure is not far from what happened in 2004 (19% historically and 19.4% in 2004). The reason why we take the historical number is because the figure does not show a linear trend (see graph 3).

Instead, we used more actual figures for other variables like the foreign debt or remittances. In the case of debt, we consider that the actual figure (2003 values) is more relevant than the same variable in the past because debt is a stock that under certain conditions may not be reversible. With respect to the remittances, the figure is not at all stationary. It has been growing with respect to US GDP as well as Mexican's (see section IV). As far as today is concerned, it seems prudent to maintain this figure as a percentage of US GDP constant but it could be actually higher (we took the figures for 2004).

The exercise assumes implicitly that other variables of the current and capital account remain zero in net terms. Those factors involve, for instance, foreign direct investment (FDI). The assumption implies that in the long run what enters as FDI leaves the economy probably as a utility remission from México to abroad. In the last years, FDI has been greater than remitted benefits abroad, which apparently implies that the assumption of zero effect over the balance of payments is a conservative one.

When using the parameters already shown in table 1, the result is very similar to the 2004 investment-GDP ratio, however. This means that the net result of FDI minus remittances from this concept is being compensated with other net exits on the capital account.

There are three scenarios in the simulation: The first is a basic one with the assumptions shown in table 1; second scenario (scenario A)

simulates what would happen if *ceteris paribus* there would be a reduction of remittances to zero; third scenario (scenario B) shows a situation where there is a reduction of the domestic savings rate in one point of GDP with respect to the basic scenario.

The basic scenario seems a reasonable benchmark case, with stationary variables (e.g. the saving ratio) taking values similar to their averages in the last twenty years and non-stationary variables (e.g. foreign debt and remittances) taking values similar to what they had in 2004.

Scenario A tries to measure the sensibility of the model to remittances and for this reason takes all the other values of the benchmark case, except for the remittances that take a zero value.

The objective of scenario B is to address the importance of the saving ratio at a marginal level in order to check for the sensibility of the model to that parameter. The assumption is then to reduce the savings ratio in one percentage point.

Main results of the exercise appear in table 4:

Table 4
Main results of the growth exercise in the AK model

	Basic scenario (%)	Scenario A (%)	Scenario B (%)
g_y short run (2005-2020)	4.6	2.7	3.9
g_y long run	3.6	Economy non viable	3.5 convergence to US in growth rates.
Y/Y^* short run (2005)	5.7	5.6	5.7
Y/Y^* long run	The Mexican economy converges to the US economy	Economy non viable	8.9
$As-\delta$	3.6	3.6	2.8

Scenario A supposes zero remittances starting in 2005.

Scenario B assumes the savings rate falls from the average of 19% GDP to 18%.

Source: Own calculations.

If parameters continued in the future as they have been in the last years (basic scenario), the Mexican economy would have a relatively good performance in the long run. Growth will be higher than US's and theoretically, extrapolating the exercise, the economy would catch up

the US economy in the very long run (almost thousand years). In practical terms, the scenario just says that the Mexican GDP-US GDP ratio would be growing slightly for a long time.

Since in this case $As-\delta > g_{y^*}$ and $\tau-(r^*-g_{y^*})D_{y^*} > 0$, $H > 0$ and $Z < 0$ (see table 2), but then equations (11) and (20) imply that the economy is viable and equation (18) means that the long rate of growth of output converges to $As-\delta$, which in this case is equal to 3.6%.

According to this exercise, in the next fifty years the Mexican economy would pass from 5.7% of the US economy to 9.1%. At the end of the 21th century, the Mexican economy would be only 12.5% of the US economy.

Scenario A, with zero remittances, shows a situation that is not viable in the long run, which happens because the term $\tau-(r^*-g_{y^*})D_{y^*} < 0$. Though $As-\delta > g_{y^*}$, the initial value of $Y(0)$ is insufficient to make H greater than zero and eventually the economy collapses. The exercise seems useful because it shows the importance of net balance of payments transfers in the process of growth of México. The reduction of τ from 0.145% of the US GDP to zero would reduce the short run Mexican growth almost two percentage points, from 4.6% to 2.7%. Furthermore, in this case growth is falling continuously until it becomes negative and eventually produces a collapse.

Scenario B shows the sensibility of growth to the domestic savings rate. If this figure passes from 19% of GDP to 18%, the US rate of growth g_{y^*} becomes greater than $As-\delta$. As the theoretical part of this paper shows, when that is the case and the term $\tau-(r^*-g_{y^*})D_{y^*} > 0$, the rate of growth of the small economy converges to g_{y^*} and in many cases, like this one, there can never be convergence in output levels. The Mexican economy would increase its participation with respect to the US economy from the actual 5.7% to 8.9% but it would never pass from that limit number.

Small changes in the domestic saving rate have a short run impact that is not very high but may have dramatic changes in the long run performance of an economy. In these simulations, the reduction of 1 percentage point in the domestic savings rate generates a reduction of 0.7 percentage points of growth in the short run (from 4.7% to 3.9%). However, in the long run, when the savings rate is like the actual one, the Mexican economy becomes large and when the rate is one percentage point less it remains small always, which means that changing the parameter upwards can make all the difference in the positive side.

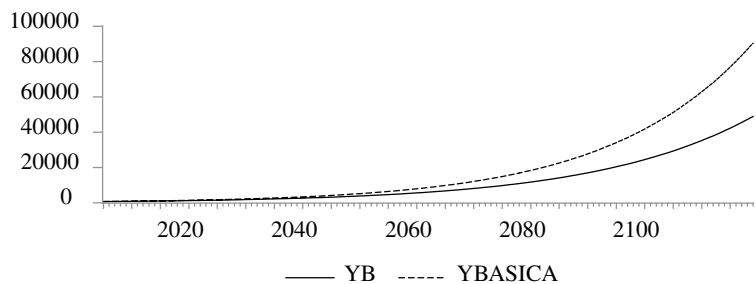
Graph 4 shows output trajectories for the Mexican output Y in the basic scenario and in scenario B, where the domestic savings rate is one

percentage point less. In 2005, the economy in the basic scenario is just 0.7% greater than in scenario B. However, in 2050, the economy in the basic scenario would be 34% greater than in scenario B, and in 2100, 70% greater. In the long run the impact is very high.

Graph 5 shows the effects of a reduction of remittances to zero. The economy continues growing at positive rates for a long time. However, it reaches a maximum output level and then starts falling very fast and collapses.

Graph 6 shows the ratio of the Mexican economy to the US economy in the three scenarios.

Graph 4
Output trajectories in the basic scenario and in scenario B

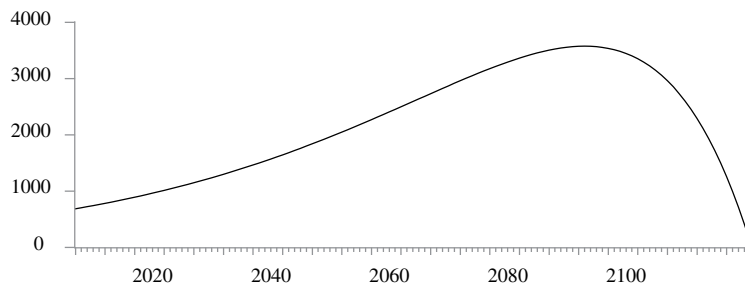


YB: Output in scenario B.

YBASICA: Output in basic scenario.

Source: Own calculations.

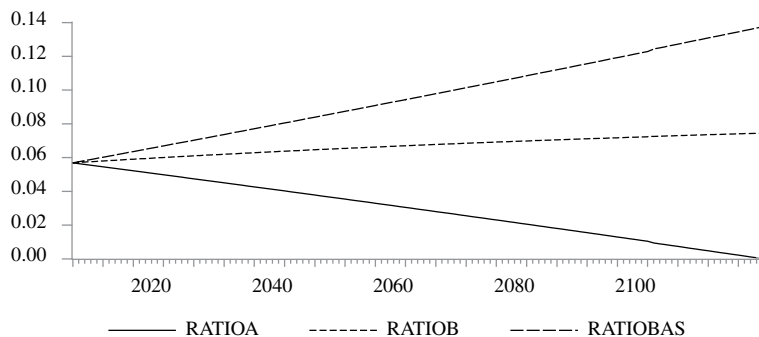
Graph 5
Output trajectory in scenario A



YA: Output in scenario A.

Source: Own calculations.

Graph 6
Ratio of Mexican GDP to US GDP



RATIOBAS: Ratio in the basic scenario.

RATIOA: Ratio in scenario A.

RATIOB: Ratio in scenario B.

Source: Own calculations.

■ *The effect of remittances on growth*

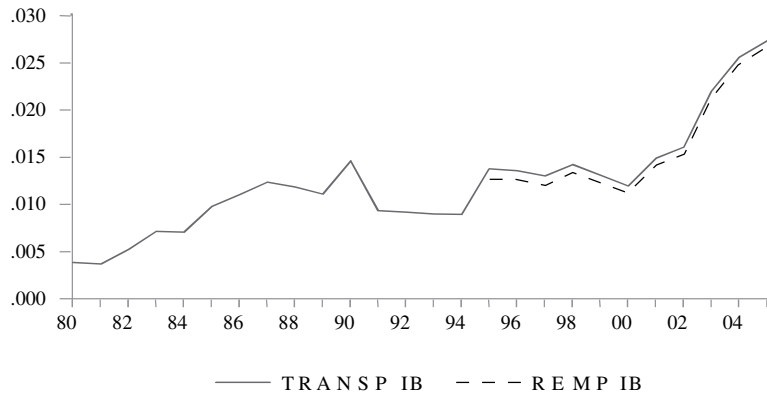
According to the main results of the exercise, net transfers in the balance of payments have an important potential impact on Mexican growth. By far, the main component of these net transfers is constituted by family remittances. In 1995 they accounted for 92% of net transfers, while in 2006 they reached 98%.

The data set of Banco de México shows net transfers of the balance of payments since 1980 and family remittances since 1995. Both concepts have a correlation of 99% and can be seen as a proportion of Mexican GDP in graph 7.

Where TRANSPIB is net transfers of the balance of payments as a proportion of Mexican GDP and REMPIB is family remittances in the same terms. As the reader can see, both concepts are not only very similar but they behave in almost identical way.

The calibrated model of section III measures the direct total potential impact of net transfers on Mexican GDP growth. The correct interpretation of these results lies in the word potential. An increase in net transfers as a proportion of US GDP of some percentage increases Mexican GDP growth up to some other percentage number. The implicit

Graph 7
Net transfers and family remittances as a proportion of GDP



Source: Banco de México.

assumption here is that domestic savings as a proportion of Mexican GDP remain constant.

Different authors (see for example Santibáñez, 2005) assert that remittances do not have effects on growth because almost all of them are directed to consumption. In terms of the model analyzed in this article, that would mean a reduction of the savings ratio when net transfers increase.

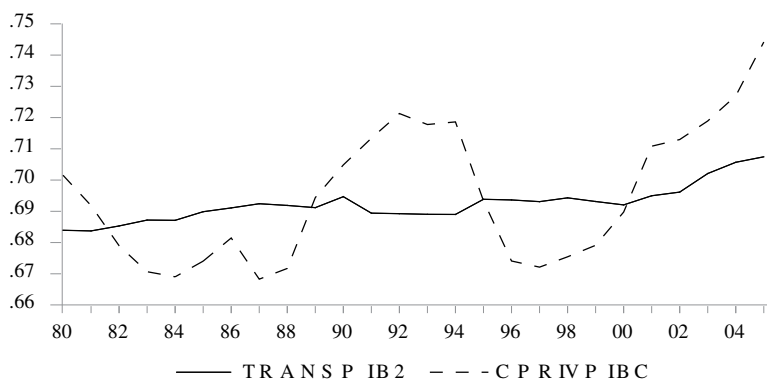
However, Ariola (2006) finds that the nature of the new consumption of people who receive remittances in México might be more related to durable goods, education and health services, as well as housing. Many of these activities are in fact investment, though some of them are accounted as consumption.

The discussion of how remittances affect consumption and growth is not new. Adelman and Taylor (1990) emphasize that remittances may actually have an important role promoting growth. Durand, Parrado and Massey (1996) find that, in certain small localities of México, remittances have increased production up to 50% with respect to previous periods without them. Canales and Montiel (2004) reflect on the same topic.

At a macroeconomic level, graph 8 shows transfers of the balance of payments and total private consumption, both variables as a percentage of GDP. Although the linear correlation is relatively high (0.5), private consumption is much more volatile. Moreover, the graph does not show a monotonic relation between the variables.

These observations suggest that it is necessary to perform more studies in the relation of transfers, remittances and private consumption in order to check how savings and balance of payments transfers are related.

Graph 8
Net transfers of the balance of payments and private consumption
as a percentage of GDP



Source: Banco de México.

TRANSPIB2 is total net transfers as a percentage of GDP. CPRIVPIBC is private consumption in the same terms. Transfers are scaled in order to be comparable with private consumption.

Other important topic with respect to remittances is the magnitude of the variable. CONAPO (Consejo Nacional de Población) argues that the information provided by Banco de México overestimates the figure. According to ENIGH (Encuesta Nacional de Ingreso Gasto de los Hogares- National Income and Expenditure Survey), family remittances are just above the half of the figure reported by Banco de México (see Santibáñez, 2005).

Several comments are necessary. Possibly Banco de México could be overestimating family remittances confusing them with other transfers where the sender is not necessarily a migrant that sends money to his/her family (see Santibáñez, 2005). In terms of our study that would change neither the potential income of transfers on growth nor the projected figure of transfers with respect to US GDP.

However, the way in which CONAPO is reaching the conclusion about the overestimated remittances is subject to criticism, basically for two reasons:

The first is that ENIGH is performed in certain part of the year, and apparently CONAPO is extrapolating the remittances reported by the receivers at that time to the complete year (see Chávez Gutiérrez, 2006). There is at least a problem of seasonal factors.

The second is that ENIGH is a survey representative of the families living in México, but it is not representative of families in which one or more members are migrants. In this respect, the reported remittances by the families interviewed in the survey can not be extrapolated to the total population.

■ *Conclusions*

According to our research, actual and historical parameters of the determinants of Mexican growth are compatible with a long run growth that could be around 3.6% in the best case. If these parameters continue in the same observed level, México could improve its relative size position with respect to the US in the coming years.

Extrapolating the exercise implies that México would catch up the US economy in several hundreds of years. This result does not have any practical utility; it only shows how far México is from the size of the US. Even growing at a higher rate in practical terms, México would never reach the size of its neighbor.

Growth exercises are very sensible to changes in the parameters. At the same time, Mexican growth depends upon strongly in the fact that the sum of factorial income plus capital entrances shows a positive number. If that were not the case, then actual parameters would not be compatible with sustained growth. Since theoretically in this case the economy would collapse, there should be strong changes in parameters to make the economy viable.

One of the main results of the exercises is that remittances from Mexican workers in the US are crucial to maintain a sustained trajectory of growth. That constitutes an uncomfortable result. Economic policy has only very few instruments to maintain or increase such remittances.

In this respect, some researchers believe that remittances do not influence growth because they increase consumption, thereby reducing the savings ratio. Other people offer explanations of why remittances do affect growth positively and in a significant way. Casual observation of the consumption and transfers is not conclusive in any way. More research is necessary in this specific topic.

Mexican growth is also quite influenced by US growth through its effect in the net foreign debt burden. A reduction of US growth increases

the net burden of foreign debt generating lower resources to invest and therefore producing lower growth in México. Again, México does not have policy instruments to generate higher US growth.

The previous analysis shows that Mexican growth is extremely vulnerable to factors that the country cannot control. Exercises show that growth is also very vulnerable to the domestic savings rate, however. In its positive side, this result implies that economic policy has to work very hard to generate a higher savings rate. A fiscal reform, better financial services and an environment enhancing the rule of law and generating more certainty could induce a much higher savings rate in the future, which would make a strong difference in the growth performance.

With respect to the fiscal side, the majority of people believe that a tax reform is necessary and probably that is true. However, a change in the composition of government expenditure would be quite desirable. A reduction of current expenditures increasing public investment would immediately generate higher long run growth because it would increase the domestic savings ratio financing directly greater investment.

To generate higher private domestic savings there are two main recommendations. The first one is to maintain the macroeconomic stability. The 1982 and 1995 macroeconomic crisis in México discouraged savings strongly. Many people saw their financial assets denominated in pesos reduced drastically after the high inflation outburst. It has taken many years to restore confidence and still that is not reflected in the economy (for instance, graph 4 shows that in the last years the private consumption GDP ratio has increased considerably).

A second recommendation is to improve competition in the financial system. Property in this sector is still highly concentrated with just few banks controlling the vast majority of transactions. There are strong deficiencies in the financial services and though new financial instruments have surged in an important way, they are provided by the same issuers.

Growth can be enhanced also increasing productivity, which is totally compatible with the analyzed model of this paper (the A factor). In this respect, different authors (see for example Goldstein and Razin, 2005) assert that foreign direct investment (FDI) is desirable not because it constitutes a net flow of long run resources, but because usually it enhances productivity when it is accompanied by new technologies.

Enhancing savings and productivity in México constitute a necessary policy to overcome those factors determining growth that are out of our control, as US growth and remittances.

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