

Tarea - Macroeconomía Internacional

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1. Problema 1: Caracterización de ciclos económicos en países ricos y emergentes

1.1 Estadísticos relevantes

En esta sección se caracterizarán los ciclos económicos reales de Nicaragua y Estados Unidos usando diferentes métodos para extraer la tendencia: tendencia determinística lineal y cuadrática, así como el filtro de Hodrick-Prescott con $\lambda = 100$ y $\lambda = 6.25$ para validar la robustez de las conclusiones.

Volatilidad. De acuerdo con la tabla 1, el PIB per cápita de Nicaragua es más volátil que el de Estados Unidos, especialmente cuando se asume tendencia determinística para determinar el ciclo. Contrario a lo discutido en clase, el consumo en Nicaragua es menos volátil que el PIB, resultado consistente con todos los métodos para restar la tendencia. Las series gasto de gobierno, inversión, exportaciones e importaciones resultan consistentemente considerablemente más volátil tanto en Estados Unidos como Nicaragua, sin importar el método de extracción de la tendencia.

Table 1. Desviaciones estándar

Estadístico	Log-lineal		Log-cuadrática		Filtro HP ($\lambda = 100$)		Filtro HP ($\lambda = 6.25$)	
	Nic.	EE.UU.	Nic.	EE.UU.	Nic.	EE.UU.	Nic.	EE.UU.
σ_y	0.23	0.04	0.19	0.03	0.06	0.02	0.03	0.02
σ_c/σ_y^a	0.23	1.2	0.17	1.13	0.5	0.93	0.6	0.87
σ_x/σ_y	2.18	1.15	2.62	1.68	2.97	1.16	2.76	0.57
σ_i/σ_y	1.58	2.16	1.79	2.97	4.61	3.31	5.54	3.38
σ_m/σ_y	2.33	3.1	2.08	4.02	2.87	4.03	2.93	3.84
σ_{lb}	1.61	3.7	1.72	3.69	3.85	3.36	4.43	3.89
	35370346.16	5047625.52	35334869.26	35774795.03	14707.69	2650.8	12555.26	1537.1

Notas:

a Datos del consumo per cápita disponibles desde 1994.

Persistencia. De acuerdo a tabla 2, tanto los componentes de demanda y oferta agregada se encuentran serialmente correlacionados. Los hallazgos muestran que las series son influenciadas de manera positiva por su comportamiento pasado. Estos resultados son robustos a distintas especificaciones y métodos de extracción de tendencia. Sin embargo, al utilizar el filtro HP con $\lambda = 6.25$, los estadísticos indican que las series están autocorrelacionadas negativamente. Esto no es consistente con los resultados obtenidos en los métodos anteriores.

Debe mencionarse que la variable balanza comercial como porcentaje del PIB muestra un comportamiento diferente en función del nivel de ingreso del país. Para el caso de Nicaragua, esta variable indica una relación negativa respecto a ella un periodo atrás. Sin embargo, para Estados Unidos, al haber un incremento en el cociente de la balanza comercial habría de esperarse también un aumento en el periodo siguiente.

Table 2. Persistencia

Estadístico	Log-lineal		Log-cuadrática		Filtro HP ($\lambda = 100$)		Filtro HP ($\lambda = 6.25$)	
	Nic.	E.E.U.U	Nic.	E.E.U.U	Nic.	E.E.U.U	Nic.	E.E.U.U
$\text{corr}(y_t, y_{t-1})$	0.94	0.85	0.89	0.71	0.54	0.50	0.22	0.21
$\text{corr}(\epsilon_t, \epsilon_{t-1})$	0.70	0.90	0.22	0.79	0.12	0.50	-0.21	0.10
$\text{corr}(i_t, i_{t-1})$	0.61	0.71	0.53	0.65	0.28	0.51	0.05	0.27
$\text{corr}(g_t, g_{t-1})$	0.92	0.93	0.92	0.92	0.48	0.83	-0.15	0.46
$\text{corr}\left(\frac{\ln}{y_t}, \frac{\ln}{y_{t-1}}\right)$	-0.11	0.32	-0.11	-0.08	0.17	0.60	-0.01	0.13
$\text{corr}\left(\frac{g}{y_t}, \frac{g}{y_{t-1}}\right)$	0.92	0.81	0.90	0.78	0.49	0.60	-0.14	0.29
$\text{corr}(x_t, x_{t-1})$	0.93	0.73	0.85	0.72	0.46	0.55	0.08	0.20
$\text{corr}(m_t, m_{t-1})$	0.74	0.76	0.65	0.63	0.31	0.21	0.01	-0.03

Notas:

a Datos del consumo per cápita disponibles desde 1994.

Ciclicidad. De la tabla 3 puede observarse que las conclusiones obtenidas son consistentes con las provistas por Uribe & Schmitt-Grohé (2017). Tanto para Estados Unidos como Nicaragua, los componentes de demanda agregada muestran estar correlacionados positivamente con el producto. Asimismo, la balanza comercial como porcentaje del PIB presenta un comportamiento contracíclico en ambos países.

Controlando por nivel de ingreso, puede corroborarse que la contracicilidad del gasto de gobierno como porcentaje del PIB aumenta con el producto. En este sentido, la capacidad de un país de utilizar la política fiscal como herramienta para suavizar el ciclo económico está correlacionado positivamente con el nivel de ingreso.

Estas conclusiones son robustas a distintos métodos de extracción de tendencia, con excepción de la especificación cuadrática, pues el signo difiere con respecto los demás métodos. Si bien es cierto que hay consistencia en la dirección de los comovimientos entre las series ante distintos métodos de extracción, las magnitudes de estos comovimientos varían significativamente entre especificaciones de tendencia.

Table 3. Ciclicidad

Estadístico	Log-lineal		Log-cuadrática		Filtro HP ($\lambda = 100$)		Filtro HP ($\lambda = 6.25$)	
	Nic.	E.E.U.U	Nic.	E.E.U.U	Nic.	E.E.U.U	Nic.	E.E.U.U
$\text{corr}(y, y)$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
$\text{corr}(y, \epsilon)$	0.13	0.98	0.16	0.94	0.68	0.94	0.75	0.92
$\text{corr}(y, i)$	0.71	0.78	0.67	0.74	0.67	0.88	0.66	0.91
$\text{corr}(y, g)$	0.25	0.45	0.36	0.32	0.05	0.05	0.12	-0.27
$\text{corr}(y, \frac{b}{y})$	-0.04	-0.52	0.36	-0.11	-0.10	-0.60	-0.21	-0.59
$\text{corr}(y, \frac{g}{y})$	-0.31	-0.61	-0.08	-0.40	-0.33	-0.73	-0.30	-0.94
$\text{corr}(y, x)$	0.89	0.40	-0.12	-0.04	0.12	0.17	0.08	0.42
$\text{corr}(y, m)$	0.73	0.77	0.84	0.43	0.12	0.68	0.18	0.71

Notas:

a Datos del consumo per cápita disponibles desde 1994.

1.2 ¿Cómo los distintos métodos de remover tendencia afectan la volatilidad del componente cíclico de una serie?

En la figura 1, en la fila superior se observa que el filtro HP produce ciclos más cortos debido a la cercanía de la tendencia, siendo ésta más cercana cuanto menor es el valor del parámetro lambda. Consecuencia de lo anterior, es que la tendencia de la serie cae considerablemente junto con la serie en el periodo posterior a la década de los 80, volviendo a recuperarse a mediados de la década de 1990.

Por otra parte, cuando es utilizada la tendencia determinística lineal, los ciclos son bastante extensos; el PIB se mantiene por debajo de su tendencia desde 1979 hasta 2008 aproximadamente, por lo tanto, la recuperación reflejada dura 30 años. Lo anterior contribuye a una mayor volatilidad, ya que la serie se encuentra persistentemente muy por encima o debajo del potencial. La especificación cuadrática, tiene un ajuste cuestionable debido a que no captura oportunamente la gran caída en el PIB que se experimentó en 1979 y los ochenta, lo anterior debido a que los quiebres estructurales en la serie han sido pronunciados y frecuentes. Por lo tanto, el filtro HP realiza mejor la extracción del ciclo que las demás especificaciones.

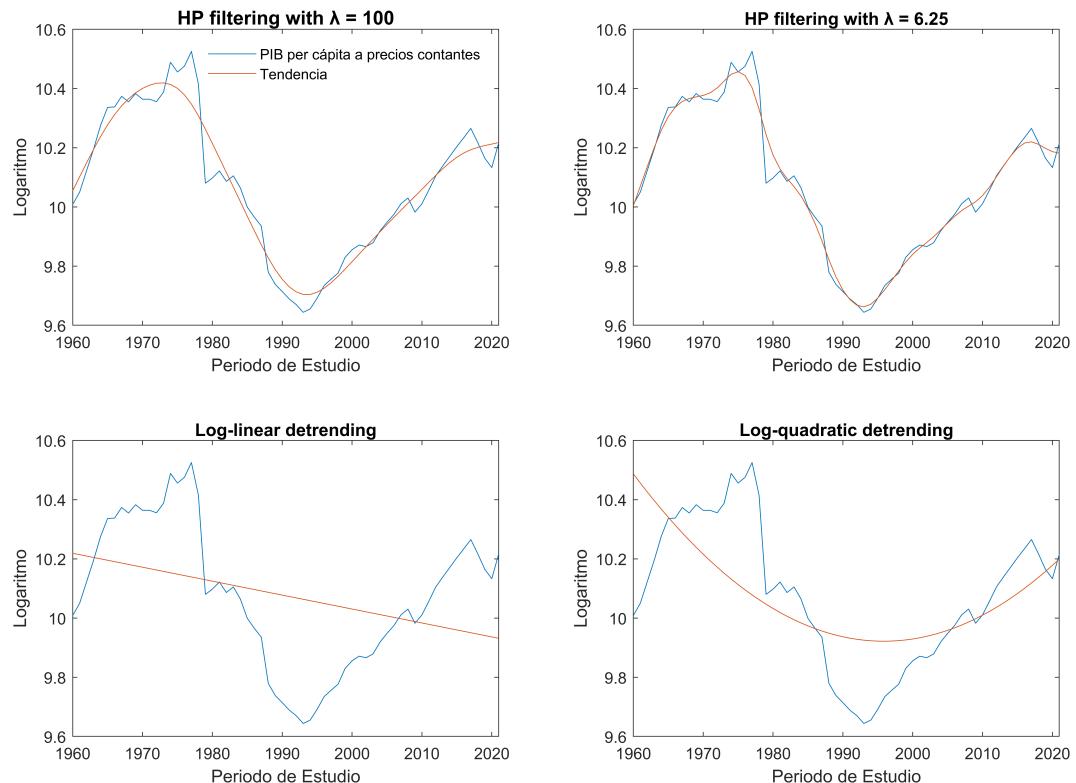


Figure 1. Nivel del PIB per cápita y tendencia determinada por diferentes métodos para Nicaragua

En el caso de Estados Unidos, la serie del PIB per cápita ha mostrado una clara tendencia creciente y considerablemente más suave, adicionalmente los shocks son menos persistentes que en el caso de Nicaragua. Lo anterior, hace que los métodos se desempeñen bastante bien y de forma similar. No obstante, igual que en el caso anterior, el filtro HP destaca por capturar mejor la dinámica del ciclo económico. En particular, usando $\lambda = 6.25$ se captura bastante bien los distintos quiebres estructurales de la economía estadounidense. Se puede observar que los métodos de detrending que mejor se

aproximan a los ciclos económicos según la NBER son los HP. Debido a que estos asumen que la serie presenta una tendencia estocástica, por lo general las tendencias estocásticas son mejores, permitiendo que shocks provoquen cambios estructurales en la tendencia.

Por otra parte, se puede observar que las tendencias lineales y cuadráticas se comportan de forma opuesta. Por ejemplo, en el periodo 1989-2000, la especificación lineal considera que PIB se encuentra por encima de su tendencia, mientras que la tendencia cuadrática refleja lo contrario. Esta inconsistencia también puede notarse en los extremos de la serie.

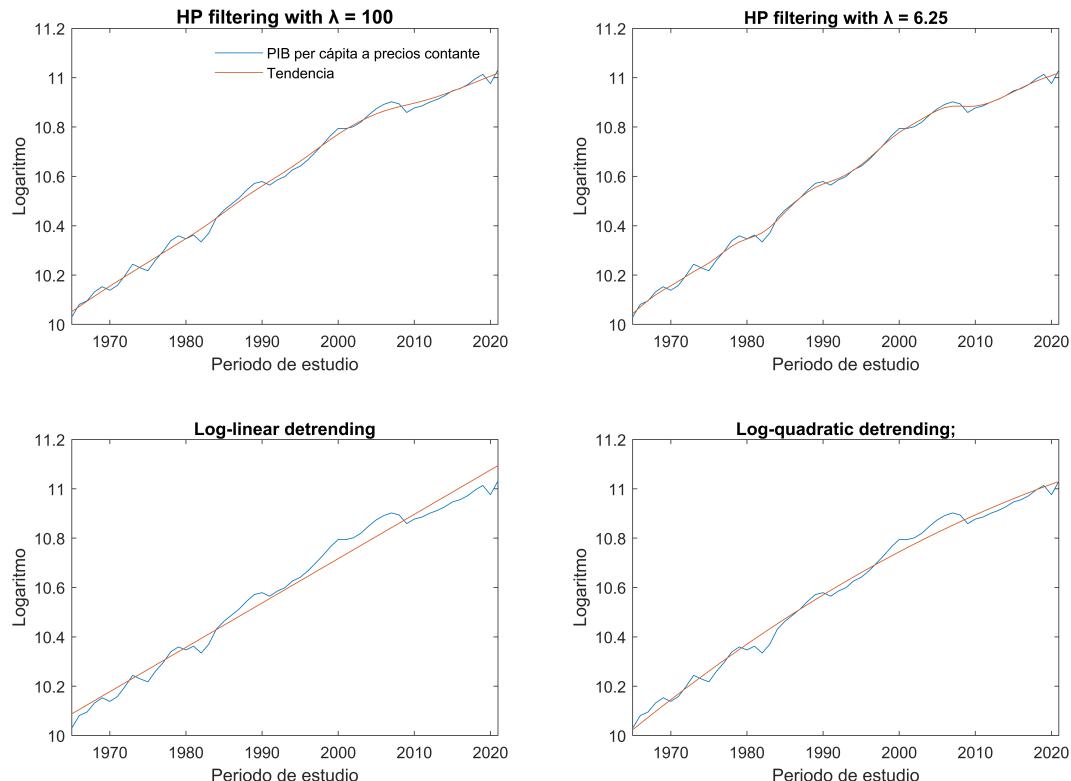


Figure 2. Nivel del PIB per cápita y tendencia determinada por diferentes métodos para Estados Unidos

1.3 Usando solo la serie del PIB real, calcule el número de ciclos que experimentó cada economía durante el período bajo análisis y la duración y magnitud promedio (desde de pico a través).

Con la figura 3 que muestra el PIB real de Nicaragua en niveles, se pueden identificar los ciclos de la economía nicaragüense.¹ Las áreas sombreadas intercaladas muestran un total de 5 ciclos, siendo la duración de estas muy variables entre sí, en promedio la duración es de: 13.2 años y la magnitud es de una tasa de crecimiento promedio de -4.34 en las recesiones y de 5.32 puntos porcentuales en las expansiones.

Se realizó el mismo ejercicio con la figura 3 que muestra el PIB real de Estados Unidos en niveles. Nuevamente, las regiones sombreadas intercaladas muestran los ciclos, para este caso un total de 7 ciclos, siendo la duración de estos menos variables que en el caso de Nicaragua. En promedio, la duración es de 8.8 años y la magnitud es de una tasa de crecimiento promedio -1.18 en las recesiones y de 3.38 puntos porcentuales en las expansiones.

1. Un ciclo se ha definido como el rango que va de pico a pico en la serie.

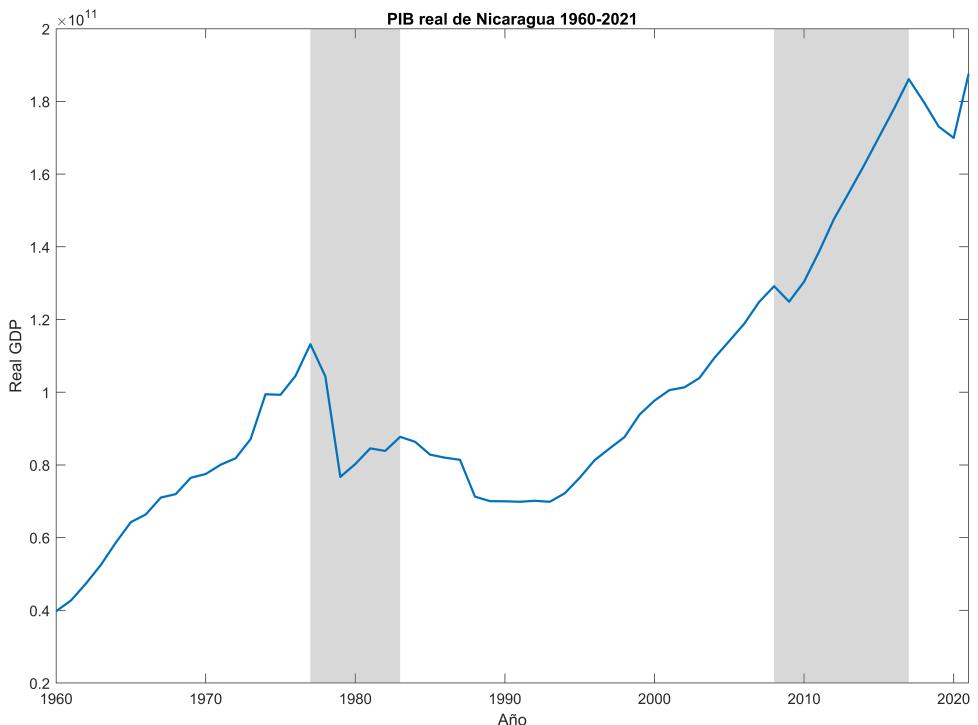


Figure 3. Nivel del PIB per cápita y tendencia determinada por diferentes métodos para Nicaragua

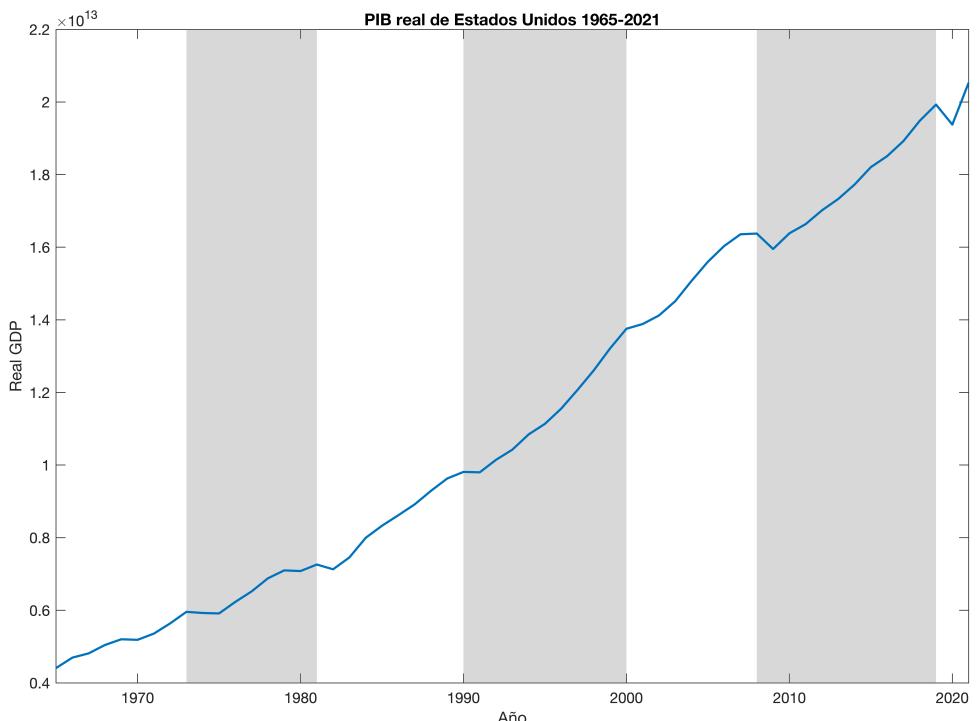


Figure 4. Nivel del PIB per cápita y tendencia determinada por diferentes métodos para Estados Unidos

2. Problema 2: Un proceso de la PTF AR(2) y la volatilidad del exceso de consumo

2.1 Elabore una tabla que muestre la desviación estándar incondicional, la correlación serial y correlación con la producción de la producción, el consumo, la inversión, las horas, la balanza comercial a la producción y la relación cuenta corriente-producto.

Table 4. Respuesta inciso a., problema 2

	σ_x	$\rho_{x_t, x_{t-1}}$	ρ_{x_t, GDP_t}
γ	3.08	0.99	0.99
c	3.39	0.99	0.94
i	4.19	0.79	0.74
h	2.12	0.99	0.99
tby/γ	1.14	0.82	-0.06
cay/γ	0.72	0.56	0.22

Fuente: Elaboración propia.

2.2 Producza una figura de 3×2 que muestre las respuestas de impulso de producción, consumo, inversión, horas, la relación entre la balanza comercial y la producción y la PTF a una unidad de innovación en la PTF. Figura 5. Respuestas de y , c , i , h , tby y cay ante un shock de la productividad, asumiendo un proceso AR(2) para la productividad

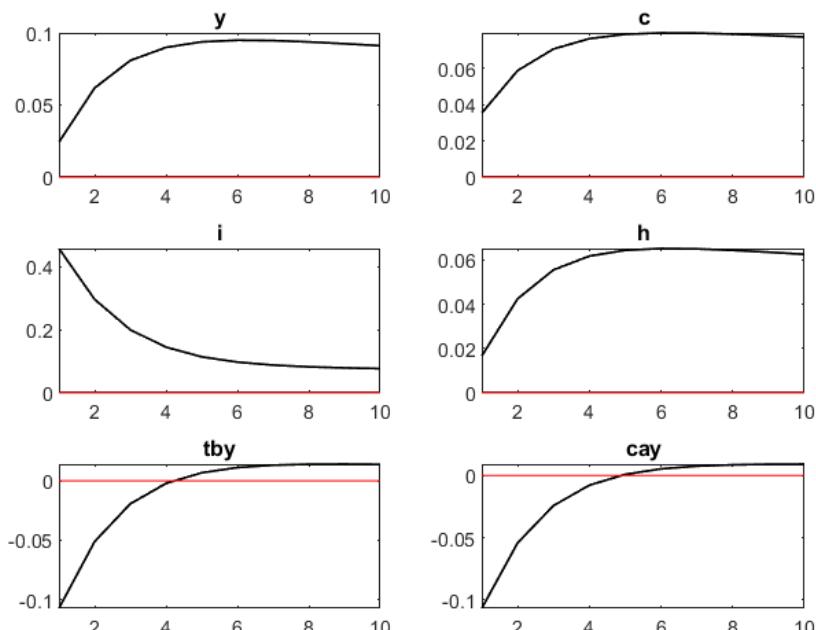


Figure 5. Respuestas de y , c , i , h , tby y cay ante un shock de la productividad, asumiendo un proceso AR(2) para la productividad.

2.3 Compare and contrast the predictions of the model under the AR(1) and the AR(2) TFP processes. Provide intuition.

A continuación se presenta el escenario base de un modelo con AR(1):

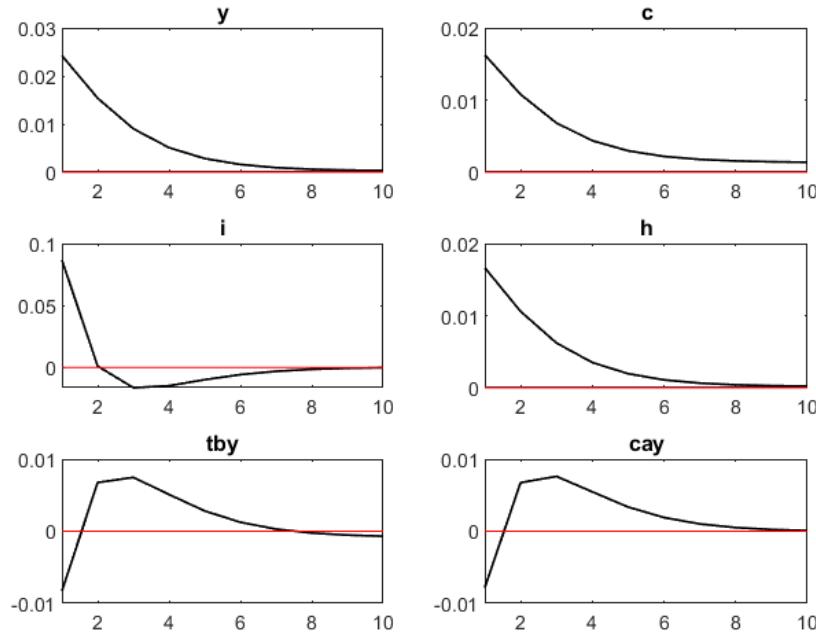


Figure 6. Respuestas de y , c , i , h , tby y cay ante un shock de la productividad, asumiendo un proceso AR(1) para la productividad.

Contrastando con la figura 5, destaca que la reacción del producto (y) difiere en su dinámica, ya que, con un proceso AR(1) para la TPF, el producto aumenta inicialmente, pero este aumento desvanece y el producto converge a su valor de estado estacionario luego de cierto horizonte. No obstante, con un proceso AR(2) para la TPF, el producto aumenta persistentemente aproximadamente 10 por ciento sobre su valor de estado estacionario. Un resultado análogo se puede identificar para el consumo y las horas trabajadas, en el caso AR(2), el consumo aumenta aproximadamente 6.5% y 6% por sobre el valor de estado estacionario para el consumo y las horas trabajadas, respectivamente; mientras que con AR(1), ambos *shocks* iniciales decaen a cero.

Por otra parte, el comportamiento dinámico de la cuenta corriente y la balanza comercial como porcentaje en la especificación AR(1) se distingue porque en los horizontes 2 – 5 aproximadamente experimentaron un aumento, no obstante hacia el final de los horizontes considerados ambas variables regresan a sus valores de estado estacionario.

En el caso de la inversión para el proceso AR(2) el efecto *upon impact* es superior, y con el caso AR(1) la inversión llega a experimentar tasas negativas por un breve periodo de tiempo, hacia el final del horizonte, con ambas especificaciones la inversión converge a su valor de estado estacionario.

Intuitivamente, en ambos casos las variables son consistentes en el sentido de la ciclicidad: y , c , i y h son procíclicas y la tby y cay contracíclicas, la principal diferencia se da en el proceso de ajuste que la productividad sea AR(2) implica que la TPF se demora cierto tiempo en alcanzar su peak exhibiendo una dinámica "hump-shape" lo anterior claramente esta influenciando el comportamiento dinámico de las variables relevantes en el modelo, al haber expectativas de un incremento futuro de la productividad el producto y consumo aumentan ya que la inversión experimenta un aumento permanente, mientras que con AR(1) el aumento de la inversión es transitorio.

3. Problema 5: Calibración de un Modelo EDEIR utilizando datos de Canadá para el periodo 1960-2011

3.1 Estimación de parámetros ρ , $\tilde{\eta}$, ϕ , ψ

Al calibrar el modelo para que fuera coherente con las desviaciones estándares propuestas, se encontró que ϕ y ψ mantienen sus valores originales. No obstante, los parámetros asociados a la especificación de la productividad son mayores.

Table 5. Calibración de modelo EDEIR-SOE-RBC

Parámetro	ρ	$\tilde{\eta}$	ϕ	ψ
Valor encontrado	1.0104	0.4986	0.028	0.0007
Valor original	0.42	0.0129	0.028	0.0007

Fuente: Elaboración propia

3.2 Computación de segundos momentos teóricos

	Modelo Original ^a			Modelo Re-parametrizado		
	σ_x	$\rho_{x_t, x_{t-1}}$	$\rho_{x_t, x_{t-1}}$	σ_x	$\rho_{x_t, x_{t-1}}$	ρ_{x_t, GDP_t}
y	3.08	0.62	1	2.8604	0.0080	1.0000
c	2.71	0.78	0.84	2.2000	0.3192	0.8811
i	9.04	0.07	0.67	0.3717	0.9085	0.4479
h	2.12	0.62	1	1.9659	0.0080	1.0000
$\frac{tb}{y}$	1.78	0.51	-0.04	1.5638	0.1922	0.8367
$\frac{ca}{y}$	1.45	0.32	0.05	1.4244	-0.0125	0.9937

Notas:

- a Modelo presentado en Uribe & Schmitt-Grohé (2017) en pg. 143
 Fuente: Elaboración propia

3.3 Comente la habilidad del modelo para explicar los ciclos económicos observados en Canadá durante 1960-2011

Podemos observar que el modelo re-parametrizado tiene semejanza con algunos de los hechos estilizados presentados en clase. Las series presentan persistencia y se encuentran positivamente autocorrelacionadas, salvo para el caso de la cuenta corriente como porcentaje del PIB. No obstante, el orden de volatilidad presentado en Uribe & Schmitt-Grohé (2017) no es coherente con los obtenidos en este ejercicio. En este sentido la desviación estándar del producto es mayor a la del consumo que a su vez es mayor a la inversión. Asimismo, la balanza comercial como porcentaje del PIB

no es contraciclica como lo indica la teoría. Además, tomando en cuenta un shock positivo a la productividad logra observarse que todas las variables presentan contracción hasta converger a su estado estacionario. Posiblemente, esto pueda deberse a que los parámetros ϕ y ψ mantienen sus valores originales. Probablemente, esto provoca que no se captara la dinámica idónea que corresponde a los datos empíricos. Tal como lo indica Uribe & Schmitt-Grohé (2017), las estrategias de calibración no son únicas y pueden probarse distintas especificaciones.

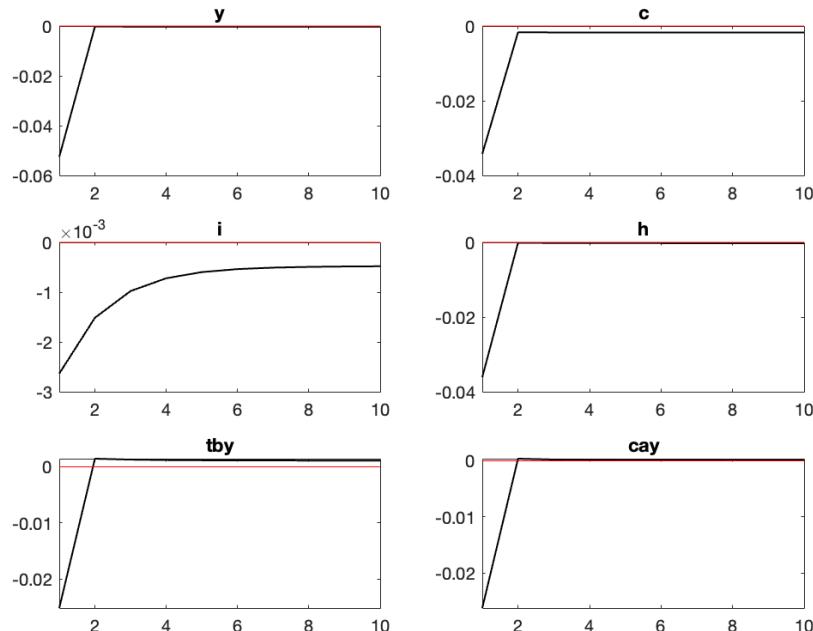


Figure 7. Modelo con parámetros originales

3.4 Compute la desviación estándar incondicional de $\ln(A_t)$ y γ_t bajo la calibración realizada.

Podemos observar que ante la nueva especificación, el producto y la productividad son más volátiles. Esto podría ser consecuencia de una mayor correlación entre $\ln(A_t)$ y $\ln(A_{t-1})$ así como un shock más fuerte en la productividad (medido como la desviación estándar del error en la productividad.)

Parametro	Y_t	$\ln(A_t)$
Estimación Original ^a	1.0084	0.9778
Nueva Estimación	2.8604	1.5198

Notas:

a Modelo obtenido del match realizado por A. Gatty en las ayudantías.

Fuente: Elaboración propia

4. Ejercicios Analíticos

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Problema 2: Anticipated endowment shocks

Preferencias: $U(c_t) = -\frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t (c_t - \bar{c})^2$ $\beta \in (0, 1)$

Tasa de interés int.: $r^* \rightarrow \beta(1+r^*)=1$

Asset position: b_{-1}

Ley de movimiento del ingreso: $y_t = \rho y_{t-1} + \epsilon_{t-1}$ $\epsilon_t \sim (0, \sigma_\epsilon)$

$$E_{t-1}(y_t) = y_t$$

a) El problema de maximización de los hogares es:

$$\max_{\{c_t, b_t\}} U(c_t) = -\frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t (c_t - \bar{c})^2$$

S.a. $c_t + b_t = y_t + (1+r)b_{t-1}$

$$\lim_{j \rightarrow \infty} \frac{d_{t+j}}{(1+r)^j} \leq 0$$

dado b_{t-1} y $\{y_t\}_{t=0}^{\infty}$

Dado r^*, b_{-1} y $\{y_t\}_{t=0}^{\infty}$, un equilibrio competitivo en esta economía es una serie para $\{c_t, b_t\}_{t=0}^{\infty}$ para $t \geq 0$ que resuelve el problema de maximización de los hogares.

b) Equilibrio para consumo y la cuenta corriente.

$$\lambda = \sum_{t=0}^{\infty} \beta^t \left\{ -\frac{1}{2} (c_t - \bar{c})^2 + \lambda_t [y_t + (1+r)b_{t-1} - c_t - b_t] \right\}$$

Las CPO son:

$$[C_t]: U'(c_t) - \lambda_t = 0 \quad (1)$$

$$[b_t]: -\lambda_t + \beta(1+r)\bar{E}_t \lambda_{t+1} = 0 \quad (2)$$

$$[\lambda_t]: y_t + (1+r)b_{t-1} - c_t - b_t = 0 \quad (3)$$

La optimización de los hogares implica que la condición de NO-Ponzi se cumple con igualdad:

$$\lim_{j \rightarrow \infty} \frac{b_{t+j}}{(1+r)^j} = 0 \quad (4)$$

$$\text{De P2.1: } \lambda_t = U'(c_t) \Rightarrow \lambda_t = c_t - \bar{c}$$

$$\text{De P2.2: } \lambda_t = \beta \cancel{(1+r)} \bar{E}_t \lambda_{t+1} \Rightarrow \lambda_t = \bar{E}_t \lambda_{t+1}$$

$$\lambda_t = \bar{E}_t (c_{t+1} - \bar{c})$$

$$\lambda_t = \bar{E}_t c_{t+1} - \bar{c}$$

$$c_t - \bar{c} = \bar{E}_t c_{t+1} - \bar{c}$$

$$c_t = \bar{E}_t c_{t+1}$$

Aplicando la ley de expectativas iteradas:

$$c_t = \bar{E}_t [\bar{E}_{t+1} [\bar{E}_{t+2} \dots [\bar{E}_{t+j-1} c_{t+j}] \dots]]$$

Entonces:

$$c_t = \bar{E}_t c_{t+j} \quad (5)$$

Dada la restricción presupuestaria:

$$c_t + b_t = y_t + (1+r)b_{t-1}$$

$$\Rightarrow b_t = y_t - c_t + (1+r)b_{t-1}$$

Iterando recursivamente hacia adelante:

$$j=1 \quad C_{t+1} + b_{t+1} = Y_{t+1} + (1+r) b_t$$

$$C_{t+1} + b_{t+1} = Y_{t+1} + (1+r) [Y_t - C_t + (1+r) b_{t-1}]$$

$$\Rightarrow b_{t+1} = Y_{t+1} - C_{t+1} + (1+r) [Y_t - C_t + (1+r) b_{t-1}]$$

$j=2$

$$C_{t+2} + b_{t+2} = Y_{t+2} + (1+r) b_{t+1}$$

$$C_{t+2} + b_{t+2} = Y_{t+2} + (1+r) [Y_{t+1} - C_{t+1} + (1+r) [Y_t - C_t + (1+r) b_{t-1}]]$$

$$C_{t+2} + (1+r) C_{t+1} + (1+r)^3 C_t - (1+r)^3 b_{t-1} = Y_{t+2} + (1+r) Y_{t+1} + (1+r)^2 Y_t - b_{t+2}$$

Dividiendo por $(1+r)^2$:

$$C_t + \frac{C_{t+1}}{1+r} + \frac{C_{t+2}}{(1+r)^2} - (1+r) b_{t-1} = Y_t + \frac{Y_{t+1}}{1+r} + \frac{Y_{t+2}}{(1+r)^2} - \frac{b_{t+2}}{(1+r)^2}$$

Si se continua hasta $j=J$:

$$\sum_{j=0}^J \frac{C_{t+j}}{(1+r)^j} - (1+r) b_{t-1} = \sum_{j=0}^J \frac{Y_{t+j}}{(1+r)^j} - \frac{b_{t+2}}{(1+r)^J}$$

Tomando límite cuando $j \rightarrow \infty$ y valor esperado.

$$\sum_{j=0}^{\infty} \frac{E_t C_{t+j}}{(1+r)^j} - (1+r) b_{t-1} = \sum_{j=0}^{\infty} \frac{E_t Y_{t+j}}{(1+r)^j} - \underbrace{\lim_{j \rightarrow \infty} \frac{E_t b_{t+2}}{(1+r)^j}}_{=0}$$

Reordenando los términos:

$$(1+r) b_{t-1} = \sum_{j=0}^{\infty} \frac{E_t [C_{t+j} - Y_{t+j}]}{(1+r)^j}$$

$$(1+r) b_{t-1} = \sum_{j=0}^{\infty} \frac{E_t C_{t+j}}{(1+r)^j} - \sum_{j=0}^{\infty} \frac{E_t Y_{t+j}}{(1+r)^j}$$

(6)

Reemplazando 5 en 6:

$$(1+r)b_{t-1} = \sum_{j=0}^{\infty} \frac{c_t}{(1+r)^j} - \sum_{j=0}^{\infty} \frac{\epsilon_t y_{t+j}}{(1+r)^j}$$

Considerando el proceso que sigue el producto e iterando j horizontes adelante:

$$j=1 \rightarrow y_{t+1} = \rho y_t + \epsilon_t$$

$$\begin{aligned} j=2 \quad y_{t+2} &= \rho y_{t+1} + \epsilon_{t+1} = \rho[\rho y_t + \epsilon_t] + \epsilon_{t+1} \\ &= \rho^2 y_t + \rho \epsilon_t + \epsilon_{t+1} \end{aligned}$$

$$\downarrow \quad \vdots \quad y_{t+j} = \rho^j y_t + \sum_{k=0}^{j-1} \rho^{j-1-k} \epsilon_{t+k} = \rho^j y_t + \sum_{k=0}^{j-1} \rho^k \overset{0}{\epsilon}_{t+k}$$

Tomando valor esperado:

$$E_t y_{t+j} = E_t \rho^j y_t + \sum_{k=0}^{j-1} E_t \rho^{j-k} \overset{0}{\epsilon}_t \epsilon_{t+k}$$

$$E_t y_{t+j} = \rho^j y_t$$

(7)

Reemplazando:

$$(1+r)b_{t-1} = \sum_{j=0}^{\infty} \frac{c_t}{(1+r)^j} - \sum_{j=0}^{\infty} \frac{\rho^j y_t}{(1+r)^j}$$

Considerando y_t constante determinamos y_t^P :

$$= c_t \sum_{j=0}^{\infty} \left(\frac{1}{1+r}\right)^j - y_t \sum_{j=0}^{\infty} \left(\frac{\rho}{1+r}\right)^j$$

$$= \frac{1}{1 - \frac{1}{1+r}} \cdot c_t - \frac{1}{1 - \frac{\rho}{1+r}} \cdot y_t$$

$$(1+r)b_{t-1} = \left(\frac{1+r}{r}\right)c_t - \frac{1+r}{1+r-\rho} \cdot y_t$$

$$\left(\frac{1+r}{r}\right)c_t = (1+r)b_{t-1} + \frac{1+r}{1+r-\rho} y_t$$

$$c_t = r b_{t-1} + \frac{r}{1+r-\rho} y_t \Rightarrow c_t = r b_{t-1} + y_t^P$$

c) Compute $\text{corr}(Y_t, c_{at})$

Por definición:

$$ca_t = tb_t + rb_{t-1}$$

$$ca_t = Y_t - c_t + rb_{t-1}$$

$$= Y_t - \cancel{rb_{t-1}} - Y_t^p + \cancel{rb_{t-1}}$$

$$ca_t = Y_t - Y_t^p$$

$$ca_t = Y_t - \frac{r}{1+r-p} Y_t$$

$$ca_t = \left[1 - \frac{r}{1+r-p} \right] Y_t$$

$$= \left[\frac{1+r-p-r}{1+r-p} \right] Y_t = \frac{1-p}{1+r-p} Y_t$$

$$\frac{\partial ca_t}{\partial Y_t} = \frac{1-p}{1+r-p} > 0 \quad \text{por lo tanto la cuenta corriente es procíclica.}$$

lo cual es igual que el resultado estándar.

Problema 4.

- (a) Describa la restriccion presupuestaria del hogar

$$C_t + i_t + b_t = y_t + (1+r)b_{t+1}$$

$$C_0 + C_N + i_t + b_t = y_t + (1+r)b_{t+1}$$

Donde: $C_t = [(1-\alpha)^{1/n} C_N^{1-\frac{1}{n}} + \alpha^{1/n} s_t^{1-\frac{1}{n}}]^{1-\frac{1}{n}}$ donde $s_t = (1-\delta)s_{t-1} + c_0$

- (b) Defina el problema de optimización del hogar

$$\text{Max } \sum_{t=0}^{\infty} \beta^t \cdot U(c_t)$$

$$\text{s.a. } C_0 + C_N + i_t + b_t = y_t + (1+r)b_{t+1}$$

$$s_t = (1-\delta)s_{t-1} + c_0$$

$$\lim_{j \rightarrow \infty} \frac{d_{t+j}}{(1+r)^j} = 0$$

$$y_t = F(K_t)$$

$$K_{t+1} = (1-\delta_K)K_t + i_t$$

- (c) Present the complete set of equilibrium conditions

• Households choose processes $\{c_N, y_t, i_t, K_{t+1}, s_t, b_t\}$ para maximizar la función de utilidad sujeto a las restricciones mencionadas anteriormente.

- El lagrangiano asociado al problema del agente

$$L = \sum_{t=0}^{\infty} \beta^t \cdot f(U(c_t)) + \lambda_t [y_t + (1+r)b_{t+1} - c_0 - c_N - i_t - b_t]$$

$$L = \sum_{t=0}^{\infty} \beta^t \cdot f(U(c_t)) + \lambda_t [F(K_t) + (1+r)b_{t+1} - (s_t - (1-\delta)s_{t-1}) - c_N - (K_{t+1} - (1-\delta)K_t) - b_t]$$

Realizar condiciones de primer orden respecto $b_t, K_{t+1}, c_N, s_t, \lambda_t$

$$\{c_N\}: U'_N(c_t) \cdot \frac{\partial c_t}{\partial c_N} - \lambda_t = 0 \Rightarrow U'_N(c_t) \cdot \frac{\partial c_t}{\partial c_N} = \lambda_t \quad (1) \quad (\text{agregar derivada } \frac{\partial}{\partial c_N}?)$$

$$\{b_t\}: \beta^{t+1} \cdot \lambda_{t+1} \cdot (1+r) - \beta^t \cdot \lambda_t = 0 \\ \beta(1+r) \cdot \lambda_{t+1} = \lambda_t \quad (2)$$

$$\{K_{t+1}\}: \beta^{t+1} \cdot \lambda_{t+1} \cdot F'(K_{t+1}) - \beta^t \lambda_t + \beta^{t+1} \cdot \lambda_{t+1} \cdot (1-\delta) = 0$$

$$\beta \cdot \lambda_{t+1} [F'(K_{t+1}) + (1-\delta)] = \lambda_t \quad (3)$$

$$\{s_t\}: \beta \cdot \frac{\partial c}{\partial s} U_S(c_t) - \beta^t \cdot \lambda_t + \beta^{t+1} \cdot \lambda_{t+1} (1-\delta) = 0$$

$$\beta^t U_S(c_t) \cdot \frac{\partial c}{\partial s} + \beta^{t+1} \cdot \lambda_{t+1} (1-\delta) = \beta^t \cdot \lambda_t$$

$$\{s_t\}: U_S(c_t) \cdot \frac{\partial c}{\partial s} + \beta(1-\delta) \cdot \lambda_{t+1} = \lambda_t \quad (4) \quad (\text{agregar derivada } \frac{\partial}{\partial s}?)$$

$$\{\lambda_t\}: [F(K_t) + (1+r)b_{t+1} - (s_t - (1-\delta)s_{t-1}) - c_N - (K_{t+1} - (1-\delta)K_t) - b_t] = 0$$

Simplificando

$$\text{De (1) y (2)} \quad U'(c_t) \cdot \frac{\partial c}{\partial c_N} = \lambda_t \quad \Rightarrow$$

$$U'(c_{t+1}) \cdot \frac{\partial c}{\partial c_N} = \lambda_{t+1}$$

D2 (2):

$$\beta(1+r) \cdot U'(c_{N,t+1}) \cdot \frac{\partial c}{\partial c_N} = U'(c_{N,t}) \cdot \frac{\partial c_{t+1}}{\partial c_N}$$

• De (2) y (3)

$$\beta(1+r) \cdot \lambda_{t+1} = \beta \cdot \lambda_{t+1} [F'(K_{t+1}) + (1-\delta)]$$

$$(1+r) = F'(K_{t+1}) + 1 - \delta$$

$$r = F'(K_{t+1}) - \delta_K \quad (6)$$

• De (2) y (4)

$$\beta(1+r) \cdot \lambda_{t+1} = U_S(c_t) \frac{\partial c}{\partial s} + \beta(1-\delta) \cdot \lambda_{t+1}$$

$$\beta \cdot \lambda_{t+1} (1+r - 1 + \delta) = U_S(c_t) \cdot \frac{\partial C_t}{\partial s} \quad \text{cargar } c_S^{1/2}$$

$$\beta \cdot \lambda_{t+1} (r + \delta) = U_S(c_t) \cdot \frac{\partial C_t}{\partial s} \quad (7)$$

• Realizando las derivadas $\frac{\partial C_t}{\partial C_N}, \frac{\partial C_t}{\partial s}$

$$\bullet \frac{\partial C_t}{\partial C_N} = \frac{1}{1-\frac{1}{n}} \left[(1-\alpha)^{1/n} \cdot C_N^{1-\frac{1}{n}} + \alpha^{\frac{1}{n}} S_t^{1-\frac{1}{n}} \right]^{\frac{1}{1-\frac{1}{n}}-1} \cdot (1-\alpha)^{\frac{1}{n}} \cdot \left(\frac{1-\frac{1}{n}}{n} \right) \cdot C_N^{-\frac{1}{n}}$$

$$= \cancel{\frac{n}{n-1}} \left[(1-\alpha)^{1/n} \cdot C_N^{1-\frac{1}{n}} + \alpha^{\frac{1}{n}} S_t^{1-\frac{1}{n}} \right]^{\frac{1}{1-\frac{1}{n}}-1} \cdot (1-\alpha)^{\frac{1}{n}} \cdot \left(\frac{n-1}{n} \right)$$

$$\frac{\partial C_t}{\partial C_N} = \left[(1-\alpha)^{1/n} \cdot C_N^{1-\frac{1}{n}} + \alpha^{\frac{1}{n}} S_t^{1-\frac{1}{n}} \right]^{\frac{1}{1-\frac{1}{n}}-1} \cdot (1-\alpha)^{\frac{1}{n}} \cdot C_N^{-1/n} \quad * (8)$$

$$\bullet \frac{\partial C_t}{\partial s_t} = \frac{1}{1-\frac{1}{n}} \left[(1-\alpha)^{1/n} \cdot C_N^{1-\frac{1}{n}} + \alpha^{\frac{1}{n}} S_t^{1-\frac{1}{n}} \right]^{\frac{1}{1-\frac{1}{n}}-1} \cdot \alpha^{\frac{1}{n}} \cdot \left(1 - \frac{1}{n} \right) S_t^{-1/n}$$

$$\frac{\partial C_t}{\partial s_t} = \left[(1-\alpha)^{1/n} \cdot C_N^{1-\frac{1}{n}} + \alpha^{\frac{1}{n}} S_t^{1-\frac{1}{n}} \right]^{\frac{1}{1-\frac{1}{n}}-1} \cdot \alpha^{\frac{1}{n}} \cdot S_t^{-1/n} \quad * (9)$$

• Ordenando las condiciones de optimidad

$$\bullet \beta(1+r) \cdot U'(C_{N,t+1}) \cdot \frac{\partial C_t}{\partial C_N} = U'(C_{N,t}) \cdot \frac{\partial C_{t+1}}{\partial C_N} \quad (10)$$

$$\bullet r = F'(K_{t+1}) - \delta_K \quad (11)$$

$$\bullet \beta \cdot \lambda_{t+1} (r + \delta) = U_S(c_t) \cdot \frac{\partial C_t}{\partial s} \quad (12)$$

$$\bullet [F(K_t) + (1+r)b_{t+1} - (S_t - (1-\delta)S_{t+1}) - C_N - (K_{t+1} - (1-\delta)K_t) - b_t] = 0 \quad (13)$$

De la ecuación (2) y (2):

$$\lambda_{t+1} = \frac{\lambda_t}{\beta(1+r)} = \frac{U_N(c_t) \frac{\partial c}{\partial c_N}}{\beta(1+r)}$$

Sustituyendo en (12):

$$\beta \frac{U_N(c_t) \frac{\partial c}{\partial c_N}}{\beta(1+r)} (r+\delta) = U_S(c_t) \frac{\partial c}{\partial s}$$

$$\Rightarrow \frac{U_N(c_t) \frac{\partial c}{\partial c_N}}{U_S(c_t) \frac{\partial c}{\partial s}} = \frac{1+r}{r+\delta} \quad (14)$$

Sustituyendo (8) y (9) en (14):

$$\frac{U_N(c_t)}{U_S(c_t)} \cdot \frac{\frac{(1-\alpha)^{\frac{1}{n}} \cdot c_N^{-1/n}}{\alpha^{\frac{1}{n}} \cdot s_t^{-1/n}}}{\frac{(1-\alpha) \cdot s_t}{(\alpha) \cdot c_N}} = \frac{1+r}{r+\delta}; \quad \left(\frac{U_N(c_t) \cdot \frac{(1-\alpha) \cdot s_t}{(\alpha) \cdot c_N}}{U_S(c_t)} \right)^{1/n} = \frac{1+r}{r+\delta} \quad (15)$$

Reordenando

$$\left(\frac{(1-\alpha) \cdot s_t}{(\alpha) \cdot c_N} \right)^{1/n} = \frac{1+r}{r+\delta} \cdot \frac{U_S(c_t)}{U_N(c_t)}; \quad \frac{(1-\alpha) \cdot s_t}{\alpha} \cdot \frac{U_S(c_t)}{c_N} = \left[\frac{1+r}{r+\delta} \cdot \frac{U_S(c_t)}{U_N(c_t)} \right]^n$$

De las condiciones de Primer orden sabemos

$$\lambda_t = \frac{U'_N(x)}{P_1} = \dots = \frac{U'_N(x)}{P_n} \text{ es decir } \frac{U'_N(c)}{P_N} = \frac{U'_S(c)}{P_S} \Rightarrow \frac{U'_N(c)}{U'_S(c)} = \frac{P_N}{P_S}$$

Por dato del problema "the relative price of durables in term of non durables is one"

$$\frac{U'_N(c)}{U'_S(c)} = 1; \quad (16)$$

Sustituyendo (16) en (15)

$$\frac{(1-\alpha) \cdot s_t}{\alpha} \cdot \frac{U'_N(c)}{c_N} = \left[\frac{1+r}{r+\delta} \right]^n \Rightarrow c_N = \left(\frac{1-\alpha}{\alpha} \right) \left(\frac{r+\delta}{1+r} \right)^n \cdot s_t$$

- Iterando la restriccion presupuestaria para periodo $t+j$

$$F(K_{t+j}) + (1+r)b_{t+j+1} = (s_{t+j} - (1-\delta)S_{t+j-1}) + C_{N,t+j} + (K_{t+j+1} - (1-\delta)K_{t+j}) + b_{t+j}$$

$$\sum_{j=0}^J \frac{F(K_{t+j})}{(1+r)^j} + (1+r)b_{t+1} = \sum_{j=0}^J \frac{(s_{t+j} - (1-\delta)S_{t+j-1}) + C_{N,t+j} + (K_{t+j+1} - (1-\delta)K_{t+j})}{(1+r)^j} + \frac{b_{t+j}}{(1+r)^j}$$

Haciendo que $J \rightarrow \infty$ y reacomodando:

$$\sum_{j=0}^{\infty} \frac{F(K_{t+j}) - (K_{t+j+1} - (1-\delta)K_{t+j}) - (s_{t+j} - (1-\delta)S_{t+j-1}) + (1+r)b_{t+1}}{(1+r)^j} = \sum_{j=0}^{\infty} \frac{C_{N,t+j}}{(1+r)^j}$$

En resumen, las condiciones de optimidad son:

$$\bullet r = F'(K_{t+1}) - \delta_K$$

$$\bullet \beta: h_{t+1}(r+\delta) = U_S(c_t) \cdot \frac{\partial c}{\partial s}$$

$$\bullet C_N = \left(\frac{1-\alpha}{\alpha}\right) \left(\frac{r+\delta}{1+r}\right)^n \cdot S_t$$

$$\bullet C_t = \left[(1-\alpha)^{1/n} \left(\frac{1-\alpha}{\alpha}\right)^{1-1} \cdot \left(\frac{r+\delta}{1+r}\right)^{n-1} \cdot S_t^{1-\frac{1}{n}} + \alpha^{1/n} \cdot S_t^{1-\frac{1}{n}} \right]^{\frac{1}{1-\frac{1}{n}}}$$

$$C_t = \left[\left[\frac{(1-\alpha)}{\alpha^{1-\frac{1}{n}}} \cdot \left(\frac{r+\delta}{1+r}\right)^{n-1} + \alpha^{\frac{1}{n}} \right] S_t^{\frac{1}{n}} \right]^{\frac{1}{1-\frac{1}{n}}}$$

$$C_t = \left[\frac{(1-\alpha)}{\alpha^{1-\frac{1}{n}}} \left(\frac{r+\delta}{1+r}\right)^{n-1} + \alpha^{\frac{1}{n}} \right]^{\frac{n}{n-1}} \cdot S_t \quad (***)$$

Inciso d. Find the share of expenditures on durables in total consumption in the ss

Se toma: $r+1 = \frac{1}{\beta} \Leftrightarrow \beta(1+r) = 1$ y sea $b_{-1} = b > 0$

De la ecuación (2):

$$f'(1+r) U'_n(c_t) \frac{\partial c}{\partial n} = U'_N(c_{t+1}) \frac{\partial c}{\partial N} \Rightarrow U'(c_t) \frac{\partial c}{\partial n} = U'(c_{t+1}) \frac{\partial c}{\partial N}$$

Lo cual implica que en estado estacionario $c_t^N = c_{t+1}^N = \bar{c}_N$

Usando la restricción presupuestaria:

$$\sum_{j=0}^{\infty} F(K_{t+j}) - (K_{t+j+1} - (1-\delta_K)K_{t+j}) - (S_{t+j} - (1-\delta)S_{t+j-1}) + (1+r)b_{-1} = \sum_{j=0}^{\infty} \frac{c_{N,t+j}}{(1+r)^j}$$

y que en el estado estacionario:

$$\bar{k} = k_t = k_{t+1} = \dots = k_{t+j} \Rightarrow i_t = K_{t+j+1} - (1-\delta_K)K_{t+j}$$

$$i_t = \bar{k} - \bar{k} + \delta \bar{k} = \delta \bar{k}$$

$$\bar{s} = S_t = \dots = S_{t+j} \Rightarrow \bar{c}_D^N = S_t - (1-\delta)S_{t-1} \\ = \bar{s} - \bar{s} + \delta \bar{s} = \delta \bar{s} \quad (1)$$

Simplificando la RPI: $\bar{y} = F(\bar{k})$

$$\sum_{j=0}^{\infty} \frac{\bar{c}_0^N}{(1+r)^j} = \bar{c}_0^N \left(\frac{1}{1 - \frac{1}{1+r}} \right) = \left(\frac{1+r}{r} \right) c_0^N$$

$$\left(\frac{1+r}{r} \right) \bar{c}_0^N - (1+r) \bar{d} = \sum_{j=0}^{\infty} \frac{F(\bar{k}) - \delta \bar{k} - \delta \bar{s}}{(1+r)^j}$$

$$\left(\frac{1+r}{r} \right) \bar{c}_0^N - (1+r) \bar{d} = \left(\frac{r}{1+r} \right) [\bar{y} - \delta \bar{k} - \delta \bar{s}] \quad (2)$$

Por (1) sabemos que $\bar{c}_D = \delta \bar{s}$

$$\frac{\bar{c}_D}{\bar{c}_t} = \frac{\delta \bar{s}}{\left[\frac{(1-\alpha)}{\alpha^{1-\frac{1}{n}}} \left(\frac{r+\delta}{1+r} \right)^{n-1} + \alpha^{\frac{1}{n}} \right]^{\frac{n}{n-1}} \cdot \bar{s}} = \frac{\delta}{\left[\frac{(1-\alpha)}{\alpha^{1-\frac{1}{n}}} \left(\frac{r+\delta}{1+r} \right)^{n-1} + \alpha^{\frac{1}{n}} \right]^{\frac{n}{n-1}}}$$

La estrategia que se puede utilizar para calibrar los parámetros δ, n, α, r es la misma utilizada en VtSG, adaptada de Mendoza (1998). Los parámetros con fuentes externas $r = 0.04, \delta = 0.1$. Por otro lado α, δ , y n se pueden matchear con la std. dev. del producto, consumo y correlación del consumo con producto, autocorrelación del producto.

Inciso e. 1% increase in the consumption of non-durables
 Find the percentage increase in purchases of durables and in total consumption expenditures in period D.

Se tiene:

$$\bar{C}_N = \left(\frac{1-\alpha}{\alpha}\right) \left(\frac{r+s}{1+r}\right)^n \cdot \bar{s}$$

$$C_t = \left[\frac{(1-\alpha)}{\alpha^{1-\frac{1}{n}}} \left(\frac{r+s}{1+r} \right)^{n-1} + \alpha^{\frac{1}{n}} \right]^{\frac{n}{n-1}} \cdot \bar{s}$$

$$\bar{C}_D = \delta \bar{s} \Rightarrow \bar{s} = \frac{\bar{C}_D}{\delta}$$

$$\Rightarrow \bar{C}_N = \left(\frac{1-\alpha}{\alpha}\right) \left(\frac{r+s}{1+r}\right)^n \cdot \frac{\bar{C}_D}{\delta} \xrightarrow{\text{S}} \bar{C}_D = \bar{C}_N \left(\frac{1-\alpha}{\alpha}\right)^{-1} \left(\frac{r+s}{1+r}\right)^{-n} \delta \Rightarrow \bar{C}_D = \bar{C}_N \left(\frac{\alpha}{1-\alpha}\right) \left(\frac{1+r}{r+s}\right)^n \delta$$

Calcular:

$$\frac{C_{D,0} - \bar{C}_D}{\bar{C}_D} = \frac{1.01 \bar{C}_N \left(\frac{\alpha}{1-\alpha}\right) \left(\frac{1+r}{r+s}\right)^n \delta - \bar{C}_N \left(\frac{\alpha}{1-\alpha}\right) \left(\frac{1+r}{r+s}\right)^n \delta}{\bar{C}_N \left(\frac{\alpha}{1-\alpha}\right) \left(\frac{1+r}{r+s}\right)^n \delta}$$

$$C_{D,0} = 1.01 \bar{C}_N \left(\frac{\alpha}{1-\alpha}\right) \left(\frac{1+r}{r+s}\right)^n \delta$$

$$\Delta \frac{C_{D,t}}{\bar{C}_D} = \frac{\left(\frac{\alpha}{1-\alpha}\right) \left(\frac{1+r}{r+s}\right)^n \delta [1.01 \bar{C}_N - \bar{C}_N]}{\bar{C}_N \left(\frac{\alpha}{1-\alpha}\right) \left(\frac{1+r}{r+s}\right)^n \delta} = 0.01 = \frac{\Delta C_{N,t}}{\bar{C}_N}$$

Se tiene que: $C_t = \left[\frac{(1-\alpha)}{\alpha^{1-\frac{1}{n}}} \left(\frac{r+s}{1+r} \right)^{n-1} + \alpha^{\frac{1}{n}} \right]^{\frac{n}{n-1}} \cdot \frac{\bar{C}_D}{\delta}$

Por tanto: $\frac{\partial C_t}{\partial \bar{C}_D} = \left[\frac{(1-\alpha)}{\alpha^{1-\frac{1}{n}}} \left(\frac{r+s}{1+r} \right)^{n-1} + \alpha^{\frac{1}{n}} \right]^{\frac{n}{n-1}} \cdot \delta$

Y como $\frac{\partial \bar{C}_D}{\partial \bar{C}_D} = 0.01 \Rightarrow C_t \text{ aumenta en } 0.01 \delta \left[\frac{(1-\alpha)}{\alpha^{1-\frac{1}{n}}} \left(\frac{r+s}{1+r} \right)^{n-1} + \alpha^{\frac{1}{n}} \right]^{\frac{n}{n-1}}$

Ante un aumento de 1% en el consumo no durable se obtiene un aumento equivalente en el consumo durable. A su vez C_t aumenta en $0.01 \delta \left[\frac{(1-\alpha)}{\alpha^{1-\frac{1}{n}}} \left(\frac{r+s}{1+r} \right)^{n-1} + \alpha^{\frac{1}{n}} \right]^{\frac{n}{n-1}}$

Si todo el consumo fuese no-durable el incremento total del consumo habría sido 1%.

$$\text{In case f)} \quad \frac{\Delta C_t}{\bar{C}_N} = 0.01$$

$$\frac{\Delta tb}{\bar{C}_t} = \frac{tb_0 - \bar{tb}}{C_t} = \frac{y' - c' - (\bar{y} - \bar{c})}{\bar{c}} = \frac{y' - c' - \bar{y} + \bar{c}}{\bar{c}} = \frac{y' - \bar{y} - (c' - \bar{c})}{\bar{c}} = \frac{\Delta Y}{\bar{c}} - \frac{\Delta C}{\bar{c}} = \frac{\Delta Y - \Delta C}{\bar{c}}$$

$$\frac{\Delta C}{\bar{c}} = \frac{0.01 b \left[\frac{(1-\alpha)}{\alpha^{1-\frac{1}{n}}} \left(\frac{r+s}{1+r} \right)^{n+1} + \alpha^{\frac{1}{n}} \right]^{\frac{n}{n-1}}}{\left[\frac{(1-\alpha)}{\alpha^{1-\frac{1}{n}}} \left(\frac{r+s}{1+r} \right)^{n-1} + \alpha^{\frac{1}{n}n} \right]^{\frac{n+1}{n-1}} \cdot \bar{s}} = \frac{0.01 s}{\bar{s}} = \frac{0.01 s}{\bar{s}}$$

$$\frac{\Delta tb}{\bar{c}} = \frac{\Delta Y}{\bar{c}} - \frac{0.01 s}{\bar{s}}$$

En conclusión, para que sea contradicción dado que $\frac{\Delta tb}{\bar{C}_t} = \frac{\Delta Y}{\bar{c}} - \frac{\Delta C}{\bar{c}} < 0 \Rightarrow \Delta Y < \Delta C$.

- Si fueran no durables

$$\frac{\Delta tb}{\bar{C}_N} = \frac{\Delta Y}{\bar{c}_N} - \frac{\Delta C_N}{\bar{C}_N} = \frac{\Delta Y}{\bar{C}_N} - 0.01. \text{ Para que sea contradicción } \frac{\Delta Y}{\bar{C}_N} < 0.01.$$

- How much amplification is there due to presence of durables?

$$\frac{\Delta tb}{\bar{C}_t} - \frac{\Delta tb}{\bar{C}_N} = \frac{\Delta Y}{\bar{c}} - \frac{\Delta C}{\bar{c}} - \left(\frac{\Delta Y}{\bar{C}_N} - \frac{\Delta C_N}{\bar{C}_N} \right)$$

$$\frac{\Delta tb}{\bar{C}_t} - \frac{\Delta tb}{\bar{C}_N} = \left(\frac{\Delta Y}{\bar{c}} - \frac{\Delta Y}{\bar{C}_N} \right) - \left(\frac{\Delta C}{\bar{c}} - \frac{\Delta C_N}{\bar{C}_N} \right)$$

Ejercicio 6.

- Period 1. zero net asset position
- $\psi_1 = 0$, $\psi_2 = A \cdot \sqrt{i_1}$
- $i \rightarrow$ investment

a) Inciso a:

$$c_1 + i + d_1 = 0 \quad (1)$$

$$c_2 + d_2 = y_2 + (1+r)d_1 \quad (2)$$

b) Inciso b:

$$\text{Despejando } d_1 \text{ en (1)} \Rightarrow d_1 = -c_1 - i_1 \quad (6)$$

$$\text{Sustituyendo } d_1 \text{ en (2)} \Rightarrow c_2 + d_2 = y_2 - (1+r)(c_1 + i_1)$$

$$\frac{c_2}{(1+r)} + \frac{d_2}{(1+r)} = \frac{y_2}{(1+r)} - \frac{c_1 + i_1}{(1+r)}$$

c) Inciso c:

$$\text{Max } \ln(c_1) + \ln(c_2)$$

$$c_1 + \frac{c_2}{(1+r)} + i_1 = \frac{y_2}{(1+r)} - \frac{d_2}{(1+r)}$$

$$\text{s.o. } c_1 + \frac{c_2}{(1+r)} = \frac{y_2}{(1+r)} - \frac{d_2}{(1+r)}$$

$$\psi_2 = A \cdot \sqrt{i_1}$$

$$d_2 \leq 0$$

d) Inciso d:

$$L = \ln(c_1) + \ln(c_2) + \lambda_t \left\{ \frac{A \cdot \sqrt{i_1}}{(1+r)} - c_1 - \frac{c_2}{(1+r)} - i_1 \right\}$$

$$\{c_1\}: \frac{1}{c_1} - \lambda_t = 0$$

• Igualando $\{c_1\}$ y $\{c_2\}$

$$\{c_2\}: \frac{1}{c_2} - \frac{\lambda_t}{(1+r)} = 0$$

$$\frac{1}{c_1} = \frac{(1+r)}{c_2} \Rightarrow c_2 = (1+r)c_1 \quad (3)$$

$$\{i_1\}: \frac{\lambda_t + A}{(1+r)} \cdot \frac{1}{2} \cdot \frac{1}{\sqrt{i_1}} - \lambda_t = 0$$

• Despejando i_1 en $\{i_1\}$

$$\frac{A}{2(1+r)\sqrt{i_1}} = 1 \Rightarrow \frac{A}{2(1+r)} = \sqrt{i_1} \Rightarrow \frac{A^2}{4(1+r)^2} = i_1 \quad (4)$$

$$\{\lambda_t\}: \frac{A \cdot \sqrt{i_1}}{(1+r)} - c_1 - \frac{c_2}{(1+r)} - i_1 = 0$$

• Sustituyendo (3) y (4) en $\{\lambda_t\}$

$$\frac{A}{(1+r)} \cdot \frac{A}{2(1+r)} - c_1 - c_1 = \frac{A^2}{4(1+r)^2} \quad (5)$$

• Despejando c_1 en (5)

$$\frac{A^2}{2(1+r)^2} - \frac{A^2}{4(1+r)^2} = 2c_1 \Rightarrow \frac{A^2}{(1+r)^2} \left(\frac{1}{2} - \frac{1}{4} \right) = 2c_1 \Rightarrow \frac{A^2}{(1+r)^2} \cdot \frac{1}{4} = 2c_1$$

$$\Rightarrow c_1 = \frac{A^2}{(1+r)^2} \cdot \frac{1}{8} \Rightarrow c_2 = \frac{A^2}{(1+r)^2} \cdot \frac{1}{8} \cdot (1+r) = \frac{A^2}{8(1+r)}$$

Valores de equilibrio

$$C_1 = \frac{A^2}{8(1+r)^2}$$

$$C_2 = \frac{A^2}{8(1+r)}$$

$$i_1 = \frac{A^2}{4(1+r)^2}$$

$$tb_2 = \frac{3}{8} \frac{A^2}{(1+r)}$$

$$tb_1 = -\frac{A^2}{8(1+r)^2}$$

$$CA_2 = -\frac{3}{8} \frac{A^2}{(1+r)^2}$$

$$d_1 = -\frac{3}{8} \frac{A^2}{(1+r)^2}$$

$d_2 = 0$ por no ponzi

$$\bullet tb_2 = y_2 - c_2 \quad \bullet tb_1 = y_1 - c_1 \quad \bullet CA_2 = -(d_2 - d_1)$$

$$tb_2 = A \cdot \bar{i}_1 - \frac{A^2}{8(1+r)} \quad tb_1 = -\frac{A^2}{8(1+r)^2}$$

$$tb_2 = \frac{A^2}{2(1+r)} - \frac{A^2}{8(1+r)}$$

$$tb_2 = \frac{3}{8} \frac{A^2}{(1+r)}$$

$$CA_2 = -(0 - d_1) \\ CA_2 = d_1$$

$$\text{Por (b)} \quad d_1 = -c_1 - i_1$$

$$CA_2 = -\frac{A^2}{8(1+r)^2} - \frac{A^2}{4(1+r)^2}$$

$$CA_2 = -\frac{A^2}{(1+r)^2} \left(\frac{1}{8} + \frac{1}{4} \right)$$

$$CA_2 = -\frac{3}{8} \frac{A^2}{(1+r)^2}$$

(e) Ahora $r' > r$

- Dado que $i = f(A, r)$, un aumento en r provoca una disminución en la inversión, ya que aumenta el costo de capital.

Esto puede verse en $\frac{\partial i}{\partial r} < 0$

- En el periodo 1, un aumento de la tasa de interés provoca un aumento en el trade balance

$$tb_1 = -\frac{A^2}{8(1+r)^2} \Rightarrow \frac{\partial tb_1}{\partial r} = -\left[-2(1+r)^{-1} \cdot \frac{A^2}{8} \right] = \frac{A^2}{4(1+r)}$$

Al aumentar r , se quiere consumir menos ya que es costoso. Esto provoca un aumento en tb_1 .

(f) Ahora $A' > A$

- La inversión es una función creciente en A , ya que se quiere invertir más porque para un nivel dado de inversión se quiere producir más.

$$i_1 = \frac{A^2}{4(1+r)^2} \Rightarrow \frac{\partial i_1}{\partial A} = \frac{2A}{4(1+r)^2} = \frac{A}{2(1+r)} \quad \frac{\partial i}{\partial A} > 0$$

Sea $tb_1 = y_1 - c_1$

$$tb_1 = -\frac{A^2}{8(1+r)^2} \Rightarrow \frac{\partial tb_1}{\partial A} = -\frac{A}{4(1+r)^2}$$

Ante un aumento de A , tb_1 empeora ya que las personas quieren consumir e invertir más debido al aumento en su ingreso.

Apéndice

Appendix 1. Scripts tarea

En esta sección se incluye los *scripts* de Matlab y Dynare utilizados en los problemas de la tarea:

Problema 1.

```
%International Macroeconomics BCN-PUC
%Homework: Prob. 1
%Team: Axel Canales & Matilde Cerdá

%%%%%%%%%%%%%
clear all; close all; clc

%directory

%read excel
[data_nic] = readmatrix('DataNicaragua.xlsx', 'Sheet', 'Data','Range','E2:BN9');
[data_usa] = readmatrix('data_usa.xlsx', 'Sheet', 'Data','Range','E2:BI9');

%transpose
nic = data_nic.';
usa = data_usa.';

%%%%%%%%% NIC data %%%%%%%%%%
%Ratio series
GDP_pc_nic = nic(:,1); % GDP
C_nic_gdp = nic(:,2); % Consumption
I_nic_gdp = nic(:,3); %Investment
G_nic_gdp = nic(:,4); %Government
M_nic_gdp = nic(:,5); %Imp.
X_nic_gdp = nic(:,6); %Exp.
GDP_nic_constant = nic(:,7); %PIB precios constantes

%convert to leveles per capita
C_nic = C_nic_gdp.*GDP_pc_nic;
I_nic= I_nic_gdp.*GDP_pc_nic;
G_nic= G_nic_gdp.*GDP_pc_nic;
M_nic= M_nic_gdp.*GDP_pc_nic;
X_nic= X_nic_gdp.*GDP_pc_nic;

%%%%%%%%% USA data %%%%%%%%%%
%Ratio series
GDP_pc_usa = usa(6:57,6); % PIB
C_usa_gdp = usa(6:57,1); % Consumo
I_usa_gdp = usa(6:57,2); %Inversion
G_usa_gdp = usa(6:57,3); %Gobierno
M_usa_gdp = usa(6:57,4); %Imp
X_usa_gdp = usa(6:57,5); %Exp
GDP_usa_constant = usa(6:57,8); %PIB precios constantes

%convert to leveles per capita
C_usa = C_usa_gdp.*GDP_pc_usa;
I_usa= I_usa_gdp.*GDP_pc_usa;
G_usa= G_usa_gdp.*GDP_pc_usa;
M_usa= M_usa_gdp.*GDP_pc_usa;
```

```

X_usa= X_usa_gdp.*GDP_pc_usa;

%%%%%%%%%%%%% Cycle-trend decomposition %%%%%%%%
%%%%%%%
%Using Hodrick-Prescott filter

%NIC
%lambda=100
[trend_y_pc_nic, hp_cycle_nic_1] = hpfilter(log(GDP_pc_nic),100);
[~, hp_cycle_nic_2] = hpfilter(log(C_nic),100);
[~, hp_cycle_nic_3] = hpfilter(log(I_nic),100);
[~, hp_cycle_nic_4] = hpfilter(log(G_nic),100);
[~, hp_cycle_nic_x_1] = hpfilter(log(X_nic),100);
[~, hp_cycle_nic_m_1] = hpfilter(log(M_nic),100);
[~, hp_cycle_nic_5] = hpfilter((X_nic-M_nic)./trend_y_pc_nic,100);
[~, hp_cycle_nic_6] = hpfilter(log(G_nic)./log(GDP_pc_nic),100);

%lambda=6.25
[hp6_trend_y_pc_nic, hp_cycle_nic_7] = hpfilter(log(GDP_pc_nic),6.25);
[~, hp_cycle_nic_8] = hpfilter(log(C_nic),6.25);
[~, hp_cycle_nic_9] = hpfilter(log(I_nic),6.25);
[~, hp_cycle_nic_10] = hpfilter(log(G_nic),6.25);
[~, hp_cycle_nic_x_2] = hpfilter(log(X_nic),6.25);
[~, hp_cycle_nic_m_2] = hpfilter(log(M_nic),6.25);
[~, hp_cycle_nic_11] = hpfilter((X_nic-M_nic)./trend_y_pc_nic,6.25);
[~, hp_cycle_nic_12] = hpfilter(log(G_nic)./log(GDP_pc_nic),6.25);

%USA
%lambda=100
[trend_y_pc_usa_1, hp_cycle_usa_1] = hpfilter(log(GDP_pc_usa),100);
[~, hp_cycle_usa_2] = hpfilter(log(C_usa),100);
[~, hp_cycle_usa_3] = hpfilter(log(I_usa),100);
[~, hp_cycle_usa_4] = hpfilter(log(G_usa),100);
[~, hp_cycle_usa_x_1] = hpfilter(log(X_usa),100);
[~, hp_cycle_usa_m_1] = hpfilter(log(M_usa),100);
[~, hp_cycle_usa_5] = hpfilter((X_usa-M_usa)./trend_y_pc_usa_1,100);
[~, hp_cycle_usa_6] = hpfilter(log(G_usa)./log(GDP_pc_usa),100);

%lambda=6.25
[trend_y_pc_usa, hp_cycle_usa_7] = hpfilter(log(GDP_pc_usa),6.25);
[~, hp_cycle_usa_8] = hpfilter(log(C_usa),6.25);
[~, hp_cycle_usa_9] = hpfilter(log(I_usa),6.25);
[~, hp_cycle_usa_10] = hpfilter(log(G_usa),6.25);
[~, hp_cycle_usa_x_2] = hpfilter(log(X_usa),6.25);
[~, hp_cycle_usa_m_2] = hpfilter(log(M_usa),6.25);
[~, hp_cycle_usa_11] = hpfilter((X_usa-M_usa)./trend_y_pc_usa, 6.25);
[~, hp_cycle_usa_12] = hpfilter(log(G_usa)./log(GDP_pc_usa),6.25);

%%%%%%%%%%%%%
% Using log linear detrending

%Nic
det1_gdp_pc_nic = detrend(log(GDP_pc_nic),1);

```

```

det1_C_nic = detrend(log(C_nic(35:62)),1);
det1_I_nic = detrend(log(I_nic),1);
det1_G_nic = detrend(log(G_nic),1);
det1_X_nic = detrend(log(X_nic),1);
det1_M_nic = detrend(log(M_nic),1);
det1_tb_nic = detrend((X_nic-M_nic)./det1_gdp_pc_nic,1);
det1_gy_nic = detrend(log(G_nic)./log(GDP_pc_nic),1);

%USA
det1_gdp_pc_usa = detrend(log(GDP_pc_usa),1);
det1_C_usa = detrend(log(C_usa),1);
det1_I_usa = detrend(log(I_usa),1);
det1_G_usa = detrend(log(G_usa),1);
det1_X_usa = detrend(log(X_usa),1);
det1_M_usa = detrend(log(M_usa),1);
det1_tb_usa = detrend((X_usa-M_usa)./det1_gdp_pc_usa,1);
det1_gy_usa = detrend(log(G_usa)./log(GDP_pc_usa),1);

%%%%%%%%%%%%%
% 2. log quadratic detrending

%Nicaragua
det2_gdp_pc_nic = detrend(log(GDP_pc_nic),2);
det2_C_nic = detrend(log(C_nic(35:62)),2);
det2_I_nic = detrend(log(I_nic),2);
det2_G_nic = detrend(log(G_nic),2);
det2_X_nic = detrend(log(X_nic),2);
det2_M_nic = detrend(log(M_nic),2);
det2_tb_nic = detrend((X_nic-M_nic)./det1_gdp_pc_nic,2);
det2_gy_nic = detrend(log(G_nic)./log(GDP_pc_nic),2);

%USA
det2_gdp_pc_usa = detrend(log(GDP_pc_usa),2);
det2_C_usa = detrend(log(C_usa),2);
det2_I_usa = detrend(log(I_usa),2);
det2_G_usa = detrend(log(G_usa),2);
det2_X_usa = detrend(log(X_usa),2);
det2_M_usa = detrend(log(M_usa),2);
det2_tb_usa = detrend((X_usa-M_usa)./det2_gdp_pc_usa,2);
det2_gy_usa = detrend(log(G_usa)./log(GDP_pc_usa),2);

%%%%%%%%%%%%%
% 3. Correlatios per country and detrending method
%Nicaragua

%HP lambda = 100
hp100nic_ciclo = [hp_cycle_nic_1 hp_cycle_nic_3 hp_cycle_nic_4 hp_cycle_nic_5
    hp_cycle_nic_6];

hp100nic_y_c = [hp_cycle_nic_1(35:62) hp_cycle_nic_2]; %matriz que contiene
    variables para sacar correlacion
hp100nic_corr_ciclo= corrcoef(hp100nic_ciclo); %para sacar tabla de correlaciones
    de todas variables juntas %matriz de correlacion de
    todas variables exceptuando consumo con PIB

```

```

hp100nic_corr_y_c= corrcoef(hp100nic_y_c);%consultar si debido al consumo debemos
    recortar la muestra
nic_ciclo = [hp_cycle_nic_1 hp_cycle_nic_3 hp_cycle_nic_4 hp_cycle_nic_5
    hp_cycle_nic_6];
nic_y_c = [hp_cycle_nic_1(35:62) hp_cycle_nic_2];
nic_corr_ciclo= corrcoef(nic_ciclo);

%HP lambda = 6.25
hp6nic_ciclo = [hp_cycle_nic_7 hp_cycle_nic_9 hp_cycle_nic_10 hp_cycle_nic_11
    hp_cycle_nic_12];
hp6nic_y_c = [hp_cycle_nic_7(35:62) hp_cycle_nic_8];
hp6nic_corr_ciclo= corrcoef(hp6nic_ciclo);
hp6nic_corr_y_c= corrcoef(hp6nic_y_c);%consultar si debido al consumo debemos
    recortar la muestra

%log-linear detrending
det1_nic_ciclo = [det1_gdp_pc_nic det1_I_nic det1_G_nic det1_tb_nic det1_gy_nic];
det1_nic_y_c = [det1_gdp_pc_nic(35:62) det1_C_nic];
det1_nic_corr_ciclo= corrcoef(det1_nic_ciclo);
det1_nic_corr_y_c= corrcoef(det1_nic_y_c);%consultar si debido al consumo debemos
    recortar la muestra

%log-quadratic detrending
det2_nic_ciclo = [det2_gdp_pc_nic det2_I_nic det2_G_nic det2_G_nic det2_tb_nic
    det2_gy_nic];
det2_nic_y_c = [det2_gdp_pc_nic(35:62) det2_C_nic];
det2_nic_corr_ciclo= corrcoef(det2_nic_ciclo);
det2_nic_corr_y_c= corrcoef(det2_nic_y_c);%consultar si debido al consumo debemos
    recortar la muestra

%USA

%HP lambda = 100
hp100usa_ciclo = [hp_cycle_usa_1 hp_cycle_usa_3 hp_cycle_usa_4 hp_cycle_usa_5
    hp_cycle_usa_6];
hp100usa_y_c = [hp_cycle_usa_1 hp_cycle_usa_2];
hp100usa_corr_ciclo= corrcoef(hp100usa_ciclo);
hp100usa_corr_y_c= corrcoef(hp100usa_y_c);%consultar si debido al consumo debemos
    recortar la muestra

%HP lambda = 6.25
hp6usa_ciclo = [hp_cycle_usa_7 hp_cycle_usa_9 hp_cycle_usa_10 hp_cycle_usa_11
    hp_cycle_usa_12];
hp6usa_y_c = [hp_cycle_usa_7 hp_cycle_usa_8];
hp6usa_corr_ciclo= corrcoef(hp6usa_ciclo);
hp6usa_corr_y_c= corrcoef(hp6usa_y_c);%consultar si debido al consumo debemos
    recortar la muestra

%log-linear detrending
det1_usa_ciclo = [det1_gdp_pc_usa det1_I_usa det1_G_usa det1_tb_usa det1_gy_usa];
det1_usa_y_c = [det1_gdp_pc_usa det1_C_usa];
det1_usa_corr_ciclo= corrcoef(det1_usa_ciclo);
det1_usa_corr_y_c= corrcoef(det1_usa_y_c);%consultar si debido al consumo debemos
    recortar la muestra

```

```
%LAMBDA=6.25

%log-quadratic detrending
det2_usa_ciclo = [det2_gdp_pc_usa det2_I_usa det2_G_usa det2_tb_usa det2_gy_usa];
det2_usa_y_c = [det2_gdp_pc_usa det2_C_usa];
det2_usa_corr_ciclo= corrcoef(det2_usa_ciclo);
det2_usa_corr_y_c= corrcoef(det2_usa_y_c);%consultar si debido al consumo debemos
    recortar la muestra

%%% Data Collection of correlation cycles by country and detrending methods
%Metodo detrending lineal - Nicaragua
results_correl(1,1)= det1_nic_corr_ciclo(1,1); %respecto a ella misma y_pc
results_correl(2,1)= det1_nic_corr_y_c(2,1); %respecto a c
results_correl(3,1)= det1_nic_corr_ciclo(2,1);%respecto a i
results_correl(4,1)= det1_nic_corr_ciclo(3,1);%respecto a g
results_correl(5,1)= det1_nic_corr_ciclo(4,1);%respecto a tb
results_correl(6,1)= det1_nic_corr_ciclo(5,1);%respecto a g/y

%Metodo detrending lineal - USA
results_correl(1,2)= det1_usa_corr_ciclo(1,1);% respecto a ella misma y_pc
results_correl(2,2)= det1_usa_corr_y_c(2,1); %respecto a c
results_correl(3,2)= det1_usa_corr_ciclo(2,1);%respecto a i
results_correl(4,2)= det1_usa_corr_ciclo(3,1);%respecto a g
results_correl(5,2)= det1_usa_corr_ciclo(4,1);%respecto a tb
results_correl(6,2)= det1_usa_corr_ciclo(5,1);%respecto a g/y

%Metodo detrending cuadratico - Nicaragua
results_correl(1,3)= det2_nic_corr_ciclo(1,1); %respecto a ella misma y_pc
results_correl(2,3)= det2_nic_corr_y_c(2,1); %respecto a c
results_correl(3,3)= det2_nic_corr_ciclo(2,1);%respecto a i
results_correl(4,3)= det2_nic_corr_ciclo(3,1);%respecto a g
results_correl(5,3)= det2_nic_corr_ciclo(4,1);%respecto a tb
results_correl(6,3)= det2_nic_corr_ciclo(5,1);%respecto a g/y

%Metodo detrending cuadratico - USA
results_correl(1,4)= det2_usa_corr_ciclo(1,1); %respecto a ella misma y_pc
results_correl(2,4)= det2_usa_corr_y_c(2,1); %respecto a c
results_correl(3,4)= det2_usa_corr_ciclo(2,1);%respecto a i
results_correl(4,4)= det2_usa_corr_ciclo(3,1);%respecto a g
results_correl(5,4)= det2_usa_corr_ciclo(4,1);%respecto a tb
results_correl(6,4)= det2_usa_corr_ciclo(5,1);%respecto a g/y

%Metodo HP lambda=100 - Nicaragua
results_correl(1,5)= hp100nic_corr_ciclo(1,1); %respecto a ella misma y_pc
results_correl(2,5)= hp100nic_corr_y_c(2,1); %respecto a c
results_correl(3,5)= hp100nic_corr_ciclo(2,1);%respecto a i
results_correl(4,5)= hp100nic_corr_ciclo(3,1);%respecto a g
results_correl(5,5)= hp100nic_corr_ciclo(4,1);%respecto a tb
results_correl(6,5)= hp100nic_corr_ciclo(5,1);%respecto a g/y

%Metodo HP lambda=100 - United States
results_correl(1,6)= hp100usa_corr_ciclo(1,1); %respecto a ella misma y_pc
results_correl(2,6)= hp100usa_corr_y_c(2,1); %respecto a c
```

```

results_corr(3,6)= hp100usa_corr_ciclo(2,1);%respecto a i
results_corr(4,6)= hp100usa_corr_ciclo(3,1);%respecto a g
results_corr(5,6)= hp100usa_corr_ciclo(4,1);%respecto a tb
results_corr(6,6)= hp100usa_corr_ciclo(5,1);%respecto a g/y

%Metodo HP lambda=6 - Nicaragua
results_corr(1,7)= hp6nic_corr_ciclo(1,1); %respecto a ella misma y_pc
results_corr(2,7)= hp6nic_corr_y_c(2,1); %respecto a c
results_corr(3,7)= hp6nic_corr_ciclo(2,1);%respecto a i
results_corr(4,7)= hp6nic_corr_ciclo(3,1);%respecto a g
results_corr(5,7)= hp6nic_corr_ciclo(4,1);%respecto a tb
results_corr(6,7)= hp6nic_corr_ciclo(5,1);%respecto a g/y

%Metodo HP lambda=6 - United States
results_corr(1,8)= hp6usa_corr_ciclo(1,1); %respecto a ella misma y_pc
results_corr(2,8)= hp6usa_corr_y_c(2,1); %respecto a c
results_corr(3,8)= hp6usa_corr_ciclo(2,1);%respecto a i
results_corr(4,8)= hp6usa_corr_ciclo(3,1);%respecto a g
results_corr(5,8)= hp6usa_corr_ciclo(4,1);%respecto a tb
results_corr(6,8)= hp6usa_corr_ciclo(5,1);%respecto a g/y

rowNames = {'y','c','i','g','tb','g/y'};
colNames = {'Linear Nic','Linear USA','Quadratic Nic','Quadratic USA', 'HP con = 100 Nic','HP con = 100 USA','HP con = 6.25 Nic','HP con = 6.25 USA'};
results_corr =
array2table(results_corr,'RowNames',rowNames,'VariableNames',colNames);
filename = 'Resultados_correlation.xlsx';
writetable(results_corr,filename);

%%%%%%%%%%%%%
%4. Standard deviations

%Metodo detrending lineal - Nicaragua
det1_nic= {det1_gdp_pc_nic, det1_C_nic, det1_G_nic, det1_I_nic, det1_X_nic, det1_M_nic, det1_tb_nic}; %declare needed variables
det1_cycle_nic_std = (cellfun(@std,det1_nic'))./std(det1_gdp_pc_nic); %Generates the standard deviation of each variable of the column vector hp

%Metodo detrending lineal - USA
det1_usa= {det1_gdp_pc_usa, det1_C_usa, det1_G_usa, det1_I_usa, det1_X_usa, det1_M_usa, det1_tb_usa}; %declare needed variables
det1_cycle_usa_std = (cellfun(@std,det1_usa'))./std(det1_gdp_pc_usa); %Generates the standard deviation of each variable of the column vector hp

%Metodo detrending cuadratico - Nicaragua
det2_nic= {det2_gdp_pc_nic, det2_C_nic, det2_G_nic, det2_I_nic, det2_X_nic, det2_M_nic, det2_tb_nic}; %declare needed variables
det2_cycle_nic_std = (cellfun(@std,det2_nic'))./std(det2_gdp_pc_nic); %Generates the standard deviation of each variable of the column vector hp

%Metodo detrending cuadratico - USA
det2_usa= {det2_gdp_pc_usa, det2_C_usa, det2_G_usa, det2_I_usa, det2_X_usa, det2_M_usa, det2_tb_usa}; %declare needed variables
det2_cycle_usa_std = (cellfun(@std,det2_usa'))./std(det2_gdp_pc_usa); %Generates

```

```

the standard deviation of each variable of the column vector hp

%Metodo HP lambda=100 - Nicaragua
hp_nic_100 = {hp_cycle_nic_1, hp_cycle_nic_2, hp_cycle_nic_4,
    hp_cycle_nic_3,hp_cycle_nic_x_1,hp_cycle_nic_m_1, hp_cycle_nic_5}; %declare
needed variables
hp_cycle_nic_100_std = (cellfun(@std,hp_nic_100'))./std(hp_cycle_nic_1); %Generates
the standard deviation of each variable of the column vector hp

%Dismissed code:
% for i = 1:6
%fprintf('%5.2f \n ', eval(sprintf('std(hp_cycle_nic_%i)*100',i)))
%end

%Metodo HP lambda=100 - United States
hp_usa_100 = {hp_cycle_usa_1, hp_cycle_usa_2, hp_cycle_usa_4,
    hp_cycle_usa_3,hp_cycle_usa_x_1,hp_cycle_usa_m_1,hp_cycle_usa_5}; %declare
needed variables
hp_cycle_usa_100_std = (cellfun(@std,hp_usa_100'))./std(hp_cycle_usa_1); %Generates
the standard deviation of each variable of the column vector hp

%Metodo HP lambda=6 - Nicaragua
hp_nic_6 = {hp_cycle_nic_7, hp_cycle_nic_8, hp_cycle_nic_10,
    hp_cycle_nic_9,hp_cycle_nic_x_2,hp_cycle_nic_m_2,hp_cycle_nic_11}; %declare
needed variables
hp_cycle_nic_6_std = (cellfun(@std,hp_nic_6'))./std(hp_cycle_nic_7); %Generates the
standard deviation of each variable of the column vector hp

%Metodo HP lambda=6 - United States
hp_usa_6 = {hp_cycle_usa_7, hp_cycle_usa_8, hp_cycle_usa_10,
    hp_cycle_usa_9,hp_cycle_usa_x_2,hp_cycle_usa_m_2,hp_cycle_usa_11}; %declare
needed variables
hp_cycle_usa_6_std = (cellfun(@std,hp_usa_6'))./std(hp_cycle_usa_7); %Generates the
standard deviation of each variable of the column vector hp

%Compilation

results_std = [det1_cycle_nic_std, det1_cycle_usa_std, det2_cycle_nic_std,
    det2_cycle_usa_std, hp_cycle_nic_100_std, hp_cycle_usa_100_std,
    hp_cycle_nic_6_std, hp_cycle_usa_6_std]
results_std(1,:) = [std(det1_gdp_pc_nic), std(det1_gdp_pc_usa),
    std(det2_gdp_pc_nic), std(det2_gdp_pc_usa), std(hp_cycle_nic_1),
    std(hp_cycle_usa_1), std(hp_cycle_nic_2), std(hp_cycle_usa_2)]%primera fila
solo incluye la desviacion por si sola
results_std(7,:) = [std(det1_tb_nic), std(det1_tb_usa), std(det2_tb_nic),
    std(det2_tb_usa), std(hp_cycle_nic_5), std(hp_cycle_usa_5),
    std(hp_cycle_nic_11), std(hp_cycle_usa_11)]%primera fila solo incluye la
desviacion por si sola
%results_std_round=varfun(@(x)round(x,2), results_std);

%Export to excel

rowNames1_std = {'s_y','s_c/s_y','s_g/s_y','s_i/s_y','s_x/s_y','s_m/s_y',
    's_(tb)'};%"s" represents standard deviation

```

```

colNames1_std = {'Linear Nic','Linear USA','Quadratic Nic','Quadratic USA', 'HP con
= 100 Nic','HP con = 100 USA','HP con = 6.25 Nic','HP con = 6.25 USA'};;
results_std =
array2table(results_std,'RowNames',rowNames1_std,'VariableNames',colNames1_std);
results_std_round=varfun(@(x)round(x,2), results_std) %round to the nearest
hundredth
filename = 'Resultados_std.xlsx';
writetable(results_std_round,filename);

%%%%%%%%%%%%%
%5.autocorrelation/persistence
%%%%%%%%%%%%%
%Metodo detrending lineal - Nicaragua
[acf_det1_gdp_pc_nic,~] = autocorr(det1_gdp_pc_nic,1);
[acf_det1_C_nic,~] = autocorr(det1_C_nic,1);
[acf_det1_I_nic,~] = autocorr(det1_I_nic,1);
[acf_det1_G_nic,~] = autocorr(det1_G_nic,1);
[acf_det1_tb_nic,~] = autocorr(det1_tb_nic,1);
[acf_det1_gy_nic,~] = autocorr(det1_gy_nic,1);

%Metodo detrending lineal - USA
[acf_det1_gdp_pc_usa,~] = autocorr(det1_gdp_pc_usa,1);
[acf_det1_C_usa,~] = autocorr(det1_C_usa,1);
[acf_det1_I_usa,~] = autocorr(det1_I_usa,1);
[acf_det1_G_usa,~] = autocorr(det1_G_usa,1);
[acf_det1_tb_usa,~] = autocorr(det1_tb_usa,1);
[acf_det1_gy_usa,~] = autocorr(det1_gy_usa,1);

%Metodo detrending cuadratico - Nicaragua
[acf_det2_gdp_pc_nic,~] = autocorr(det2_gdp_pc_nic,1);
[acf_det2_C_nic,~] = autocorr(det2_C_nic,1);
[acf_det2_I_nic,~] = autocorr(det2_I_nic,1);
[acf_det2_G_nic,~] = autocorr(det2_G_nic,1);
[acf_det2_tb_nic,~] = autocorr(det2_tb_nic,1);
[acf_det2_gy_nic,~] = autocorr(det2_gy_nic,1);

%Metodo detrending cuadratico - USA
[acf_det2_gdp_pc_usa,~] = autocorr(det2_gdp_pc_usa,1);
[acf_det2_C_usa,~] = autocorr(det2_C_usa,1);
[acf_det2_I_usa,~] = autocorr(det2_I_usa,1);
[acf_det2_G_usa,~] = autocorr(det2_G_usa,1);
[acf_det2_tb_usa,~] = autocorr(det2_tb_usa,1);
[acf_det2_gy_usa,~] = autocorr(det2_gy_usa,1);

%Metodo HP lambda=100 - Nicaragua
[acf_hp100_cycle_nic_1,~] = autocorr(hp_cycle_nic_1,1);
[acf_hp100_cycle_nic_2,~] = autocorr(hp_cycle_nic_2,1);
[acf_hp100_cycle_nic_3,~] = autocorr(hp_cycle_nic_3,1);
[acf_hp100_cycle_nic_4,~] = autocorr(hp_cycle_nic_4,1);
[acf_hp100_cycle_nic_5,~] = autocorr(hp_cycle_nic_5,1);
[acf_hp100_cycle_nic_6,~] = autocorr(hp_cycle_nic_6,1);

%Metodo HP lambda=100 - United States
[acf_hp100_cycle_usa_1,~] = autocorr(hp_cycle_usa_1,1);

```

```

[acf_hp100_cycle_usa_2,~] = autocorr(hp_cycle_usa_2,1);
[acf_hp100_cycle_usa_3,~] = autocorr(hp_cycle_usa_3,1);
[acf_hp100_cycle_usa_4,~] = autocorr(hp_cycle_usa_4,1);
[acf_hp100_cycle_usa_5,~] = autocorr(hp_cycle_usa_5,1);
[acf_hp100_cycle_usa_6,~] = autocorr(hp_cycle_usa_6,1);

%Metodo HP lambda=6 - Nicaragua
[acf_hp6_cycle_nic_7,~] = autocorr(hp_cycle_nic_7,1);
[acf_hp6_cycle_nic_8,~] = autocorr(hp_cycle_nic_8,1);
[acf_hp6_cycle_nic_9,~] = autocorr(hp_cycle_nic_9,1);
[acf_hp6_cycle_nic_10,~] = autocorr(hp_cycle_nic_10,1);
[acf_hp6_cycle_nic_11,~] = autocorr(hp_cycle_nic_11,1);
[acf_hp6_cycle_nic_12,~] = autocorr(hp_cycle_nic_12,1);

%Metodo HP lambda=6 - United States
[acf_hp6_cycle_usa_7,~] = autocorr(hp_cycle_usa_7,1);
[acf_hp6_cycle_usa_8,~] = autocorr(hp_cycle_usa_8,1);
[acf_hp6_cycle_usa_9,~] = autocorr(hp_cycle_usa_9,1);
[acf_hp6_cycle_usa_10,~] = autocorr(hp_cycle_usa_10,1);
[acf_hp6_cycle_usa_11,~] = autocorr(hp_cycle_usa_11,1);
[acf_hp6_cycle_usa_12,~] = autocorr(hp_cycle_usa_12,1);

%%%%%%% Data collection of autocorrelation by country and detrending method
%Linear detrending method - Nicaragua
results_auto(1,1)= acf_det1_gdp_pc_nic(2,1);
results_auto(2,1)=acf_det1_C_nic(2,1);
results_auto(3,1)=acf_det1_I_nic(2,1);
results_auto(4,1)=acf_det1_G_nic(2,1);
results_auto(5,1)=acf_det1_tb_nic(2,1);
results_auto(6,1)=acf_det1_gy_nic(2,1);
%Linear detrending method - United States
results_auto(1,2)= acf_det1_gdp_pc_usa(2,1);
results_auto(2,2)=acf_det1_C_usa(2,1);
results_auto(3,2)=acf_det1_I_usa(2,1);
results_auto(4,2)=acf_det1_G_usa(2,1);
results_auto(5,2)=acf_det1_tb_usa(2,1);
results_auto(6,2)=acf_det1_gy_usa(2,1);
%Quadratic detrending method - Nicaragua
results_auto(1,3)= acf_det2_gdp_pc_nic(2,1);
results_auto(2,3)=acf_det2_C_nic(2,1);
results_auto(3,3)=acf_det2_I_nic(2,1);
results_auto(4,3)=acf_det2_G_nic(2,1);
results_auto(5,3)=acf_det2_tb_nic(2,1);
results_auto(6,3)=acf_det2_gy_nic(2,1);
%Quadratic detrending method - United States
results_auto(1,4)= acf_det2_gdp_pc_usa(2,1);
results_auto(2,4)=acf_det2_C_usa(2,1);
results_auto(3,4)=acf_det2_I_usa(2,1);
results_auto(4,4)=acf_det2_G_usa(2,1);
results_auto(5,4)=acf_det2_tb_usa(2,1);
results_auto(6,4)=acf_det2_gy_usa(2,1);
%Metodo HP lambda=100 - Nicaragua
results_auto(1,5)=acf_hp100_cycle_nic_1(2,1);
results_auto(2,5)=acf_hp100_cycle_nic_2(2,1);

```

```

results_auto(3,5)=acf_hp100_cycle_nic_3(2,1);
results_auto(4,5)=acf_hp100_cycle_nic_4(2,1);
results_auto(5,5)=acf_hp100_cycle_nic_5(2,1);
results_auto(6,5)=acf_hp100_cycle_nic_6(2,1);
%Metodo HP lambda=100 - United States
results_auto(1,6)=acf_hp100_cycle_usa_1(2,1);
results_auto(2,6)=acf_hp100_cycle_usa_2(2,1);
results_auto(3,6)=acf_hp100_cycle_usa_3(2,1);
results_auto(4,6)=acf_hp100_cycle_usa_4(2,1);
results_auto(5,6)=acf_hp100_cycle_usa_5(2,1);
results_auto(6,6)=acf_hp100_cycle_usa_6(2,1);
%Metodo HP lambda=6.25 - Nicaragua
results_auto(1,7)=acf_hp6_cycle_nic_7(2,1);
results_auto(2,7)=acf_hp6_cycle_nic_8(2,1);
results_auto(3,7)=acf_hp6_cycle_nic_9(2,1);
results_auto(4,7)=acf_hp6_cycle_nic_10(2,1);
results_auto(5,7)=acf_hp6_cycle_nic_11(2,1);
results_auto(6,7)=acf_hp6_cycle_nic_12(2,1);
%Metodo HP lambda=6.25 - United States
results_auto(1,8)=acf_hp6_cycle_usa_7(2,1);
results_auto(2,8)=acf_hp6_cycle_usa_8(2,1);
results_auto(3,8)=acf_hp6_cycle_usa_9(2,1);
results_auto(4,8)=acf_hp6_cycle_usa_10(2,1);
results_auto(5,8)=acf_hp6_cycle_usa_11(2,1);
results_auto(6,8)=acf_hp6_cycle_usa_12(2,1);

%Export to excel autocorrelation table
rowNames1 = {'y','c','i','g','tb','g/y'};
colNames1 = {'Linear Nic','Linear USA','Quadratic Nic','Quadratic USA', 'HP con = 100 Nic','HP con = 100 USA','HP con = 6.25 Nic','HP con = 6.25 USA'};
results_auto =
array2table(results_auto,'RowNames',rowNames1,'VariableNames',colNames1);
filename = 'Resultados_auto.xlsx';
writetable(results_auto,filename);

%%%%%%%% 1.B %%%%%%
%%%%% Graph showing the natural logarithm of real per capita GDP and the trend, one panel per trend.
%%%%% how the detrending method influences the volatility of the cyclical component of output.?
%%%%% Nicaragua
fig1 = figure('name', 'Nic','units','inch','position',[0,0,11,7.5]);

% add legend

subplot(2,2,1);
x = 1960:2021;
plot(x,log(GDP_pc_nic),x,trend_y_pc_nic,'-');
xlabel('Periodo de Estudio');
ylabel('Logaritmo');
xlim([1960 2021]);
legend('PIB per cpita a precios contantes ','Tendencia');
legend('boxoff');
title('HP filtering with = 100','FontSize', 12);

```

```

subplot(2,2,2);
plot(x,log(GDP_pc_nic),x,hp6_trend_y_pc_nic);
xlabel('Periodo de Estudio');
ylabel('Logaritmo');
xlim([1960 2021]);
title('HP filtering with = 6.25');

subplot(2,2,3);
trend1_gdp_pc_nic = log(GDP_pc_nic) - det1_gdp_pc_nic;
plot(x,log(GDP_pc_nic),x,trend1_gdp_pc_nic);
xlabel('Periodo de Estudio');
ylabel('Logaritmo');
xlim([1960 2021]);
title('Log-linear detrending')

subplot(2,2,4);
trend2_gdp_pc_nic = log(GDP_pc_nic) - det2_gdp_pc_nic;
plot(x,log(GDP_pc_nic),x,trend2_gdp_pc_nic);
xlabel('Periodo de Estudio');
ylabel('Logaritmo');
xlim([1960 2021]);
title('Log-quadratic detrending')

%%%%% USA
%Following variables are created for the entire sample
GDP_pc_usa1 = usa(:,6);
[graph_trend_y_pc_usa,~] = hpfilter(log(GDP_pc_usa1),100);
[graph6_trend_y_pc_usa,~] = hpfilter(log(GDP_pc_usa1),6.25);
det1_gdp_pc_usa_g = detrend(log(GDP_pc_usa1),1);
det2_gdp_pc_usa_g = detrend(log(GDP_pc_usa1),2);

fig(2)= figure('name', 'USA','units','inch','position',[0,0,11,7.5]);
subplot(2,2,1);
x = 1965:2021;
plot(x,log(GDP_pc_usa1),x,graph_trend_y_pc_usa,'-');
xlabel('Periodo de estudio');
ylabel('Logaritmo');
xlim([1965 2021]);
legend('PIB per cپta a precios contante ','Tendencia');
legend('boxoff');
title('HP filtering with = 100','FontSize', 12);

subplot(2,2,2);
plot(x,log(GDP_pc_usa1),x,graph6_trend_y_pc_usa);
xlabel('Periodo de estudio');
ylabel('Logaritmo');
xlim([1965 2021]);
title('HP filtering with = 6.25');

subplot(2,2,3);
GDP_pc_usa1 = usa(:,6);
trend1_gdp_pc_usa = log(GDP_pc_usa1) - det1_gdp_pc_usa_g;
plot(x,log(GDP_pc_usa1),x,trend1_gdp_pc_usa);

```

```

xlabel('Periodo de estudio');
ylabel('Logaritmo');
xlim([1965 2021]);
title('Log-linear detrending')

subplot(2,2,4);
trend2_gdp_pc_usa = log(GDP_pc_usa1) - det2_gdp_pc_usa_g;
plot(x,log(GDP_pc_usa1),x,trend2_gdp_pc_usa);
xlabel('Periodo de estudio');
ylabel('Logaritmo');
xlim([1965 2021]);
title('Log-quadratic detrending;')

%%Export graphics

exportgraphics(figure(1),'picture1.png','Resolution',700)
exportgraphics(figure(2),'picture2.png','Resolution',700)

%%%%% 1.C %%%%%%
%%%%% Using only the series of real GDP calculate the number of cycles that
      experienced each
%economy during the period under analysis and the average duration and magnitude
      (from
%peak to through).

%%%%% Nicaragua

fig(3)= figure('name', 'NIC_REAL_GDP','units','inch','position',[0,0,11,7.5]);
plot([1960:2021], GDP_nic_constant, 'LineWidth',1.5);
xregion(1977,1983);
xregion(2008,2017);
xlabel('Ao ');
ylabel('Real GDP');
xlim([1960 2021]);
title('PIB real de Nicaragua 1960-2021');

fig(4)= figure('name', 'USA_REAL_GDP','units','inch','position',[0,0,11,7.5]);
plot([1965:2021], usa(:,8), 'LineWidth',1.5);
xregion(1973,1981);
xregion(1990,2000);
xregion(2008,2019);
xlabel('Ao ');
ylabel('Real GDP');
xlim([1965 2021]);
title('PIB real de Estados Unidos 1965-2021');

%growth rates
growth_rate_nic = (GDP_nic_constant(2:57)./GDP_nic_constant(1:56)-1)*100
growth_rate_usa = (GDP_usa_constant(2:52)./GDP_usa_constant(1:51)-1)*100

%tabla que resume duracion y magnitud de expansiones y recesiones en promedio de
      los ciclos para nicaragua
%en la primera columna y estados unidos en la segunda
duracion_magn(1,1) = mean([abs(1960-1977)+1,abs(1977-1983)+1, abs(1983-2008)+1,

```

```

abs(2008-2017)+1, abs(2021-2017)+1])
duracion_magn(2,1) = mean(growth_rate_nic(growth_rate_nic>0))
duracion_magn(3,1) = mean(growth_rate_nic(growth_rate_nic<0))
duracion_magn(1,2) =
    mean([abs(1965-1973)+1,abs(1973-1981)+1,abs(1990-2000)+1,abs(2008-2019)+1,
    abs(2021-2019)+1])
duracion_magn(2,2) = mean(growth_rate_usa(growth_rate_usa>0))
duracion_magn(3,2) = mean(growth_rate_usa(growth_rate_usa<0))

rowNames1_dur = {'Duracion promedio', 'Expansiones', 'Recesiones'};%"s" represents
    standard deviation
colNames1_dur = {'Nic.', 'EE.UU.'};
results_dur =
    array2table(duracion_magn, 'RowNames', rowNames1_dur, 'VariableNames', colNames1_dur);
results_dur_round=varfun(@(x)round(x,2), results_dur) %round to the nearest
    hundredth
filename = 'Resultados_dur_mgn.xlsx';
writetable(results_dur_round,filename);

%export
exportgraphics(figure(3), 'picture3.png', 'Resolution', 700)
exportgraphics(figure(4), 'picture4.png', 'Resolution', 700)

```

Problema 2.

```

%Código básico DINARE
%EDEIR model

%%%% Especificación de productividad AR(2)

var y c i h k r d A tby tb ca cay
    la Uc Uh;

predetermined_variables k;

varexo eps;

parameters sigma delta rstar alpha omega dbar psi phi rho0 rho1 sigmiae
    beta sigma_eps;

sigma    = 2;                      %MENDOZA
delta   = 0.1;                     %depreciation rate
rstar   = 0.04;                    %long-run interest rate
alpha   = 0.32;                    %F(k,h) = k^ALFA h^(1-ALFA)
omega   = 1.455;                   %Frisch et al. st. from Mendoza 1991
dbar    = 0.7442;                  %debt
psi     = 0.000742;                %debt elasticity of interest rate
phi     = 0.028;                   %capital adjustment cost
rho0   = 1.42;                     %persistence of TFP shock
rho1   = -0.43;                   %persistence of TFP shock lag 2
sigmiae= 0.0129;                 %sd of innovation to TFP shock
beta    = 1/(1+rstar);            %sd of innovation to TFP shock
sigma_eps = 1;

```

```

model;

% FOC of d (Eq. 4.7)
la = beta*(1+r)*la(+1);

% FOC of c (Eq. 4.8)
Uc = la;

% FOC of h (Eq. 4.9)
Uh = (1-alpha)*la*y/h;      % Without (-)
                            % The same in line 47

% FOC of k{t+1} (Eq. 4.10)
la*(1+phi*(k(+1)-k)) = beta*la(+1)*(alpha*y(+1)/k(+1)+(1-delta) +
phi*(k(+2)-k(+1)));

% Marginal utility with respect to c
Uc = (c-1/omega*h^omega)^(-sigma);

% Marginal utility with respect to h
Uh = h^(omega-1)*(c-1/omega*h^omega)^(-sigma); % Without (-)

% Budget constraint
c+i+phi/2*(k(+1)-k)^2 + (1+r(-1))*d(-1) = y+d;

% Production function
y = A * k^(alpha) * h^(1-alpha);

% Capital
k(+1) = (1-delta)*k + i;

% Edeir
r = rstar + psi*(exp(d-dbar)-1);

% Trade balance
log(tb) = y - c - i - phi/2*(k(+1)-k)^2;

% Trade balance %GDP
log(tby) = log(tb)/y;

% Current account
log(ca) = -(d-d(-1));

% Current account % GDP
log(cay) = log(ca)/y;

% Productivity
log(A) = rho0*log(A(-1)) + rho1*log(A(-2))+ sigmae*eps;

end;

steady_state_model;

```

```

A = 1;
r = rstar;
d = dbar;
h = ((1-alpha)*(alpha/(rstar+delta))^(alpha/(1-alpha)))^(1/(omega-1));
k = h*(alpha/(rstar+delta))^(1/(1-alpha));
y = k^alpha*h^(1-alpha);
i = delta*k;
c = y-i-rstar*d;
tb = exp(y-c-i-phi/2*(k-k)^2);
tby = exp(log(tb)/y);
ca = exp(-(d-d));
cay = exp(log(ca)/y);
Uc = (c-1/omega*h^omega)^(-sigma);
la = Uc;
Uh = (1-alpha)*la*y/h;
end;

steady;

shocks;
var eps=sigma_eps^2;
end;

stoch_simul(order=1,irf=10,loglinear,contemporaneous_correlation) y c i h tby cay ;

%%%%% MATCHING

x_start=[sigmiae]; %use calibration as starting point, pongo los parametros que
    quiero calibrar, el orden no es importante
%make sure Dynare does not print out stuff during runs
options_.nofunctions=1;
options_.nograph=1;
options_.verbosity=0;
%set noprint option to suppress error messages within optimizer
options_.noprint=1; %no-print the results

% set csminwel options
H0 = 0.05*eye(length(x_start)); %Initial Hessian, GUESS INICIAL
crit = 1e-8; %Tolerance
nit = 1000; %Number of iterations

target=[3.08];%los parametros que yo quiero machear OJO AqUI

[fhat,x_opt_hat] = csminwel(@car2moment_objective,x_start,H0,[],crit,nit,target,oo_,
    M_,options_); %x_opt_hat sera el nuevo vector de parametros calibrados

set_param_value('sigmiae',x_opt_hat(1)); %we get the new rho which minimize the
    distance D

options_.noprint=0; %print the results
stoch_simul(order=1,loglinear,irf=20);

```

```
%File: ar2moment_objective.m
%Moment objective: vareps
function [D]=moment_objective(xopt,target,oo_, M_,options_)
    % function [D]=moment_objective(xopt,target, other options)
% Computes the quadratic deviation of the simulated moments from the empirical
% ones; does so by calling stoch_simul.m
%
% Inputs:
%   xopt           [npar by 1]           vector of parameters in current
%   optimization step
%   target         [ntargets]          vector of targets
%
% Outputs:
%   D              [scalar]            value of the objective function
% Codes based in Johannes Pfeifer
%% set parameter for use in Dynare

M_.params(strmatch('sigmae',M_.param_names,'exact')) = xopt(1); %rho AQUI SE DEBE
CAMBIAR DEPENDIENDO DE QUE MOMENTOS QUIERES MACHEAR

%El siguiente if se utiliza solamente si deseas agregar una restriccion a
%alguno de los parametros
%if any(xopt(2)<=-1) || any(xopt(2)>0.8) %make sure coefficient PSSI is between 0
%    and 0.5
%    D=10e6+sum([xopt].^2);             %penalty function
%    return                           % return to csmminwel - do not execute the rest
%end

var_list=M_.endo_names';

[info, oo_] = stoch_simul(M_, options_, oo_, var_list);
%run stoch_simul to generate moments with the options specified in the mod-file
if info %solution was not successful
    D=10e6+sum([xopt].^2); %return with penalty
else
%Collecting moments of the model
    model_moments(1,1) = sqrt(oo_.var(1,1)); %we get sd of y in oo_.var oo_.var es
        una matriz de varianzas y covarianzas
    %we get the corr of y and c in oo_.contemporaneous_correlation

%Defining z
    z = model_moments-target;
%Min distance (D)
    D=sqrt(z'*z);
end
```

Problema 5.

```
%File: prob5edeir.mod
%%% PROBLEMA 5
```

```

var y c i h k r d A tby tb ca cay
    la Uc Uh;

predetermined_variables k;

varexo eps;

parameters sigma delta rstar alpha omega dbar psi phi rho etatilde
    beta sigma_eps;

sigma = 2;                      %MENDOZA
delta = 0.1;                     %depreciation rate
rstar = 0.04;                    %long-run interest rate
alpha = 0.32;                    %F(k,h) = k^ALFA h^(1-ALFA)
omega = 1.455;                   %Frisch elas. from Mendoza 1991
dbar = 0.7442;                  %debt
psi = 0.000742;                 %debt elasticity of interest rate
phi = 0.028;                     %capital adjustment cost
rho = 1.42;                      %persistence of TFP shock
etatilde= 0.0129;                %sd of innovation to TFP shock
beta = 1/(1+rstar);             %sd of innovation to TFP shock
sigma_eps = 3.08;

%parameters to be matched

model;

% FOC of d (Eq. 4.7)
la = beta*(1+r)*la(+1);

% FOC of c (Eq. 4.8)
Uc = la;

% FOC of h (Eq. 4.9)
Uh = (1-alpha)*la*y/h;      % Without (-)
                            % The same in line 47

% FOC of k{t+1} (Eq. 4.10)
la*(1+phi*(k(+1)-k)) = beta*la(+1)*(alpha*y(+1)/k(+1)+(1-delta)+
                                phi*(k(+2)-k(+1)));

% Marginal utility with respect to c
Uc = (c-1/omega*h^omega)^(-sigma);

% Marginal utility with respect to h
Uh = h^(omega-1)*(c-1/omega*h^omega)^(-sigma); % Without (-)

% Budget constraint
c+i+phi*2*(k(+1)-k)^2 + (1+r(-1))*d(-1) = y+d;

% Production function
y = A * k^(alpha) * h^(1-alpha);

```

```

% Capital
k(+1) = (1-delta)*k + i;

% Edeir
r = rstar + psi*(exp(d-dbar)-1);

% Trade balance
log(tb) = y - c - i - phi/2*(k(+1)-k)^2;

% Trade balance %GDP
log(tby) = log(tb)/y;

% Current account
log(ca) = -(d-d(-1));

% Current account % GDP
log(cay) = log(ca)/y;

% Productivity
log(A(+1)) = rho*log(A)+ etatilde*eps;

end;

steady_state_model;
A = 1;
r = rstar;
d = dbar;
h = ((1-alpha)*(alpha/(rstar+delta))^(alpha/(1-alpha)))^(1/(omega-1));
k = h*(alpha/(rstar+delta))^(1/(1-alpha));
y = k^alpha*h^(1-alpha);
i = delta*k;
c = y-i-rstar*d;
tb = exp(y-c-i-phi/2*(k-k)^2);
tby = exp(log(tb)/y);
ca = exp(-(d-d));
cay = exp(log(ca)/y);
Uc = (c-1/omega*h^omega)^(-sigma);
la = Uc;
Uh = (1-alpha)*la*y/h;
end;

steady;

shocks;
var eps=sigma_eps^2;
end;

stoch_simul(order=1,irf=10,loglinear,contemporaneous_correlation) y c i h tby cay ;

%%%%% MATCHING

x_start=[rho etatilde phi psi]; %use calibration as starting point, pongo los
parametros que quiero calibrar, el orden no es importante
%make sure Dynare does not print out stuff during runs

```

```

options_.nofunctions=1;
options_.nograph=1;
options_.verbosity=0;
%set noprint option to suppress error messages within optimizer
options_.noprint=1; %no-print the results

% set csminwel options
H0 = 0.05*eye(length(x_start)); %Initial Hessian, GUESS INICIAL
crit = 1e-8; %Tolerance
nit = 1000; %Number of iterations

target=[3.0406; 0.9960; 5.6157; 0.4135];%los parametros que yo quiero machinear OJO
AQUI

[fhat,x_opt_hat] =
csminwel(@prob5moment_objective,x_start,H0,[],crit,nit,target,oo_,
M_,options_); %x_opt_hat sera el nuevo vector de parametros calibrados

set_param_value('rho',x_opt_hat(1)); %we get the new sigmae which minimize the
distance D
set_param_value('etatilde',x_opt_hat(2)); %we get the new rho which minimize the
distance D
set_param_value('phi',x_opt_hat(3)); %we get the new phi which minimize the
distance D
set_param_value('psi',x_opt_hat(4)); %we get the new psi which minimize the
distance D

%El orden del vector fila [rho,etatilde,phi,psi]
x_opt_hat

options_.noprint=0; %print the results
stoch_simul(order=1,loglinear,irf=20);

%%%%%%%crear tabla inciso b %%%%
%%%%% std. dev %% [y c i h tby cay]'
prob5_inc(:,1) = [sqrt(oo_.var(1,1)) sqrt(oo_.var(2,2)) sqrt(oo_.var(3,3))
sqrt(oo_.var(4,4)) sqrt(oo_.var(9,9)) sqrt(oo_.var(12,12))]'

%%%%% autocorrelacion %% [y c i h tby cay]'
prob5_inc(:,2) = [oo_.autocorr{1,1}(1,1) oo_.autocorr{1,1}(2,2)
oo_.autocorr{1,1}(3,3) oo_.autocorr{1,1}(4,4) oo_.autocorr{1,1}(9,9)
oo_.autocorr{1,1}(12,12)]'

%%%% correlacion con el producto %% [y c i h tby cay]'
prob5_inc(:,3) = [oo_.contemporaneous_correlation(1,1)
oo_.contemporaneous_correlation(2,1) oo_.contemporaneous_correlation(3,1)
oo_.contemporaneous_correlation(4,1) oo_.contemporaneous_correlation(9,1)
oo_.contemporaneous_correlation(12,1)]'

%%%%% inciso d. %%%%
prob5_incisod(2, :) = [sqrt(oo_.var(1,1)) sqrt(oo_.var(8,8))]
prob5_incisod(1, :) = [sqrt(1.0169) sqrt(0.9561)]

```

```

%File:prob5moment_objective.mod
function [D]=moment_objective(xopt,target,oo_, M_,options_)
% function [D]=moment_objective(xopt,target, other options)
% Computes the quadratic deviation of the simulated moments from the empirical
% ones; does so by calling stoch_simul.m
%
% Inputs:
% xopt           [npar by 1]           vector of parameters in current
% optimization step
% target         [ntargets]          vector of targets
%
% Outputs:
% D              [scalar]            value of the objective function
% Codes based in Johannes Pfeifer
%% set parameter for use in Dynare

M_.params(strmatch('rho',M_.param_names,'exact')) = xopt(1); % rho AQUI SE DEBE
% CAMBIAR DEPENDIENDO DE QUE MOMENTOS QUIERES MACHEAR
M_.params(strmatch('etatilde',M_.param_names,'exact')) = xopt(2); %rho AQUI SE DEBE
% CAMBIAR DEPENDIENDO DE QUE MOMENTOS QUIERES MACHEAR
M_.params(strmatch('phi',M_.param_names,'exact')) = xopt(2); % phi
M_.params(strmatch('psi',M_.param_names,'exact')) = xopt(2); % psi

%El siguiente if se utiliza solamente si deseas agregar una restriccion a
%alguno de los parametros
%if any(xopt(2)<=-1) || any(xopt(2)>0.8) %make sure coefficient PSSI is between 0
% and 0.5
%    D=10e6+sum([xopt].^2);           %penalty function
%    return                         % return to csminwel - do not execute the rest
%    of the code
%end

var_list=M_.endo_names';

[info, oo_] = stoch_simul(M_, options_, oo_, var_list);
%run stoch_simul to generate moments with the options specified in the mod-file
if info %solution was not successful
    D=10e6+sum([xopt].^2); %return with penalty
else
%Collecting moments of the model
    model_moments(1,1) = sqrt(oo_.var(1,1)); %we get sd of y in oo_.var oo_.var es
        una matriz de varianzas y covarianzas
    model_moments(2,1) = oo_.autocorr{1,1}; %we get the autocorr of y in
        oo_.autocorr{1,1}
    model_moments(3,1) = sqrt(oo_.var(3,3)); %we get sd of i in oo_.var oo_.var es
        una matriz de varianzas y covarianzas
    model_moments(3,1) = sqrt(oo_.var(5,5)); %we get sd of tby in oo_.var oo_.var es
        una matriz de varianzas y covarianzas

%Defining z
z = model_moments-target;
%Min distance (D)
D=sqrt(z'*z);
end

```

Appendix 2. Enunciados originales tarea

Pontificia Universidad Católica de Chile
Instituto de Economía

Banco Central de Nicaragua

**Macroeconomía Internacional
Problem Set**

Deadline: Jun 26, 2023 - 23:59 hrs.

IMPORTANT: This problem set consists of six exercises: three to be solved analytically and three to be solved empirically and computationally. You should send the PDF report, database, and codes in a zip file. The groups and individuals were selected in the following manner:

- Group 1: Matilde Guadalupe Cerdá Ruiz
Axel Omar Canales García
- Group 2: Christian Alexander Bejarano Chavarría
Rolando Antonio Largaespada Fernández
- Group 3: Néstor Adolfo Torres Betanco
Sonia María Olivas Obregón
- Group 4: Marilene Joan Ruiz Vega
Mijael Enoc Zúñiga Sánchez
- Group 5: María Dolores Fajardo Jirón
Luis Daniel Pavón Centeno
- Group 6: Bianka Libertad Flores Moreno
Hansel de Jesús González Pichardo
- Group 7: Richard Antonio González Rugama
Jennyfer Beatriz Flores Cerrato
- Group 8: Leonel Alberto Aburto Calderón
Carlos Andrés Martínez Rivera
- Group 9: Octavio Alejandro Quiroz
Jhoselyn Carolina Torres Vanegas
- Individual 1: Norvin Antonio Duarte
- Individual 2: Raquel Mercedes Escobar Vilchez
- Individual 3: Rodrigo Javier Salinas Portobanco

1. Business-Cycle Regularities in Emerging and Rich Countries (Based on Exercise 1.1 in U&SG)

In this exercise, you are asked to analyze the extent to which the numbered business-cycle facts discussed in class apply to a selected emerging country and the United States.

- (a) Compute the relevant business-cycle statistics for the following four alternative detrending methods: (i) log-linear detrending; (ii) log-quadratic detrending; (iii) HP filtering with $\lambda = 100$; and (iv) HP filtering with $\lambda = 6.25$. Characterize the business-cycle facts discussed in class and how the alternative detrending methods affect them.
- (b) Make a 2×2 graph showing the natural logarithm of real per capita GDP and the trend, one panel per trend. Discuss how the detrending method influences the volatility of the cyclical component of output. Also discuss which detrending method identifies recessions for the United States most in line with the NBER business cycle. dates¹
- (c) Using only the series of real GDP calculate the number of cycles that experienced each economy during the period under analysis and the average duration and magnitude (from peak to trough).

The data should be downloaded from the World Bank's WDI database. As the sample period for the selected emerging economy use 1960 to 2022 (or as long as there is available data), and for the United States use 1965 to 2022. Specifically, use the following time series to construct the required business-cycle statistics:

- GDP per capita (constant LCU): NY.GDP.PCAP.KN
- Households and NPISHs final consumption expenditure (percentage of GDP): NE.CON.PRVT.ZS²
- Gross capital formation (percentage of GDP): NE.GDI.TOTL.ZS
- General government final consumption expenditure (percentage of GDP): NE.CON.GOVT.ZS
- Imports of goods and services (percentage of GDP) NE.IMP.GNFS.ZS
- Exports of goods and services (percentage of GDP) NE.EXP.GNFS.ZS

Note: Selected emerging country means that each group have been assigned a different country. If you did not attend class, please email me to assign you a specific country.

GROUPS: selected emerging country

- Group 1: Nicaragua.
- Group 2: Chile.
- Group 3: Colombia.
- Group 4: Mexico.
- Group 5: Peru.

¹<https://www.nber.org/research/data/us-business-cycle-expansions-and-contractions>

²U&SG data includes an old version of this time serie: Household final consumption expenditure, etc. (percentage of GDP): NE.CON.PETC.ZS

- Group 6: South Africa.
- Group 7: Argentina.
- Group 8: Costa Rica.
- Group 9: Korea, Rep.
- Individual 1: Brazil
- Individual 2: Ecuador
- Individual 3: Uruguay

LINKS:

<https://databank.worldbank.org/reports.aspx?source=world-development-indicators#>
http://www.columbia.edu/~mu2166/book/empirics/usg_data_annual.xls

2. Anticipated Endowment Shocks

(Based on Exercise 2.5 in U&SG)

Consider a small open endowment economy enjoying free capital mobility. Preferences are described by the utility function

$$-\frac{1}{2}E_0 \sum_{t=0}^{\infty} \beta^t (c_t - \bar{c})^2,$$

with $\beta \in (0, 1)$. Agents have access to an internationally traded bond paying the constant interest rate r^* , satisfying $\beta(1 + r^*) = 1$. The representative household starts period zero with an asset position b_{-1} . Each period $t \geq 0$, the household receives an endowment y_t , which obeys the law of motion, $y_t = \rho y_{t-1} + \epsilon_t$, where ϵ_t is an i.i.d. shock with mean zero and standard deviation σ_ϵ . Notice that households know already in period $t - 1$ the level of y_t with certainty.

- Define the competitive equilibrium in this economy
- Derive the equilibrium process of consumption and the current account.
- Compute the correlation between the current account and output. Compare your result with the standard case in which y_t is known only in period t .

3. An AR(2) TFP Process and Excess Consumption Volatility

(Based on Exercise 4.6 in U&SG)

In this exercise you are asked to show that the SOE-RBC model can predict consumption to be more volatile than output when the productivity shock follows an AR(2) process displaying a hump-shaped impulse response. The theoretical model to be used is the EDEIR model presented in class (Section 4.1.1 of the book). Replace the AR(1) process with the following AR(2) specification:

$$\ln A_{t+1} = 1.42 \ln A_t - 0.43 \ln A_{t-1} + \epsilon_{t+1},$$

where ϵ_t is an i.i.d. random variable with mean zero and standard deviation $\sigma_\epsilon > 0$. Scale σ_ϵ to ensure that the predicted standard deviation of output is 3.08, the value predicted by the AR(1) version of this model. Otherwise use the same calibration and functional forms as presented in class. Use the code `edeir.mod` that we saw in class and then modify them to accommodate the present specification.

- (a) Produce a table displaying the unconditional standard deviation, serial correlation, and correlation with output of output, consumption, investment, hours, the trade balance-to-output ratio, and the current-account-to-output ratio.
- (b) Produce a 3 x 2 figure displaying the impulse responses of output, consumption, investment, hours, the trade-balance-to-output ratio, and TFP to a unit innovation in TFP.
- (c) Compare and contrast the predictions of the model under the AR(1) and the AR(2) TFP processes. Provide intuition.

4. Durable Consumption, I

(Based on Exercise 4.7 in U&SG)

Consider an SOE model with nondurable and durable consumption goods. Let $c_{N,t}$ denote consumption of nondurables in period t , and let $c_{D,t}$ denote purchases of durables in period t . The stock of durable consumer goods, denoted s_t , is assumed to evolve over time as $s_t = (1 - \delta)s_{t-1} + c_{D,t}$, where $\delta \in (0, 1]$ denotes the depreciation rate of durable goods. Households have preferences over consumption, c_t , of the form $\sum_{t=0}^{\infty} \beta^t U(c_t)$, where U is increasing in consumption and concave. Consumption, c_t , is a composite of nondurable consumption and the service flow provided by the stock of consumer durables. Specifically, assume that

$$c_t = \left[(1 - \alpha)^{\frac{1}{\eta}} c_{N,t}^{1-\frac{1}{\eta}} + \alpha^{\frac{1}{\eta}} s_t^{1-\frac{1}{\eta}} \right]^{\frac{1}{1-\frac{1}{\eta}}},$$

where $\eta > 0$ and $\alpha \in (0, 1)$. Households have access to an internationally traded risk-free one-period bond, which pays the interest rate r_t when held between periods t and $t + 1$. The relative price of durables in terms of nondurables is one. The household is subject to a borrowing limit that prevents it from engaging in Ponzi schemes. Output, denoted y_t , is produced with capital according to a production function of the form $y_t = F(k_t)$, where k_t denotes physical capital. The capital stock evolves over time as $k_{t+1} = (1 - \delta_k)k_t + i_t$, where i_t denotes investment in period t , and δ_k is the depreciation rate on physical capital.

- (a) Describe the household's budget set.
- (b) State the optimization problem of the household.
- (c) Present the complete set of equilibrium conditions.
- (d) The interest rate is constant over time and equal to $r_t = r = 1/\beta - 1$. Assume that up to period -1 , the economy was in a steady state equilibrium in which all variables were constant and $d = \bar{d} > 0$, where d denotes net external debt in the steady state. Find the share of expenditures on durables in total consumption expenditures in the steady state in terms of the parameters δ, r, α, η . Suggest a strategy for calibrating those four parameters.
- (e) Assume that in period 0 the economy unexpectedly receives a positive income shock as a consequence of the rest of the world forgiving part of the country's net foreign debt. Assume that the positive income shock results in a 1 percent increase in the consumption of nondurables in period 0. Find the percentage increase in purchases of durables and in total consumption expenditures in period 0. Compare your answer to the one you would have obtained if all consumption goods were nondurable.

- (f) Continuing to assume that consumption of nondurables has increased by 1 percent, find the change in the trade balance in period 0 expressed as a share of steady-state consumption expenditures. Is the response of the trade balance countercyclical? Compare your findings to those you would have obtained if all consumption goods were nondurable. How much amplification is there due to the presence of durables?

5. Calibrating the EDEIR Model Using Canadian Data over the Period 1960-2011 (Based on Exercise 4.10 in U&SG)

In Section 4.5, we calibrated the EDEIR model using second moments computed with Canadian data for the period 1946-1985. The middle panel of Table 4.2 updates the empirical second moments for the period 1960-2011. The present exercise uses these empirical regularities to calibrate and evaluate the SOE-RBC model. You can use the EDEIR model in dynare (`edeir.mod`).

- (a) Calibrate the EDEIR model as follows. Set $\beta = 1/1.04, \sigma = 2, \omega = 1.455, \alpha = 0.32, \delta = 0.1, \bar{d} = 0.7442$. Set the remaining four parameters, $\rho, \tilde{\eta}, \phi, \psi_1$ to match the observed standard deviations and serial correlations of output and the standard deviations of investment and the trade-balance-to-output ratio in Canada during 1960-2011. Approximate the equilibrium dynamics up to first order, and use a distance minimization as we saw in class. Compare the resulting values for $\rho, \tilde{\eta}, \phi, \psi_1$ with those reported in Table 4.1.

Table 4.1 Calibration of the EDEIR SOE-RBC Model

Parameter	σ	δ	r^*	α	\bar{d}	ω	ϕ	ψ_1	ρ	$\tilde{\eta}$
Value	2	0.1	0.04	0.32	0.7442	1.455	0.028	0.000742	0.42	0.0129

- (b) Compute theoretical second moments and present your findings as in the third panel of Table 4.2.

Table 4.2 Empirical and Theoretical Second Moments

Variable	Canadian Data									Model					
	1946–1985			1960–2011											
	σ_{x_t}	$\rho_{x_t, x_{t-1}}$	ρ_{x_t, GDP_t}	σ_{x_t}	$\rho_{x_t, x_{t-1}}$	ρ_{x_t, GDP_t}	σ_{x_t}	$\rho_{x_t, x_{t-1}}$	ρ_{x_t, GDP_t}						
y	2.81	0.62	1	3.71	0.86	1	3.08	0.62	1						
c	2.46	0.70	0.59	2.19	0.70	0.62	2.71	0.78	0.84						
i	9.82	0.31	0.64	10.31	0.69	0.80	9.04	0.07	0.67						
h	2.02	0.54	0.80	3.68	0.75	0.78	2.12	0.62	1						
$\frac{tb}{y}$	1.87	0.66	-0.13	1.72	0.76	0.12	1.78	0.51	-0.04						
$\frac{ca}{y}$							1.45	0.32	0.05						

Sources: Empirical moments for the period 1946–1985 are taken from Mendoza (1991) and for the period 1960–2011 are based on the authors' calculations using data from WDI (GDP, consumption, investment, imports, and exports) and Statistics Canada (hours worked).

Notes: Empirical second moments are based on annual, per capita, and quadratically detrended data. Standard deviations are measured in percentage points. Theoretical moments are produced by running the Matlab code `edeir_run.m`.

- (c) Comment on the ability of the model to explain observed business cycles in Canada during 1960-2011.
- (d) Compute the unconditional standard deviation of the productivity shock, $\ln A_t$, under the present calibration. Compare this number to the one corresponding to the 1946-1985 calibration presented in Section 4.5. Now do the same with the standard deviation of output. Discuss and interpret your findings.

6. Interest-Rate Shocks, Investment, and the Trade Balance

(Based on Exercise 6.2 in U&SG)

Consider a two-period small open economy populated by a large number of households with preferences given by $\ln(c_1) + \ln(c_2)$, where c_1 and c_2 denote consumption in periods 1 and 2, respectively. Households start period 1 with a zero net asset position. They have no endowments in either period but can produce goods in period 2 by operating the technology $y_2 = A\sqrt{i_1}$, where y_2 denotes output in period 2, $A > 0$ is a productivity factor, and i_1 denotes investment in period 1. In period 1, households can participate in the international financial market, where the interest rate is r . They are subject to a no-Ponzi-game constraint of the form $d_2 \leq 0$, where $d_t, t = 1, 2$, denotes one-period debt assumed in period t and maturing in period $t + 1$.

- (a) Write down the household's budget constraints in periods 1 and 2.
- (b) Derive the household's intertemporal budget constraint.
- (c) State the household's maximization problem.
- (d) Compute the equilibrium values of consumption, investment, the trade balance, the current account, and external debt in periods 1 and 2.
- (e) Suppose now that the interest rate increases to $r' > r$. Characterize the effect of this shock on investment and the trade balance in period 1. Is it qualitatively in line with the related SVAR evidence examined in this chapter? Explain.
- (f) Suppose that in period 1 agents learn that a positive productivity shock elevates A to $A' > A$. Analyze the effect of this innovation on the equilibrium levels of investment and the trade balance in period 1. How does this effect relate to the SVAR evidence studied in this chapter?