energies

The impact of energy efficiency on economic growth: Application of the MARCO model to the Portuguese economy 1960-2014.

Supplementary Materials: the Portugal MAcroeconometric Resource COnsumption Model (MARCO-PT)

S1. Model equations

Gross Domestic Product

According to the expenditure approach to measure gross domestic product (Y), this is defined as the sum of total private consumption expenditure (C_T), total government expenditure (G), total investment expenditure (I), the trade balance between exports and imports ($X - M$), plus a statistical difference, as reported in national accounts ($STAT1$) – Equation (S1.1).

$$Y_t = C_T_t + G_t + I_t + (X_t - M_t) + STAT1_t \quad \text{(S1. 1)}$$

According to the income approach, GDP (Y) is defined as the sum of income by private firms (i.e. gross operating surplus of corporations and other income) (YF), total compensation of employees (W), government income (taxes minus subsidies) (YG), plus a statistical difference ($STAT2$) – Equation (S1.2).

$$YF_t = Y_t - W_t - YG_t - STAT2_t \quad \text{(S1. 2)}$$

Finally, according to the production approach, GDP (Y) is defined as the sum of gross value added (GVA), net taxes (NET_TAX), and a statistical difference ($STAT3$) – Equation (S1.3).

$$GVA_t = Y_t - NET_TAX_t - STAT3_t \quad \text{(S1. 3)}$$

Sectoral GDP

The model assumes that all income is spent, hence, from the expenditure side, GDP (Y) is equal to total expenditure by industry (IND_T), and other sectors (i.e., agriculture and services) (OTH_T) – Equation (S1.4).

$$OTH_T_t = Y_t - IND_T_t - STAT1_t \quad \text{(S1. 4)}$$

Total expenditure by industry is equal to the sum of industry expenditure on non-energy goods (IND_NE) and energy goods (IND_E) – Equation (S1.5).

$$IND_T_t = IND_NE_t + IND_E_t \quad \text{(S1. 5)}$$

Industry expenditure on non-energy goods is a function of investment (I), total useful exergy (UEX_TOT), and the real interest rate (R_REAL) – Equation (S1.6).

$$IND_NE_t = f(I_t, UEX_TOT_t, R_REAL_t) \quad \text{(S1. 6)}$$

Industry expenditure on energy goods is, in turn, calculated by the physical amount of final energy used in industry (FEN_IND), multiplied by its corresponding price (P_EN_IND) – Equation (S1.7).

$$IND_E_t = ((P_EN_IND_t/CPI_t) \cdot FEN_IND_t \quad \text{(S1. 7)}$$

For other sectors, expenditure in energy goods is similarly calculated by the physical amount of final energy used by these sectors (FEN_OTH) multiplied by the corresponding price (P_EN_OTH) – Equation (S1.8).

$$OTH_E_t = ((P_EN_OTH_t/CPI_t) \cdot FEN_OTH_t \quad \text{(S1. 8)}$$

Expenditure on non-energy goods by other sectors is computed as the difference between total expenditure by these sectors and expenditure on energy goods by these sectors – Equation (S1.9).

$$OTH_NE_t = OTH_T_t - OTH_E_t \quad \text{(S1. 9)}$$

Consumption

Total consumption expenditure (C_T) is the sum of consumption expenditure on non-energy goods (C_NE) and consumption expenditure on energy goods (C_E) – Equation (S1.10).

$$C_T_t = C_NE_t + C_E_t \quad \text{(S1. 10)}$$

Consumption expenditure on non-energy goods (C_NE) is a function of households' disposable income (YD), wages (W), and total useful exergy (UEX_TOT) – Equation (S1.11).

$$C_NE_t = f(YD_t, W_t, UEX_TOT_t) \quad \text{(S1. 11)}$$

Consumption expenditure on energy goods (C_E) is given by multiplying the physical amount of final energy used by households (FEN_C) by its corresponding price (P_EN_C) – Equation (S1.12).

$$C_E_t = ((P_EN_C_t/CPI_t) \cdot FEN_C_t \quad \text{(S1. 12)}$$

Investment

Investment expenditure by private firms (I) is a function of profits made by these firms (YF), capital productivity (Y/K_NET), the productivity of useful exergy (Y/UEX_TOT), and labour productivity (Y/L) – Equation (S1.13).

$$I_t = f(YF_t, Y_t/K_NET_t, Y_t/UEX_TOT_t, Y_t/L_t) \quad \text{(S1. 13)}$$

Exports

Exports (X) are a function of GDP from the rest of the world (Y_RW), the price of exports (PX), total useful exergy (UEX_TOT), and net capital stock (K_NET) – Equation (S1.14).

$$X_t = f(Y_RW_t, PX_t, UEX_TOT_t, K_NET_t) \quad \text{(S1. 14)}$$

Imports

Imports (M) are a function of total consumption expenditure (C_T), GDP from the rest of the world (Y_RW), the price of imports (PM), and the real exchange rate (E_INDEX_REAL) – Equation (S1.15).

$$M_t = f(C_T_t, Y_RW_t, PM_t, E_INDEX_REAL_t) \quad \text{(S1. 15)}$$

Trade balance

The trade balance is simply defined as the difference between exports and imports – Equation (S1.16).

$$TB_t = X_t - M_t \quad \text{(S1. 16)}$$

Capital stock

Gross capital stock (K_GRS) is computed by summing to the gross capital stock of the previous year t-1 the investment expenditure (I) in capital from the current year t – Equation (S1.17).

$$K_GRS_t = K_GRS_{t-1} + I_t \quad \text{(S1. 17)}$$

Net capital stock (K_NET) is obtained by subtracting depreciation from gross capital stock (K_GRS). Depreciation is assumed to be constant and equal to 5.5% of the value of net capital stock in the previous year t-1 – Equation (S1.18).

$$K_NET_t = K_GRS_t - 0.055 \cdot K_NET_{t-1} \quad \text{(S1. 18)}$$

Capital services (K_SERV) is calculated by multiplying the net capital stock (K_NET) by an index (K_SERV_INDEX) – Equation (S1.19).

$$K_SERV_t = K_SERV_INDEX_t \cdot K_NET_t \quad \text{(S1. 19)}$$

Labor

The labor force (L_FORCE) is defined as the amount of people in the country that are available to work. It is a function of the labor supply (L), GDP (Y), and population (POP) – Equation (S1.20).

$$L_FORCE_t = f(L_t, Y_t, POP_t) \quad \text{(S1. 20)}$$

The labor supply to production represents the amount of people that are actually employed in the economy. It is a function of GDP (Y) and the other two factors of production – capital services (K_SERV) and total useful exergy (UEX_TOT), as well as the unemployment rate (UR) – Equation (S1.21).

$$L_t = f(Y_t, K_SERV_t, UEX_TOT_t, UR_t) \quad \text{(S1. 21)}$$

Quality-corrected labor supply is computed by multiplying labor (L) by two indices: the average annual hours worked by persons engaged (L_HRS_INDEX) and the human capital index, based on years of schooling and returns to education (L_HC_INDEX) – Equation (S1.22).

$$HL_t = L_t \cdot L_HRS_INDEX_t \cdot L_HC_INDEX_t \quad \text{(S1. 22)}$$

Labor productivity (Y_L) is computed simply as the ratio between GDP (Y) and labour supply (L) – Equation (S1.23).

$$Y_L_t = Y_t / L_t \quad \text{(S1. 23)}$$

The unemployment rate (UR) is computed as the percentage of people that are out of work – Equation (S1.24).

$$UR_t = ((L_FORCE_t - L_t)/L_FORCE_t) \cdot 100 \quad \text{(S1. 24)}$$

Disposable income and net wealth

Households' disposable income (YD) is a function of wages (W) – Equation (S1.25).

$$YD_t = f(W_t) \quad \text{(S1. 25)}$$

Savings, on the other hand, is defined as a ratio (S_RATIO), given as the percentage of disposable income (YD) that is not destined to total consumption expenditure (C_T) – Equation (S1.26).

$$S_RATIO_t = ((YD_t - C_T_t)/YD_t) \cdot 100 \quad \text{(S1. 26)}$$

Wages

Total remuneration of employees (W) is a function of profits received by firms (YF), average hourly wages (W_HOUR), the consumer price index (CPI), and quality-adjusted labour (HL) – Equation (S1.27).

$$W_t = f(YF_t, W_HOUR_t, CPI_t, HL_t) \quad \text{(S1. 27)}$$

Average hourly wages (W_HOUR), in turn, are a function of the consumer price index (CPI), labour productivity (Y_L), and the unemployment rate (UR) – Equation (S1.28).

$$W_HOUR_t = f(CPI_t, Y_t/L_t, UR_t) \quad \text{(S1. 28)}$$

Energy

The model distinguishes between primary energy (PEN), primary exergy (PEX), total final energy (FEN_T), and total useful exergy (UEX_TOT). Primary exergy (PEX) is calculated by dividing total final energy (FEN_T) by the efficiency to transform primary energy into final energy ($EXEFF_PF$) – Equation (S1.29).

$$PEX_t = FEN_T_t / EXEFF_PF_t \quad \text{(S1. 29)}$$

Primary energy, in turn, is computed by dividing primary exergy (PEX) by the ratio between primary exergy and primary energy (PEX_PEN_RATIO) – Equation (S1.30).

$$PEN_t = PEX_t / PEX_PEN_RATIO_t \quad \text{(S1. 30)}$$

Total final energy (FEN_T) is given by the sum of final energy used by households (FEN_C), industry (FEN_IND), and other sectors (FEN_OTH) – Equation (S1.31).

$$FEN_T_t = FEN_C_t + FEN_IND_t + FEN_OTH_t \quad \text{(S1. 31)}$$

Final energy used by households (FEN_C) is a function of energy prices faced by households (P_EN_C), total useful exergy (UEX_TOT), heating degree days (HDD), and average hourly wages (W_HOUR) – Equation (S1.32).

$$FEN_C_t = f(P_EN_C_t, UEX_TOT_t, HDD_t, W_HOUR_t) \quad \text{(S1. 32)}$$

Final energy used by industry (FEN_IND) is similarly a function of energy prices faced by industry (P_EN_IND) and total useful exergy (UEX_TOT) – Equation (S1.33).

$$FEN_IND_t = f(P_EN_IND_t, UEX_TOT_t) \quad \text{(S1. 33)}$$

Final energy use by other sectors of the economy (FEN_OTH) is a function of the relative price of energy (CPI_REL_EN), and the expenditure by these sectors on non-energy goods (OTH_NE) – Equation (S1.34).

$$FEN_OTH_t = f(CPI_REL_EN_t, OTH_NE_t) \quad \text{(S1. 34)}$$

Finally, total useful exergy (UEX_TOT) is a function of quality-adjusted labour (HL), net capital stock (K_GRS), and GDP (Y) – Equation (S1.35).

$$UEX_TOT_t = f(HL_t, K_NET_t, Y_t) \quad \text{(S1. 35)}$$

Energy efficiency

Total energy efficiency (EN_EFF_TOT) is computed as the combined efficiency of transforming primary energy into final energy ($EXEFF_PF$), and the efficiency to transform final energy into its useful stage ($EXEFF_FU$) – Equation (S1.36).

$$EN_EFF_TOT_t = EXEFF_PF_t \cdot EXEFF_FU_t \quad \text{(S1. 36)}$$

The efficiency to transform final energy to useful exergy ($EXEFF_FU$) is simply defined as the ratio between total useful exergy (UEX_TOT) and total final energy (FEN_T) – Equation (S1.37).

$$EXEFF_FU_t = UEX_TOT_t / FEN_T_t \quad \text{(S1. 37)}$$

Energy intensity (EY), often used as a proxy for energy efficiency in the economy, is computed as the ratio between total final energy (FEN_T) and GDP (Y) – Equation (S1.38).

$$EY_t = FEN_T_t / Y_t \quad \text{(S1. 38)}$$

The energy-GDP ratio (EN_GDP_RATIO) is computed by dividing total final expenditure (i.e., the sum of expenditure on energy goods by households, industry, and other sectors) by GDP (Y) – Equation (S1.39).

$$EN_GDP_RATIO_t = (C_E_t + IND_E_t + OTH_E_t)/Y_t \quad \text{(S1. 39)}$$

Prices

The general level of prices is represented by the consumer price index (CPI), which is a function of the general price of energy (CPI_E), wage productivity (W/Y), and the real exchange rate (E_INDEX_REAL) – Equation (S1.40).

$$CPI_t = f(CPI_E_t, W_t/Y_t, E_INDEX_REAL_t) \quad \text{(S1. 40)}$$

The general price of energy (CPI_E) is a function of the general consumer price index (CPI), and the prices paid for energy in industry (P_EN_IND) – Equation (S1.41).

$$CPI_E_t = f(CPI_t, P_EN_IND_t) \quad \text{(S1. 41)}$$

The relative price of energy (CPI_REL_EN) is then calculated as the ratio between the general price of energy (CPI_E) and the consumer price index (CPI) – Equation (S1.42).

$$CPI_REL_EN_t = CPI_E_t / CPI_t \quad \text{(S1. 42)}$$

Energy prices for households (P_EN_OTH) are expressed as a demand function, given by the amount of final energy consumed by households (FEN_C) and the consumer price index (CPI) – Equation (S1.43).

$$P_EN_C_t = f(FEN_C_t, CPI_t) \quad \text{(S1. 43)}$$

Similarly, energy prices for industry (P_EN_IND) are a function of the amount of final energy consumed by industry (FEN_IND), the consumer price index for energy (CPI_E), and the consumer price index (CPI) – Equation (S1.44).

$$P_EN_IND_t = f(FEN_IND_t, CPI_E_t, CPI_t) \quad \text{(S1. 44)}$$

Finally, energy prices for other sectors (P_EN_OTH) are a function of final energy consumed by these sectors (FEN_OTH), the price paid for energy in the industry sector (P_EN_IND), and the consumer price index (CPI) – Equation (S1.45).

$$P_EN_OTH_t = f(P_EN_IND_t, FEN_OTH_t, CPI_t) \quad \text{(S1. 45)}$$

The price of exports (PX) is given by the consumer price index (CPI), GDP (Y), and the real exchange rate (E_INDEX_REAL) – Equation (S1.46).

$$PX_t = f(E_INDEX_REAL_t, Y_t, CPI_t) \quad \text{(S1. 46)}$$

The price of imports (PM) is given by GDP (Y) relative to that of the rest of the world (Y_RW), the value of imports (M), and the real exchange rate (E_INDEX_REAL) – Equation (S1.47).

$$PM_t = f(Y_t / Y_RW_t, E_INDEX_REAL_t, M_t) \quad \text{(S1. 47)}$$

Finally, the inflation rate (INF) is simply the change of the consumer price index from period $t-1$ to period t – Equation (S1.48).

$$INF_t = ((CPI_t / CPI_{t-1}) - 1) \cdot 100 \quad \text{(S1. 48)}$$

Money supply and interest rates

The nominal interest rate (R_NOM) is a function of GDP (Y), and the consumer price index (CPI) – Equation (S1.49).

$$R_NOM_t = f(Y_t, CPI_t) \quad \text{(S1. 49)}$$

The real interest rate (R_REAL) is calculated by subtracting inflationary effects from the nominal interest rate (R_NOM) – Equation (S1.50).

$$R_REAL_t = R_NOM_t - INF_t \quad \text{(S1. 50)}$$

Exchange rate

The nominal exchange rate (E_INDEX_NOM) is a function of the relative price of imports (CPI/PM), the ratio between domestic GDP (Y) and GDP from the rest of the world (Y_RW), and the nominal interest rate (R_NOM) – Equation (S1.51).

$$E_INDEX_NOM_t = f(CPI_t/PM_t, Y_t/Y_RW_t, R_NOM_t) \quad \text{(S1. 51)}$$

The real exchange rate (E_INDEX_REAL) is calculated by multiplying the nominal exchange rate (E_INDEX_NOM) by the relative price of imports (CPI/PM) – Equation (S1.52).

$$E_INDEX_REAL_t = E_INDEX_NOM_t \cdot (CPI_t/PM_t) \quad \text{(S1. 52)}$$

CO2 emissions

CO2 per capita, from the territorial perspective ($CO2_TERR/POP$) is expressed in the reduced form of the Kaya identity, being a function of GDP per capita (Y/POP) and (primary) energy intensity (PEN/Y) – Equation (S1.53).

$$CO2_TERR/POP_t = f(Y_t/POP_t, PEN_t/Y_t) \quad \text{(S1. 53)}$$

Exogenous variables

There are 13 exogenous variables in the model:

- Government (public) expenditure – G;
- Government income – YG;
- Net taxes – NET_TAX;
- GDP from the rest of the world – Y_RW;
- Initial values for gross and net capital stock – K_GRS, K_NET;
- Capital services index – K_SERV_INDEX;
- Average annual hours worked by persons engaged – L_HRS_INDEX;
- Human capital index, based on years of schooling and returns to education – L_HC_INDEX;
- Energy efficiency to transform primary to final energy – $EXEFF_PF$;
- Ratio between primary exergy and primary energy – PEX_PEN_RATIO;
- Heating degree days – HDD;
- Population – POP;
- GDP statistical differences (as reported in national accounts) – $STAT1$, $STAT2$, $STAT3$.

S2. Data sources

Table S2. 1 – Variables, data sources, and descriptive statistics. M€ (Millions of €). TJ (TeraJoule). MJ (MegaJoule).

Variable	Description	Units	Source	Descriptive statistics			
				Mean	Max	Min	Std.Dev.
Y	Gross Domestic Product	M€	[1]	110194.1	181997.2	30784.50	50942.62
YF	Gross operating surplus	M€	[1]	31679.49	58713.10	3124.296	17835.44
GVA	Gross value added	M€	[1]	97846.92	159508.3	27687.20	44325.29
OTH_T	GVA (agriculture & services)	M€	[1]	83715.42	151344.7	18610.49	47282.28
IND_T	GVA (industry)	M€	[1]	27888.32	41022.82	9617.920	9148.567
IND_NE	Non-energy expenditure (industry)	M€	-	26140.28	38275.89	9489.373	8301.957
IND_E	Final energy expenditure (industry)	M€	-	1748.045	3318.795	128.5466	921.9354
OTH_E	Final energy expenditure (other)	M€	-	4937.705	12377.76	300.1543	3790.963
OTH_NE	Non-energy expenditure (other)	M€	-	78777.72	141502.6	18310.34	43664.38
C_T	Household consumption (total)	M€	[1]	72701.97	126556.6	19830.90	36640.66
C_NE	Non-energy expenditure (households)	M€	-	70647.25	119735.3	22630.13	32329.24
C_E	Final energy consumption (household)	M€	-	1765.787	3666.397	442.7072	815.8515
I	Gross fixed capital formation (total)	M€	[1]	23478.40	43800.45	5509.430	11975.17
X	Exports (total)	M€	[1]	22682.28	66408.61	1788.590	20144.45
M	Imports (total)	M€	[1]	27314.13	69332.43	1826.510	24045.10
TB	Trade balance	M€	-	-4631.85	1833.810	-14675.7	5349.513
K_GRS	Gross capital stock	M€	[1]	309.8346	593.5196	100.7609	173.7156
K_NET	Net capital stock	M€	[1]	294.4945	562.5078	96.26990	164.6783
K_SERV	Capital services	Index (1910=100)	[2]	5678.714	13211.16	1089.100	4022.370
LF	Labour force	Thousands	[7]	4213.814	5277.161	3093.249	728.9306
L	Engaged individuals	Thousands	[7]	4170.883	5193.298	3063.775	744.8081
HL	Quality-corrected labour	Hours	-	15587780	22456930	9096009	4919985
Y_L	Labour productivity	M€/Thousands	-	25.07806	37.18537	9.711322	8.149072
UR	Unemployment rate	%	-	0.066691	0.164000	0.017000	0.035299
YD	Households' disposable income	M€	[1]	84478.75	137481.0	21748.78	38021.52
S_RATIO	Savings	%	-	15.56404	29.14347	3.569684	6.812857
W	Compensation of employees (total)	M€	[1]	67330.78	103158.8	19746.22	26684.19
W_HOUR	Average wage per hour	€	-	7.894248	10.89262	2.766970	2.379840
PEX	Primary exergy	TJ	[8,10]	538805.4	934315.0	177020.9	257447.3
PEN	Primary energy	TJ	[8,10]	511207.5	895665.3	162709.5	248999.5
FEN_T	Final energy use (total)	TJ	[8,10]	451789.8	758354.2	170946.1	202439.8
FEN_C	Final energy use (households)	TJ	[8,10]	91333.55	135059.0	54800.75	26419.75
FEN_IND	Final energy use (industry)	TJ	[8,10]	168292.4	262053.0	42184.69	61780.70
FEN_OTH	Final energy use (others)	TJ	[8,10]	192163.8	381474.1	35914.45	121027.7
UEX_TOT	Useful exergy (total)	TJ	[8,10]	97847.96	177355.2	23256.91	51848.76
EN_EFF_TOT	Total energy efficiency	%	-	0.174946	0.199287	0.131380	0.017915
EXEFF_FU	Final-to-useful exergy efficiency	%	-	0.205619	0.242603	0.136048	0.029840
E_Y	Energy intensty	TJ/ M€	-	4.194633	5.612267	3.634132	0.402656
EN_GDP_RATIO	Energy-GDP ratio	-	-	0.191080	0.219917	0.159521	0.013597
CPI	Consumer price index (all items)	Index (2010=100)	[1]	49.84464	102.2974	10.63299	32.31684
CPI_E	Consumer price index (energy)	Index (2010=100)	[9]	34.92996	105.9009	1.255656	33.31289
CPI_REL_EN	Relative price of energy	-	-	0.509043	1.065962	0.090985	0.327749
P_EN_C	Energy prices (households)	€/MJ	[2-3]	0.010085	0.032277	0.000502	0.007794
P_EN_IND	Energy prices (industry)	€/MJ	[2-3]	0.006314	0.022879	0.000225	0.005458
P_EN_OTH	Energy prices (other)	€/MJ	[2-3]	0.014434	0.044970	0.000617	0.011240

PX	Export deflator	Index (2010=100)	[1]	52.37352	106.7435	4.181649	39.56206
PM	Import deflator	Index (2010=100)	[1]	56.13454	108.3133	5.194941	39.81668
INF	Inflation rate	%	-	4.413777	19.53044	-9.033568	5.570683
R_NOM	Nominal interest rate	%	[1]	7.653061	22.46000	0.210000	6.353924
R_REAL	Real interest rate	%	-	3.319534	24.50357	-11.01971	7.464356
E_INDEX_NOM	Nominal exchange rate index	Index (1990=100)	[1]	257.7087	565.0614	92.28530	197.1990
E_INDEX_REAL	Real exchange rate index	Index	-	477.6173	1581.823	58.96618	554.0744
CO2_TERR_POP	CO2 territorial emissions per capita	Tonnes/person	[5]	3711.426	6675.563	926.5087	1854.946
G	Government consumption (total)	M€	[1]	20055.23	37765.31	2926.000	11909.62
YG	Government income	M€	[1]	11367.72	23534.05	1700.129	7671.840
NET_TAX	Total adjustment to basic prices	M€	[1]	11367.72	23534.05	1700.129	7671.840
Y_RW	GDP from the rest of the world	M€	[6]	3.35E+13	5.86E+13	1.32E+13	1.22E+13
L_HC_INDEX	Human capital index	Index	[7]	1.843838	2.427423	1.298790	0.379055
L_HRS_INDEX	Average hours worked (engaged)	Hours/year	[7]	2000.594	2251.261	1849.049	123.8214
EXEFF_PF	Primary-to-final energy efficiency	%	[8,10]	0.857647	0.975097	0.789935	0.052793
PEX_PEN_RATIO	Exergy-to-energy ratio	%	[8,10]	1.060137	1.087957	1.039656	0.013601
HDD	Heating Degree Days	Number days/year	[4]	1343.763	1550.530	894.8500	158.9651
POP	Population	Thousands	[7]	9762.715	10573.10	8630.430	652.8282
STAT1	GDP Statistical differences (as reported in national accounts)	M€	-	-1409.608	6167.824	-9339.354	5139.539
STAT2		M€	-	-183.8587	282.5967	-1235.286	281.3507
STAT3		M€	-	979.4935	5020.708	-3201.052	1688.089

S3. Statistical tests

S3.1. Unit root tests

Table S3. 1 – Unit root test results for time series for the Portuguese economy 1960-2014. Time series are tested assuming a constant term and a linear trend (CT), a constant term only (C), or None. * indicates rejection of the null hypothesis at the 1% significance level. ** indicates rejection of the null hypothesis at the 5% significance level.

Variable	Test for unit root in	Intercept / Trend	ADF	PP	Variable	Test for unit root in	Intercept / Trend	ADF	PP
log(IND_NE)	Levels	CT	-2.245759	-1.203213	log(PX)	Levels	CT	-2.907075	-0.566507
	1st Differences	C	-4.482970*	-3.575872*		1st Differences	C	-1.512915	-3.044271**
log(I)	Levels	CT	-0.798627	-0.336684	log(PEN)	Levels	CT	1.209117	1.027606
	1st Differences	C	-5.350720*	-5.396826*		1st Differences	C	-5.590981*	-5.892037*
log(UEX_TOT)	Levels	CT	1.366297	1.020722	log(W_HOUR)	Levels	CT	-2.502325	-2.584211
	1st Differences	C	-2.363744	-4.851217*		1st Differences	C	-3.383324**	-3.249421**
log(C_NE)	Levels	CT	-0.602967	-0.317545	log(HL)	Levels	CT	0.496742	-0.654333
	1st Differences	C	-5.117148*	-5.140352*		1st Differences	C	-3.864911*	-3.880132*
log(YD)	Levels	CT	-1.095444	-0.662911	log(CO2_TERR/POP)	Levels	CT	0.450191	0.118887
	1st Differences	C	-3.730912*	-3.664707*		1st Differences	C	-5.129459*	-5.330962*
log(W)	Levels	CT	-1.537987	-1.324228	log(K_SERV)	Levels	CT	0.025744	0.621086
	1st Differences	C	-3.396502**	-3.339434**		1st Differences	C	-2.260143	-1.513769
log(YF)	Levels	CT	-3.777308**	-2.415455	log(CPI)	Levels	CT	0.063232	-0.345308
	1st Differences	C	-6.347818*	-5.849398*		1st Differences	C	-6.437808*	-3.742052*
log(K_NET)	Levels	CT	-0.769219	-0.761548	UR	Levels	CT	-2.997082	-1.891987
	1st Differences	C	-1.981620	-1.231039		1st Differences	C	-3.963004*	-3.963004*
log(L)	Levels	CT	1.091942	0.260170	log(FEN_C)	Levels	CT	-2.472220	-2.456961
	1st Differences	C	-4.320909*	-4.343719*		1st Differences	C	-5.791538*	-5.894912*
log(X)	Levels	CT	-1.859806	-1.357373	log(P_EN_C)	Levels	CT	-0.914921	-0.802343
	1st Differences	C	-5.125628*	-5.588100*		1st Differences	C	-5.244955*	-5.769372*
log(Y_RW)	Levels	CT	-2.648752	-2.162209	log(HDD)	Levels	C	--2.232843	-3.556184**
	1st Differences	C	-5.739064*	-5.576879*		1st Differences	C	-12.20473*	-17.80702*
log(CPI_E)	Levels	CT	-1.451558	-1.052807	log(FEN_IND)	Levels	CT	-1.533737	-1.520004
	1st Differences	C	-2.251387	-2.191487		1st Differences	C	-6.403579*	-6.558450
log(M)	Levels	CT	-0.854887	-1.146453	log(P_EN_IND)	Levels	CT	-1.194034	-1.083290
	1st Differences	C	-6.658048*	-6.673978*		1st Differences	C	-5.751415*	-5.691776*
log(C_T)	Levels	CT	0.917116	0.375559	log(FEN_OTH)	Levels	CT	-0.050768	0.545717
	1st Differences	C	-0.607516	-4.834140*		1st Differences	C	-3.268023**	-4.624867*
log(L_FORCE)	Levels	CT	0.803358	-0.318460	log(P_EN_OTH)	Levels	CT	-0.961114	-0.448733
	1st Differences	C	-4.103733*	-4.108801*		1st Differences	C	-5.952004*	-5.831544*
log(POP)	Levels	CT	-3.270841	-1.778337	log(K_GRS)	Levels	CT	-0.475722	-0.623112
	1st Differences	C	-2.973465**	-2.588325		1st Differences	C	-2.116451	-1.548948
log(PM)	Levels	CT	-0.787711	-0.741286	log(Y)	Levels	CT	-0.955387	-0.179733
	1st Differences	C	-3.384247**	-3.384247**		1st Differences	C	-3.645015*	-3.648819*
R_NOM	Levels	CT	-1.724787	-1.156298	E_INDEX_NOM	Levels	CT	-1.199398	-0.998375
	1st Differences	C	-4.019374*	-3.849670*		1st Differences	C	-3.363748**	-2.605965
R_REAL	Levels	CT	-2.726593	-3.030479	E_INDEX_REAL	Levels	CT	-1.595930	-1.584370
	1st Differences	C	-7.383954*	-8.189711*		1st Differences	C	-4.336342*	-4.419362*

S3.2. Cointegration tests

Table S3. 2 – Johansen cointegration test results for equations defined in Section S1. Values presented are Trace and Maximum Eigenvalue test statistics. * rejection of null hypothesis at the 1% significance level. ** rejection of null hypothesis at the 5% significance level.

Equation	Intercept (no trend) in CE and test VAR						Intercept and trend in CE – no intercept in VAR					
	Lags	None	At most 1	At most 2	At most 3	At most 4	Lags	None	At most 1	At most 2	At most 3	At most 4
(S1.6)	3	68.78838*	36.60850*	17.40658**	6.024287	-	3	75.07021*	42.69880	19.69880	6.112587	-
		32.17989**	19.20192	11.38229	6.024287	-		32.31741**	23.13140	13.45481	6.112587	-
(S1.11)	3	58.93386*	33.55684**	19.15232**	8.952377*	-	3	66.33723**	40.91643	23.90136	9.521854	-
		25.37702	14.40452	10.19995	8.952377*	-		25.42080	17.01507	14.37950	9.521854	-
(S1.13)	1	72.74289*	26.59270	7.587942	0.926615	-	1	97.33807*	40.15979	18.50731	6.050622	-
		46.15020*	19.00475	6.661327	0.926615	-		57.17828*	21.65248	12.45669	6.050622	-
(S1.14)	3	59.10269*	24.51680	12.63527	2.317210	-	3	79.99949*	34.48284	20.64990	10.14362	-
		34.58589*	11.88153	10.31806	2.317210	-		45.51665*	13.83294	10.50628	10.14362	-
(S1.15)	1	81.17776*	28.38464	14.00469	4.056093	-	1	92.32818*	38.03369	20.83502	7.202122	-
		52.79312*	14.37995	9.948594	4.056093	-		54.29450*	17.19867	13.63290	7.202122	-
(S1.21)	1	70.94023*	23.52120	13.21456	5.420777	-	1	94.62844*	38.84067	14.69988	6.576393	-
		47.41903*	10.30663	7.793786	5.420777	-		55.78777*	24.14079	8.123488	6.576393	-
(S1.25)	2	17.46663**	6.583773**	-	-	-	5	35.30795*	11.21453	-	-	-
		10.88285	6.583773**	-	-	-		24.09342*	11.21453	-	-	-
(S1.32)	1	98.29512*	60.47438*	36.74201*	18.15993**	2.733575	2	108.8644*	70.81941**	41.40400	18.47830	3.024110
		37.82074**	23.73236	18.58208	15.42636	2.733575		38.04501	29.41541	22.92570	15.45419	3.024110
(S1.33)	3	36.12428*	11.06852	1.731152	-	-	3	48.43854**	19.31405	4.232848	-	-
		25.05575**	9.337370	1.731152	-	-		29.12449**	15.08120	4.232848	-	-
(S1. 34)	3	36.61421*	16.52006**	4.743735**	-	-	3	53.34903*	20.35096	6.812461	-	-
		20.09415	11.77632	4.743735**	-	-		32.99807*	13.53850	6.812461	-	-
(S1.40)	3	70.03530*	28.22402	13.99073	3.141930	-	3	82.66663*	40.76834	24.71127	10.52783	-
		41.81128*	14.23329	10.84880	3.141930	-		41.8989*	16.05708	14.18343	10.52783	-
(S1.43)	4	44.55310*	18.60152**	5.190776**	-	-	4	60.58667*	25.25097	11.36839	-	-
		25.95158*	13.41075	5.190776	-	-		35.33570*	13.88258	11.36839	-	-
(S1.44)	2	42.32789*	15.10808	1.530584	-	-	2	56.52236*	27.56544**	11.39874	-	-
		27.21981*	13.57750	1.530584	-	-		28.95692**	16.16670	11.39874	-	-
(S1.53)	4	44.10864*	18.68390**	4.542566	-	-	4	65.56291*	21.96966	4.860627	-	-
		25.42475**	14.14133	4.542566	-	-		43.59325*	17.10903	4.860627	-	-

S4. Estimated coefficients

Table S4. 1 – Estimated coefficients for Equation (S1.6) in the MARCO PT model.

Equation (S1.6)	Dependent variable: IND_NE	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(ind_ne(-1)) - (0.38442944457*log(i(-1)) + 0.59569479486*log(uex_tot(-1)) + 0.00179210603176*r_real(-1) + 0.0156489780412*@trend	
ECT	0.027577	2.921218
DLOG(IND_NE(-2))	-0.171139	-2.340931
DLOG(I)	0.339932	7.595764
DLOG(UEX_TOT(-1))	0.215420	1.930232
Constant	0.034933	2.962553
@YEAR=1965	0.072709	2.783123
@YEAR=1971	0.093900	3.573510
@YEAR=1974	-0.104029	-3.918392
@YEAR=1976	-0.077367	-2.812703
@YEAR=1984	-0.052663	-2.005964
@YEAR=1985	-0.044697	-1.742495
R^2	0.859197	
Durbin-Watson	1.985728	

Table S4. 2 - Estimated coefficients for Equation (S1.11) in the MARCO PT model.

Equation (S1.11)	Dependent variable: C_NE	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(c_ne(-1)) - (0.649289671449*log(yd(-1)) + 0.186008492026*log(uex_tot(-1)) – 0.150140161461*log(w(-1))	
ECT	-0.119110	-1.978335
DLOG(YD(-1))	0.171844	1.741997
DLOG(UEX_TOT(-1))	0.186589	1.788405
DLOG(W)	0.442091	4.319389
@YEAR=1975	-0.093441	-3.947673
@YEAR=1984	0.053585	2.178123
@TREND	0.000165	1.507726
R^2	0.638676	
Durbin-Watson	2.060096	

Table S4. 3 - Estimated coefficients for Equation (S1.13) in the MARCO PT model.

Equation (S1.13)	Dependent variable: I	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(i(-1)) - (1.09370052029*(log(y(-1))-log(k_net(-1))) – 1.69137978684*(log(y(-1))-log(uex_tot(-1))) + 1.12750854062*(log(y(-1))-log(l(-1))) + 0.00442650817367*@during("1996 2014")*@trend	
ECT	-0.429991	-5.128208
DLOG(YF)	0.122315	2.818359
D(LOG(Y)-LOG(K_NET))	0.642518	1.907030
D(LOG(Y(-2))-LOG(UEX_TOT(-2)))	-0.477443	-2.048511
D(LOG(Y(-2))-LOG(L(-2)))	1.088540	5.090177
@DURING("1999 2000")	0.061451	3.274910

@YEAR=1978	-0.194004	-3.468412
@YEAR=1980	-0.199636	-3.663087
@YEAR=1984	-0.167698	-2.994966
@YEAR=2012	-0.230909	-4.190174
@YEAR=2013	-0.116723	-2.152153
R^2	0.770799	
Durbin-Watson	1.963466	

Table S4. 4 - Estimated coefficients for Equation (S1.14) in the MARCO PT model.

Equation (S1.14)	Dependent variable: X	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(x(-1)) - (12.3962113804 - 0.265045565259*log(y_rw(-1)) + 0.176075415331*log(px(-1)) + 0.292124596914*log(uex_tot(-1)) + 0.0515542831168*@trend	
ECT	-0.439515	-6.382086
DLOG(X(-1))	0.590295	5.394774
DLOG(Y_RW(-1))	0.416663	3.879078
DLOG(PX(-1))	-0.626338	-5.789705
DLOG(K_NET)	0.910824	2.741396
@YEAR=1963	-0.219497	-4.105589
@YEAR=1986	0.078334	1.696663
@YEAR=1989	0.099442	2.199240
@YEAR=2009	-0.117549	-2.641740
@YEAR=2011	-0.069689	-1.465452
@TREND(2011)	-0.001265	-2.884093
R^2	0.662138	
Durbin-Watson	2.034385	

Table S4. 5 - Estimated coefficients for Equation (S1.15) in the MARCO PT model.

Equation (S1.15)	Dependent variable: M	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(m(-1)) - (1.81402338417*log(ct(-1)) - 0.341587394401*log(y_rw(-1)) - 0.0821885020722*log(pm(-1)) + 0.0195816493445*@trend	
ECT	-0.259714	-3.346841
DLOG(M(-2))	-0.117669	-2.092804
DLOG(C_T)	2.187126	16.06020
DLOG(Y_RW)	-0.157234	-2.199977
DLOG(E_INDEX_REAL(-1))	0.079389	2.551107
@DURING("1986 2008")*@TREND	0.000512	2.352650
@YEAR=1969	0.114825	3.409693
@YEAR=1974	-0.094946	-2.779102
@YEAR=1975	-0.120910	-3.329720
@YEAR=1991	-0.094890	-2.795656
@YEAR=1994	0.074305	2.176980
R^2	0.874242	
Durbin-Watson	1.514976	

Table S4. 6 - Estimated coefficients for Equation (S1.20) in the MARCO PT model.

Equation (S1.20)	Dependent variable: L_FORCE	
Independent variables	Estimated coefficients	t-stats
LOG(L_FORCE(-1))	1.100663	14.10049
LOG(L_FORCE(-2))	-0.153970	-2.481189
LOG(Y)	-0.143961	-3.878955
LOG(Y(-1))	0.140956	4.048393
LOG(L)	0.817654	13.78727
LOG(L(-1))	-0.758949	-9.854646
@YEAR=2012	0.019800	2.760784
@YEAR=2014	-0.019697	-2.571817
R^2	0.999161	
Durbin-Watson	1.607159	

Table S4. 7 - Estimated coefficients for Equation (S1.21) in the MARCO PT model.

Equation (S1.21)	Dependent variable: L	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(l(-1)) - (5.54233299979 – 0.222380912575*log(y(-1)) + 0.000127600599668*log(k_serv(-1)) + 0.470908652666*log(uex_tot(-1))	
ECT	-0.233512	-5.338022
DLOG(L(-2))	-0.155794	-1.431350
DLOG(Y)	0.198941	3.557831
@YEAR<1974	-0.020146	-4.164634
@DURING(“2008 2014”)	-0.021737	-4.069005
DLOG(UEX_TOT(-2))	-0.120854	-2.162269
DLOG(K_SERV(-2))	0.349510	5.361210
D(UR(-1))	-0.977280	-4.836177
R^2	0.721444	
Durbin-Watson	1.880479	

Table S4. 8 - Estimated coefficients for Equation (S1.25) in the MARCO PT model.

Equation (S1.25)	Dependent variable: YD	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(yd(-1)) - (1.93095042629 + 0.816069934322*log(w(-1)) + 0.0104642071897*@trend	
ECT	-0.089217	-1.878443
DLOG(YD(-1))	0.609496	6.192810
DLOG(W)	0.628457	7.901061
DLOG(W(-1))	-0.327343	-3.279934
@DURING(“1989 1990”)	0.033447	2.191071
@YEAR=1977	-0.056500	-2.786422
@YEAR=1978	0.109866	5.091333
R^2	0.805111	
Durbin-Watson	1.877920	

Table S4. 9 - Estimated coefficients for Equation (S1.27) in the MARCO PT model.

Equation (S1.27)	Dependent variable: W	
Independent variables	Estimated coefficients	t-stats
Constant	-9.807608	-11.94281

LOG(W(-1))-@MEAN(LOG(W))	0.285339	4.805843
LOG(YF(-1))	-0.018674	-4.724958
LOG(W_HOUR)	0.951949	26.15066
LOG(W_HOUR(-1))	-0.237419	-3.490180
LOG(CPI)	-0.096204	-6.132038
LOG(HL)	0.539988	11.48824
@DURING("1991 1992")*@TREND	0.000459	2.300528
@DURING("2011 2014")	-0.046943	-8.266673
@YEAR=1974	0.048691	5.741761
@YEAR=1975	0.039664	4.736382
@YEAR=2009	-0.017475	-2.129378
R^2	0.999765	
Durbin-Watson	1.591910	

Table S4. 10 - Estimated coefficients for Equation (S1.28) in the MARCO PT model.

Equation (S1.28)	Dependent variable: W_HOUR	
Independent variables	Estimated coefficients	t-stats
LOG(W_HOUR(-1))	0.819264	22.08554
LOG(CPI)	0.369930	4.663956
LOG(CPI(-1))	-0.321666	-4.495070
LOG(Y)-LOG(L)	0.262685	3.340164
LOG(Y(-2))-LOG(L(-2))	-0.198621	-1.958999
UR(-1)	-0.275995	-2.032003
@DURING("1983 1990")	-0.033123	-3.427348
@DURING("1963 1978")*@TREND	0.002123	2.106757
@YEAR=1980	-0.055894	-2.263822
@YEAR=1984	-0.048488	-2.052635
@YEAR=1987	0.053785	2.419648
R^2	0.996758	
Durbin-Watson	2.041805	

Table S4. 11 - Estimated coefficients for Equation (S1.32) in the MARCO PT model.

Equation (S1.32)	Dependent variable: FEN_C	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(fen_c(-1)) - (3.10470121414 – 0.241703730672*log(p_en_c(-1)) + 1.04282604574*log(uex_tot(-1)) - 0.438507553585*log(hdd(-1)) - 0.810709658792*log(w_hour(-1)) + 0.0042857891127*during("2003 2013")*@trend	
ECT	-0.059088	-1.742765
DLOG(P_EN_C)	-0.058448	-1.664821
DLOG(UEX_TOT(-2))	0.337536	3.496930
DLOG(W_HOUR)	-0.156984	-1.648028
@DURING("1990 2004")*@TREND	0.000384	1.946672
@DURING("1963 1974")*@TREND	-0.003802	-2.930257
@DURING("1979 1986")	-0.017459	-1.702064
@YEAR=1979	-0.083143	-3.197130
@YEAR=1980	0.126309	4.834645
@YEAR=1981	0.074659	2.796720
@YEAR=1989	0.242800	10.23201

@YEAR=2011	-0.057023	-2.598815
R^2	0.876715	
Durbin-Watson	1.955589	

Table S4. 12 - Estimated coefficients for Equation (S1.33) in the MARCO PT model.

Equation (S1.33)	Dependent variable: FEN_IND	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(fen_ind(-1)) - (-0.127672123399*log(p_en_ind(-1)) + 0.992599759996*log(uex_tot(-1))	
ECT	-0.198814	-5.810409
DLOG(FEN_IND(-1))	-0.332367	-4.086406
DLOG(FEN_IND(-2))	-0.267937	-3.224195
DLOG(P_EN_IND(-1))	-0.036207	-1.448518
DLOG(UEX_TOT)	0.882808	7.183398
Constant	0.112922	5.811346
@TREND	-0.003470	-6.766921
@DURING("1996 2000")	0.030130	1.971884
R^2	0.827251	
Durbin-Watson	2.057461	

Table S4. 13 - Estimated coefficients for Equation (S1.34) in the MARCO PT model.

Equation (S1.34)	Dependent variable: FEN_OTH	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(fen_oth(-1)) - (-0.223842848463*log(cpi_rel_en(-1)) + 1.38388544746*log(oth_ne(-1)) + 0.00134286897073*@during("2000 2013")*@trend – 3.65570230389)	
ECT	-0.355673	-4.664402
LOG(FEN_OTH(-1))	0.208544	1.739584
DLOG(OTH_NE)	0.748132	4.874946
@DURING("2010 2013")*@TREND	-0.000924	-2.468371
@DURING("1994 2004")	0.033010	2.704791
@YEAR=1974	-0.100829	-2.531884
R^2	0.496085	
Durbin-Watson	1.950906	

Table S4. 14 - Estimated coefficients for Equation (S1.35) in the MARCO PT model.

Equation (S1.35)	Dependent variable: UEX_TOT	
Independent variables	Estimated coefficients	t-stats
LOG(UEX_TOT(-1))	0.342986	2.770564
LOG(UEX_TOT(-2))	0.433482	3.832700
LOG(HL(-1))	0.423887	2.481229
LOG(HL(-2))	-0.475650	-2.887973
LOG(K_NET(-2))	-0.031221	-0.862366
LOG(Y)	0.765601	5.813025
LOG(Y(-1))	-0.454750	-3.347085
@DURING("1998 2011")*@TREND	0.000483	2.331912
@DURING("2008 2014")	-0.032973	-2.683959
@YEAR=1971	0.102694	4.748384

R^2	0.999121
Durbin-Watson	1.731669

Table S4. 15 - Estimated coefficients for Equation (S1.40) in the MARCO PT model.

Equation (S1.40)	Dependent variable: CPI	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(cpi(-1)) - (0.2429129656*log(cpi_e(-1)) + 0.800283427771*log(w(-1)) – 0.553663540042*log(y(-1)) + 0.0194195239009*@trend	
ECT	-0.385380	-2.952048
DLOG(CPI(-1))	0.396568	3.641129
D(E_INDEX_REAL)	0.000212	3.032948
DLOG(W)-DLOG(Y)	0.427313	2.812969
Constant	0.012488	1.793844
@DURING("1974 1981")	0.002983	2.627787
@DURING("1988 1992")	0.001136	2.174219
R^2	0.691678	
Durbin-Watson	1.732456	

Table S4. 16 - Estimated coefficients for Equation (S1.41) in the MARCO PT model.

Equation (S1.41)	Dependent variable: CPI_E	
Independent variables	Estimated coefficients	t-stats
LOG(CPI(-1))	0.181803	4.094992
LOG(CPI_E(-1))	1.525618	14.94709
LOG(CPI_E(-2))	-0.610526	-6.473457
LOG(P_EN_IND(-2))	0.050231	4.032071
@TREND	-0.004194	-1.739071
@YEAR=1978	-0.076291	-1.807869
@YEAR=2009	-0.154060	-3.815126
@YEAR=2013	-0.078952	-1.849424
R^2	0.999515	
Durbin-Watson	1.659540	

Table S4. 17 - Estimated coefficients for Equation (S1.43) in the MARCO PT model.

Equation (S1.43)	Dependent variable: P_EN_C	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(p_en_c(-1)) - (-1.69087077501*log(fen_c(-1)) + 1.93285933091*log(cpi(-1)) - 0.00712725036156*@during("1993 2002")*@trend – 0.00254816020446*during("2000 2011")*@trend + 7.23281976272	
ECT	-0.190021	-2.345729
DLOG(FEN_C)	-1.247189	-5.980381
DLOG(CPI)	1.758105	10.59507
@YEAR=1979	0.177209	2.225201
R^2	0.627576	
Durbin-Watson	1.774645	

Table S4. 18 - Estimated coefficients for Equation (S1.44) in the MARCO PT model.

Equation (S1.44)	Dependent variable: P_EN_IND	
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(p_en_ind(-1)) - (-0.667809678606*log(fen_ind(-1)) + 0.41725696388*log(cpi_e(-1)) + 0.0483751897998*@trend	
ECT	-0.151111	-5.276631
DLOG(FEN_IND)	-0.387113	-1.828777
DLOG(CPI_E)	0.495844	3.223567
DLOG(CPI)	0.923552	3.619360
@DURING("1980 1981")*@TREND	0.006953	1.847663
@DURING("1992 1997") *@TREND	-0.003519	-3.244797
@YEAR=1974	0.677676	7.137444
@YEAR=1979	0.356580	3.910955
R^2	0.745865	
Durbin-Watson	2.070687	

Table S4. 19 - Estimated coefficients for Equation (S1.45) in the MARCO PT model.

Equation (S1.45)	Dependent variable: P_EN_OTH	
Independent variables	Estimated coefficients	t-stats
Constant	-5.126779	-6.347687
LOG(P_EN_OTH(-1))	0.366811	5.761413
LOG(P_EN_IND)	0.487261	9.698186
LOG(FEN_OTH(-1))	0.508422	5.904236
LOG(CPI(-1))	-0.314181	-3.662028
@YEAR=1974	0.216324	2.934034
@YEAR=1978	-0.274062	-4.198723
@YEAR=2009	-0.250574	-3.755180
@YEAR=1989	-0.125295	1.917629
@YEAR=1999	0.152378	2.294673
@YEAR=2006	-0.228177	-3.424877
R^2	0.997523	
Durbin-Watson	1.857943	

Table S4. 20 - Estimated coefficients for Equation (S1.46) in the MARCO PT model.

Equation (S1.46)	Dependent variable: PX	
Independent variables	Estimated coefficients	t-stats
DLOG(PX(-2))	0.167525	2.955466
DLOG(CPI)	0.677156	6.644772
DLOG(CPI(-1))	-0.538636	-6.303907
LOG(Y(-1))	0.503341	4.718439
LOG(Y(-2))	-0.502905	-4.703540
D(E_INDEX_REAL)	-0.000684	-15.85337
@DURING("1985 1992")*@TREND	-0.001036	-2.752212
@DURING("1982 1985")	0.140783	9.395504
@YEAR=1987	0.094193	3.332131
@YEAR=1993	0.063507	2.306109
@YEAR=1968	0.114628	4.225291
R^2	0.924761	
Durbin-Watson	2.015073	

Table S4. 21 - Estimated coefficients for Equation (S1.47) in the MARCO PT model.

Equation (S1.47)	Dependent variable: PM	
Independent variables	Estimated coefficients	t-stats
LOG(PM(-1))	1.006086	95.71264
DLOG(Y)-DLOG(Y_RW)	-0.507992	-4.775929
DLOG(Y(-1))-DLOG(Y_RW(-1))	0.255486	2.157627
DLOG(E_INDEX_REAL(-1))	-0.298222	-5.453898
DLOG(M)	0.206185	2.466350
@YEAR=1974	0.263971	5.743137
@YEAR>1985	-0.129727	-4.490324
@YEAR>2008	-0.069777	-2.585132
@TREND	0.002989	2.041091
R^2	0.998876	
Durbin-Watson	1.864765	

Table S4. 22 - Estimated coefficients for Equation (S1.49) in the MARCO PT model.

Equation (S1.49)	Dependent variable: R_NOM	
Independent variables	Estimated coefficients	t-stats
R_NOM(-1)	0.857503	0.0000
LOG(Y)	0.341831	0.0000
DLOG(CPI)	-7.834886	0.0099
@DURING("1961 1973")	-2.762887	0.0000
@DURING("1992 2014")	-3.893964	0.0000
@DURING("1986 1988")	-3.924045	0.0000
R^2	0.975497	
Durbin-Watson	1.975654	

Table S4. 23 - Estimated coefficients for Equation (S1.51) in the MARCO PT model.

Equation (S1.51)	Dependent variable: E_INDEX_NOM	
Independent variables	Estimated coefficients	t-stats
LOG(E_INDEX_NOM(-1))	1.123512	12.96307
LOG(E_INDEX_NOM(-2))	-0.545219	-8.366016
LOG(CPI)	0.124032	2.701121
LOG(PM(-2))	-0.299811	-8.212018
LOG(Y(-1))	-0.156955	-2.625209
LOG(Y_RW(-1))	0.147249	6.377939
D(R_NOM)	-0.004067	-1.601321
@YEAR=1981	0.059329	2.237455
@DURING("1962 1976")*@TREND	0.003701	2.514843
R^2	0.999058	
Durbin-Watson	1.644837	

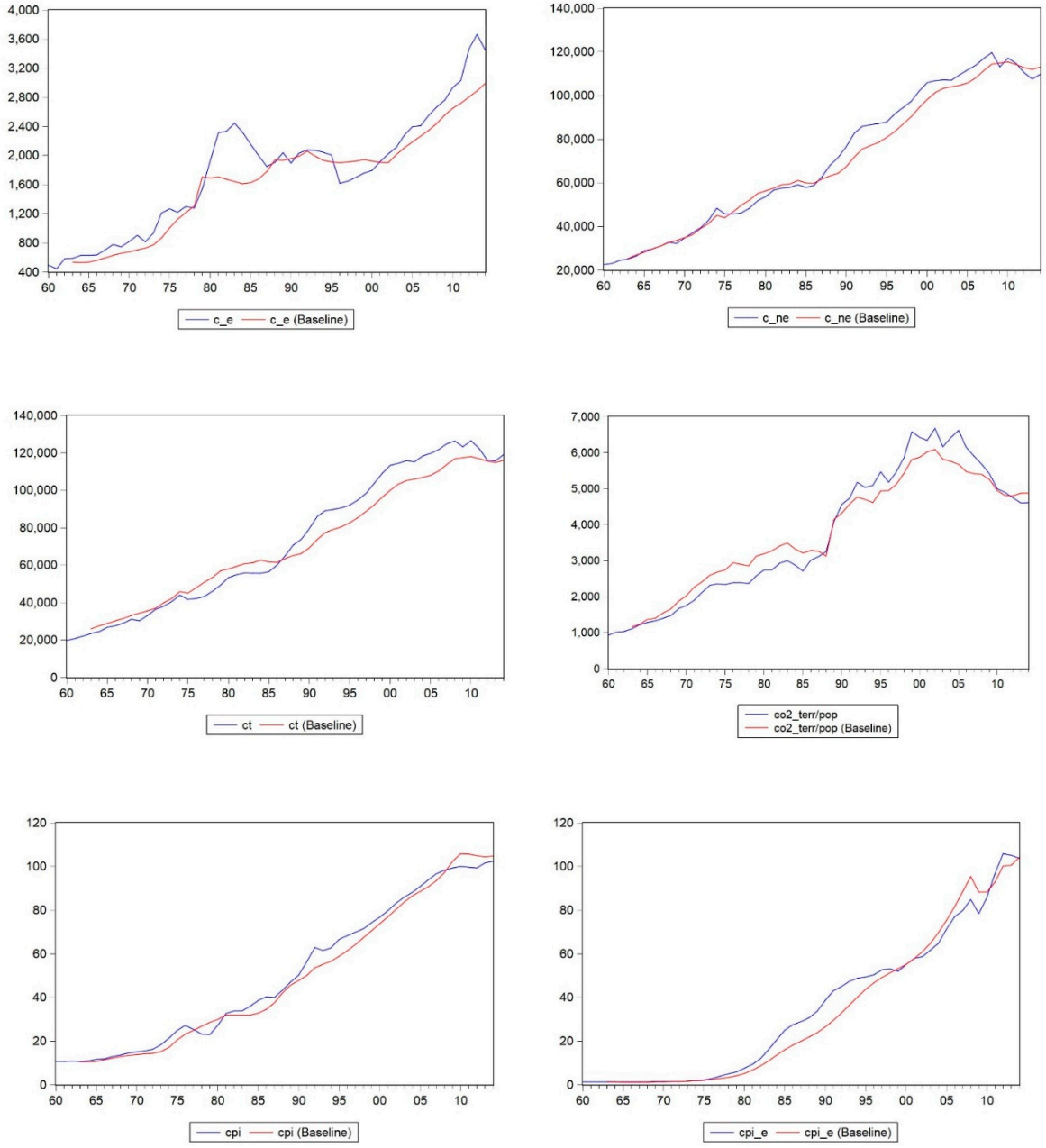
Table S4. 24 - Estimated coefficients for Equation (S1.53) in the MARCO PT model.

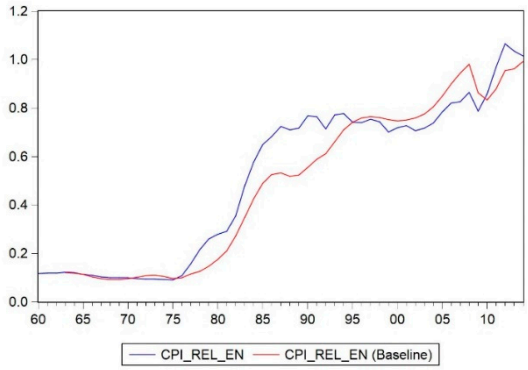
Equation (S1.53)	Dependent variable: CO2_TERR_POP

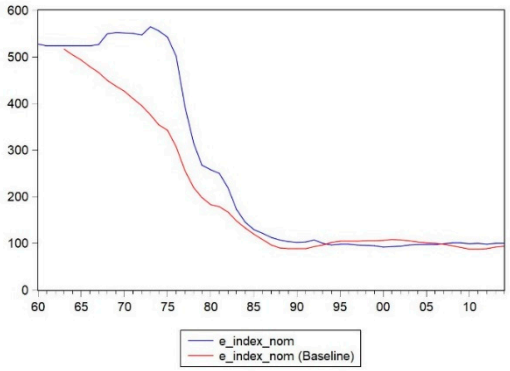
Independent variables	Estimated coefficients	t-stats
Cointegration relationship	log(co2_terr_pop(-1)) - (3.13108792464 + 1.67972625748*(log(y(-1))-log(pop(-1))) + 0.983209834478*(log(pen(-1))-log(y(-1))) - 0.0150772427722*@trend	
ECT	-0.181366	-2.508891
DLOG(Y/POP)	1.287217	12.46417
DLOG(PEN/Y)	0.887277	7.951208
@DURING("2005 2014")	-0.023469	-2.407755
@YEAR=1989	0.100137	3.172367
@YEAR=1978	-0.088867	-2.918728
R^2	0.788297	
Durbin-Watson	2.104276	

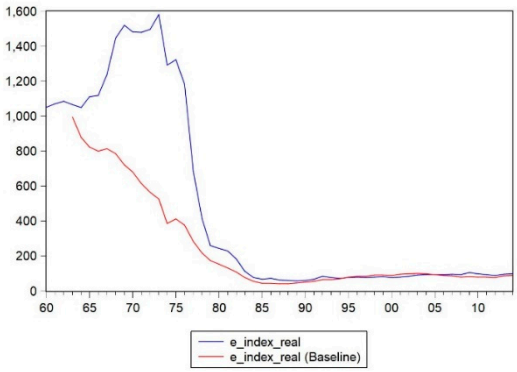
S5. Basefit model solution

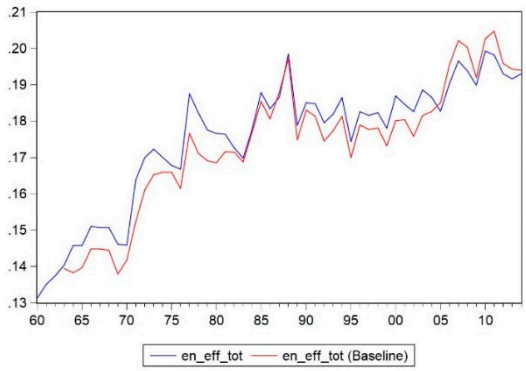
The following graphs compare the actual historial values for the annual time series of each of the model's endogenous variables (see Section S4) with each the projected historical values obtained from the basefit model solution, for those variables. It can be observed that, for most variables considered, the model can adequately replicate the historical values.

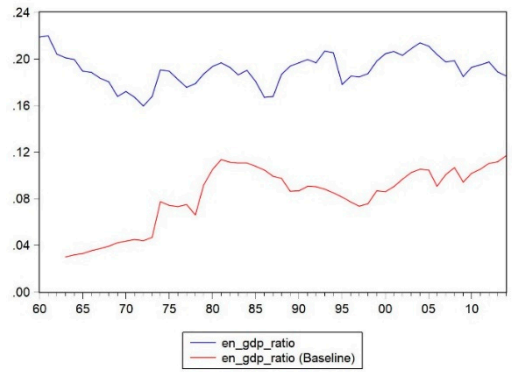


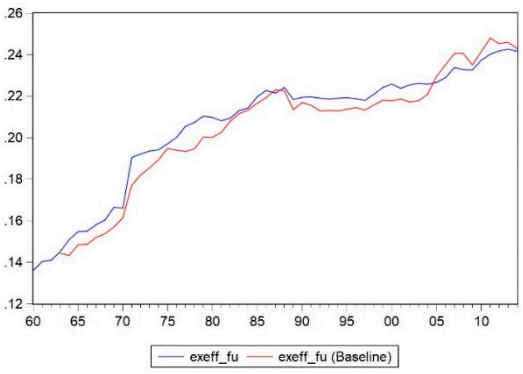

CPI_REL_EN
CPI_REL_EN (Baseline)

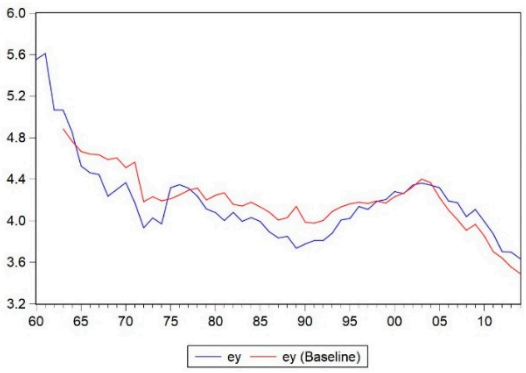

e_index_nom
e_index_nom (Baseline)

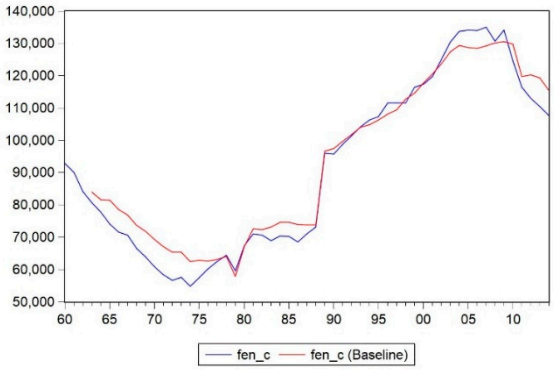

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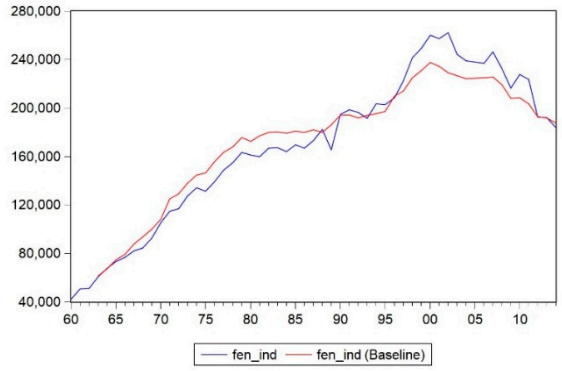

en_eff_tot
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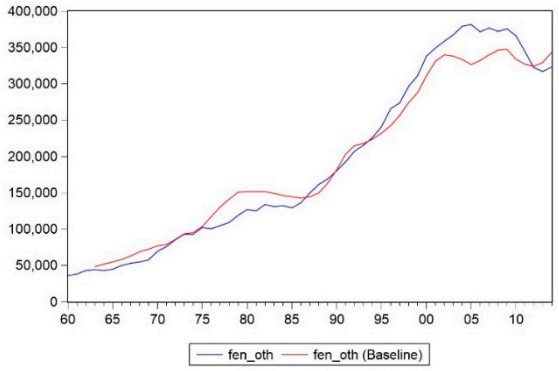

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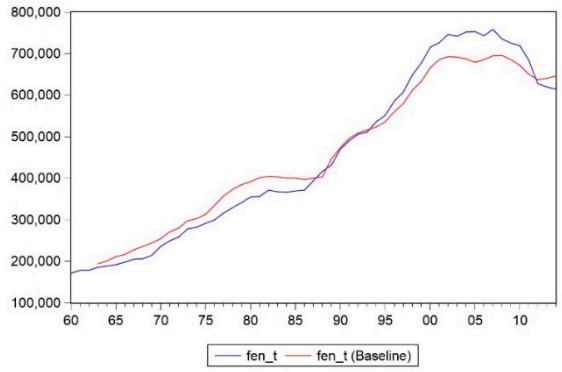

exeff_fu
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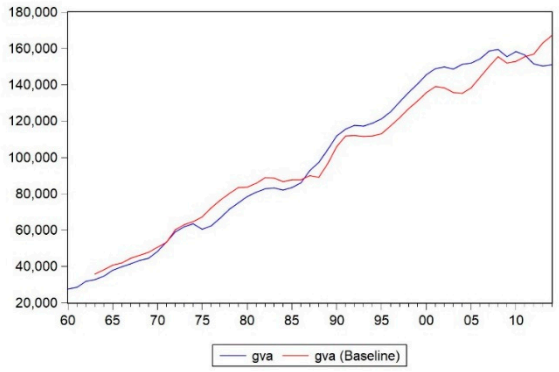

ey
ey (Baseline)

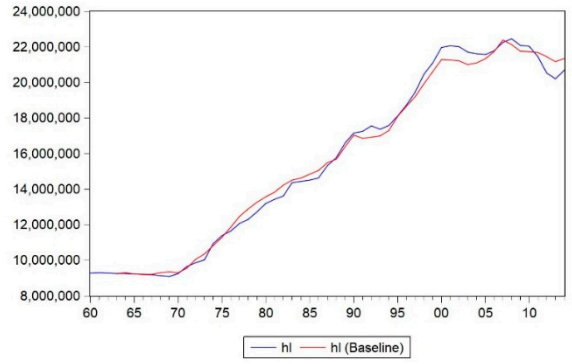

fen_c
fen_c (Baseline)

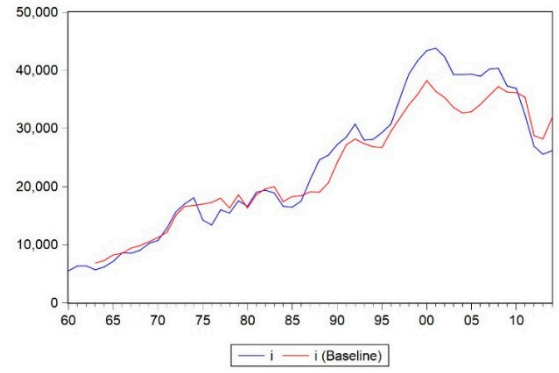

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fen_ind
fen_ind (Baseline)

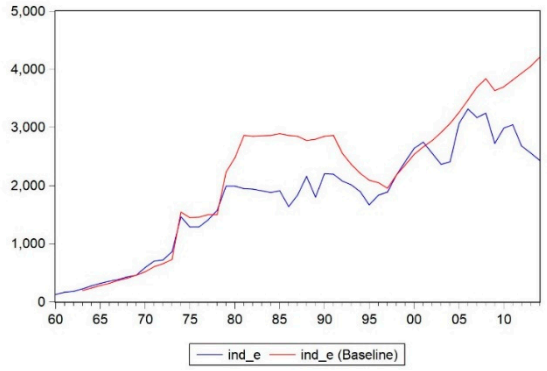

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fen_oth
fen_oth (Baseline)

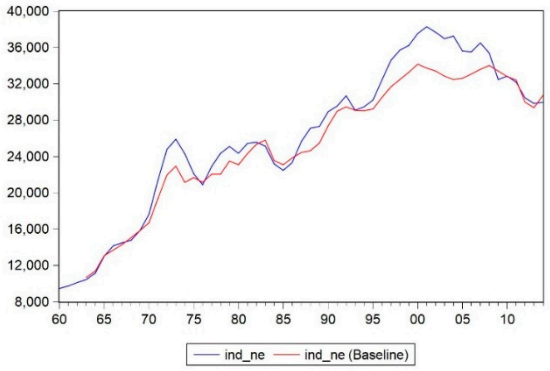

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fen_t (Baseline)

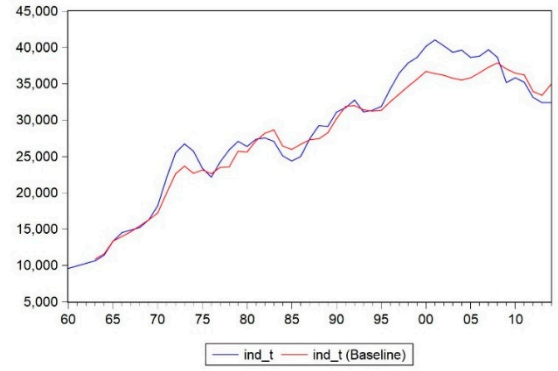

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gva
gva (Baseline)

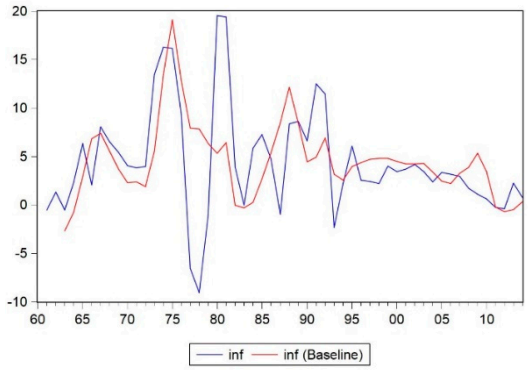

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hl
hl (Baseline)

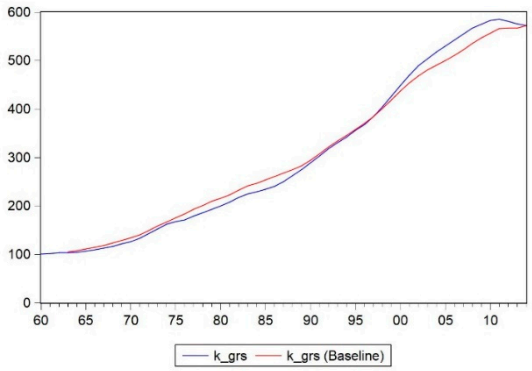

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i
i (Baseline)

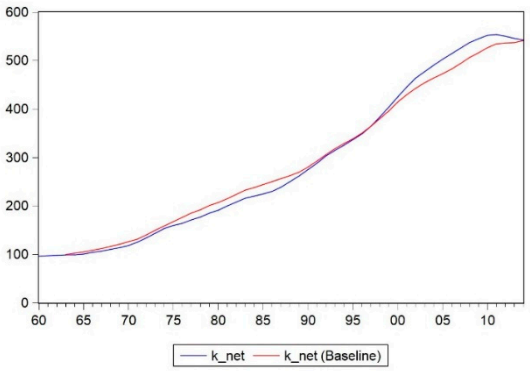

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ind_e (Baseline)

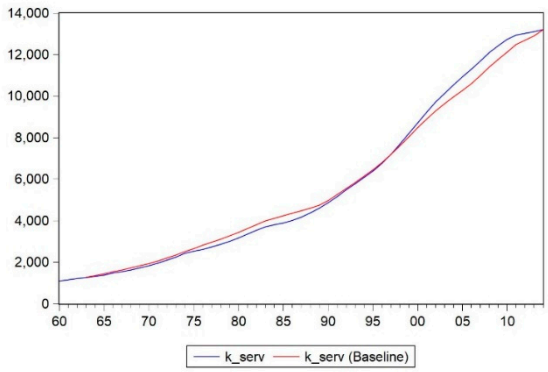

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ind_ne (Baseline)

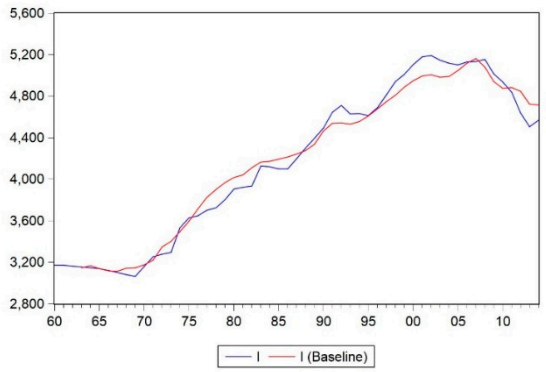

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ind_t
ind_t (Baseline)

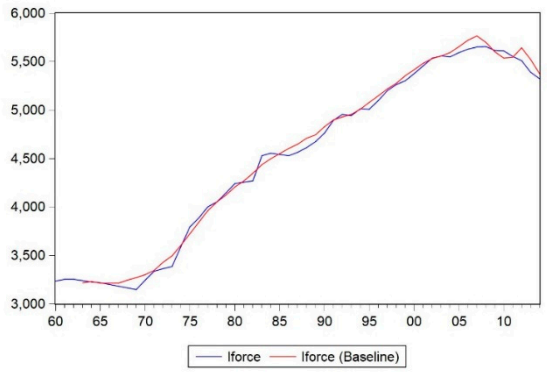

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inf
inf (Baseline)

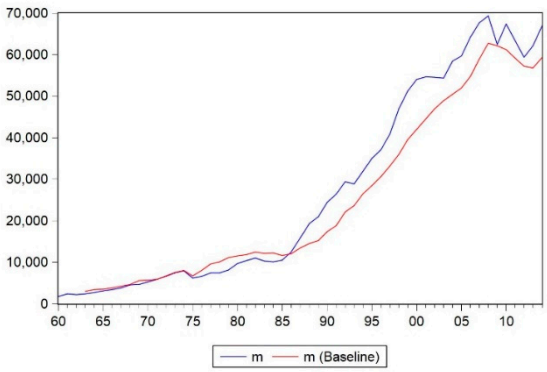

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k_grs
k_grs (Baseline)

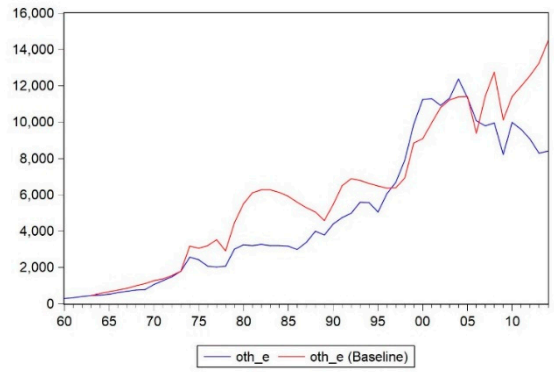

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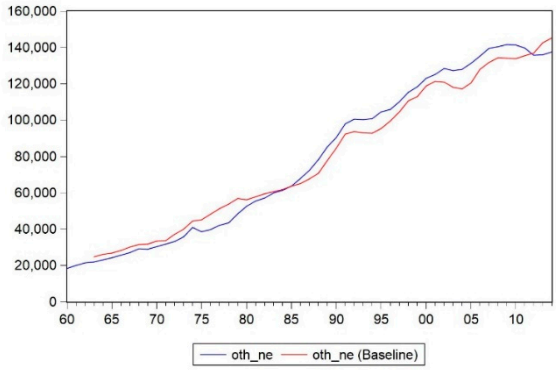

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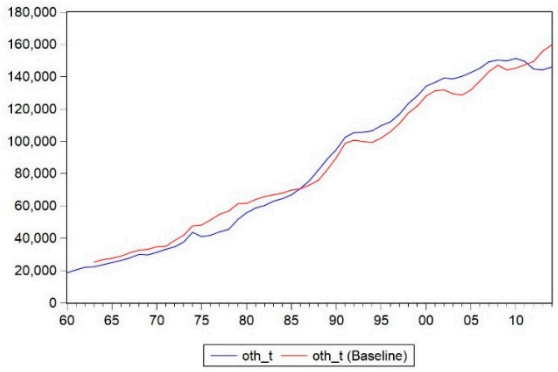

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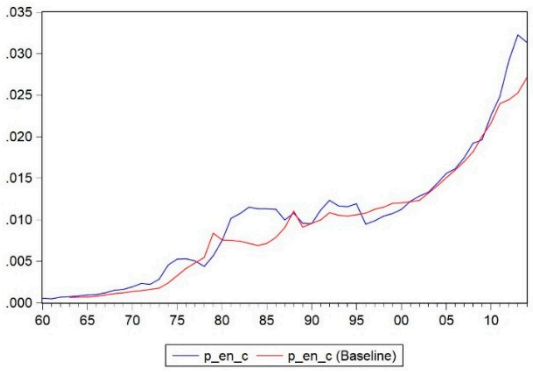

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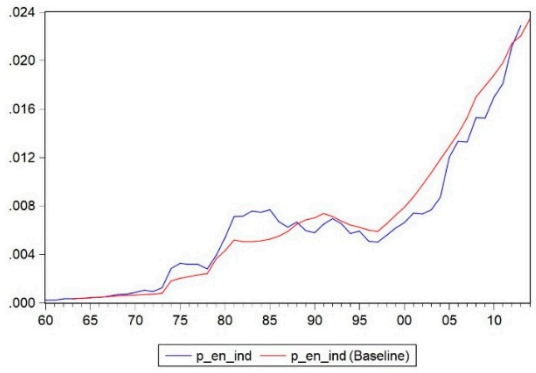

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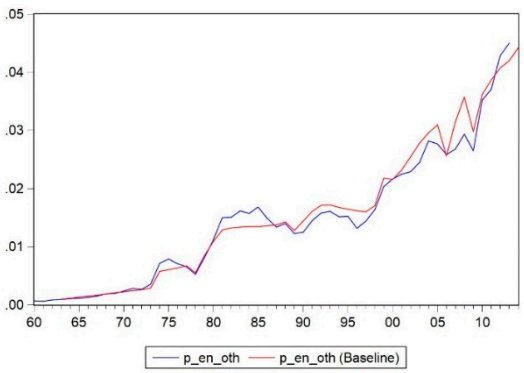

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oth_e
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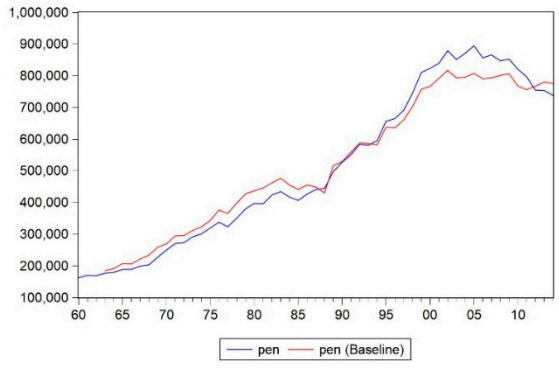

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oth_ne (Baseline)

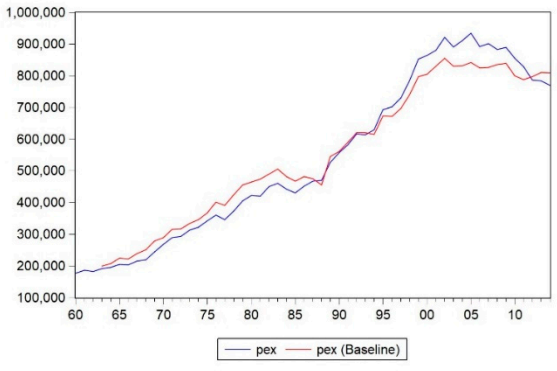

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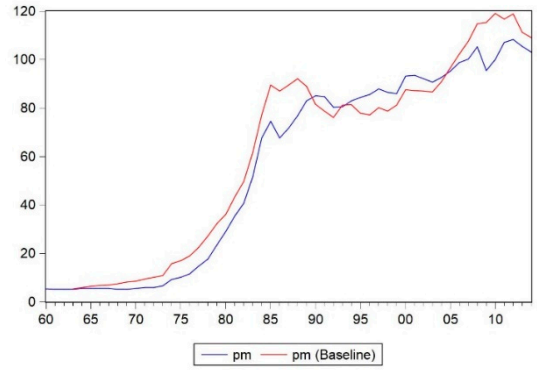

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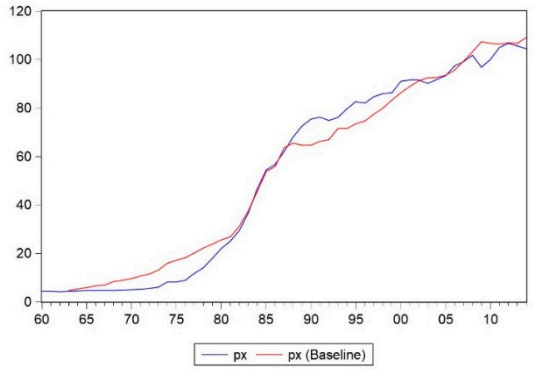

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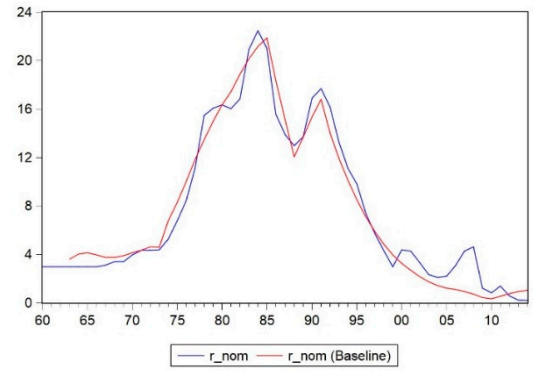

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p_en_oth
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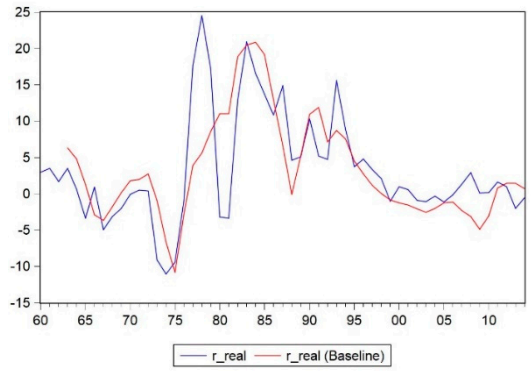

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pen
pen (Baseline)

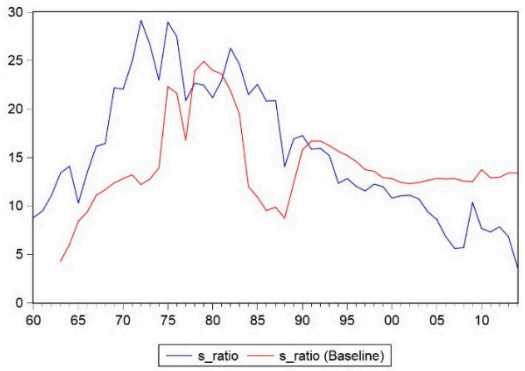

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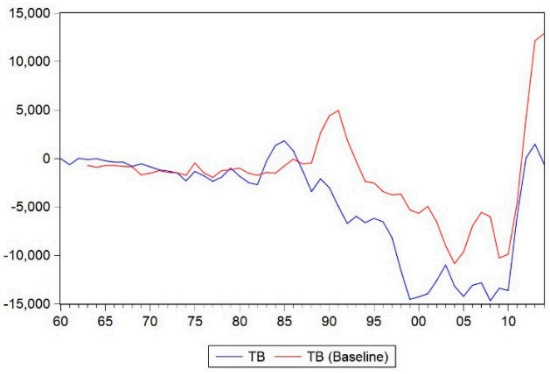

pm
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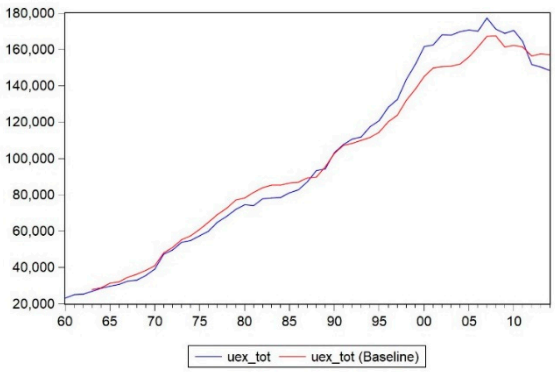

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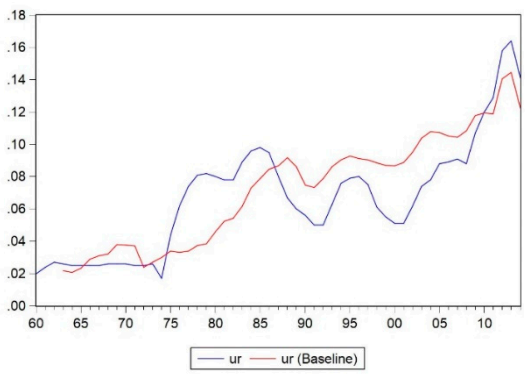

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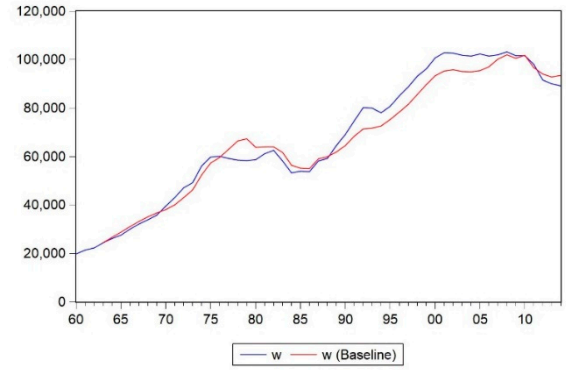

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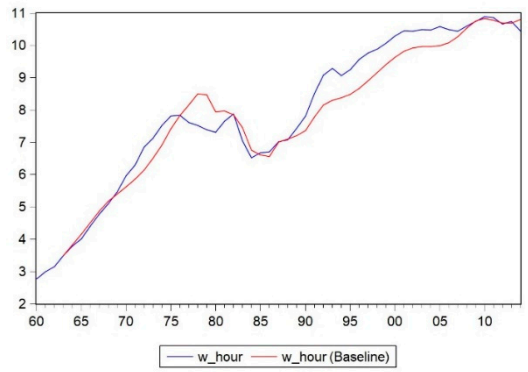

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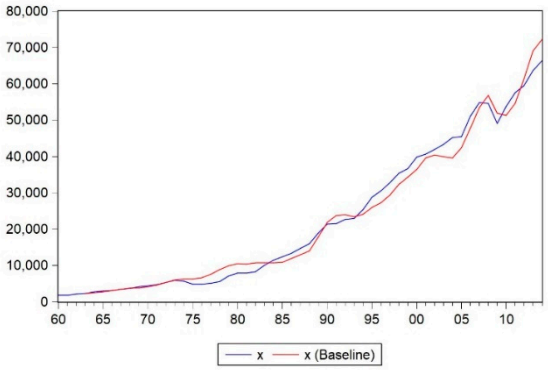

TB
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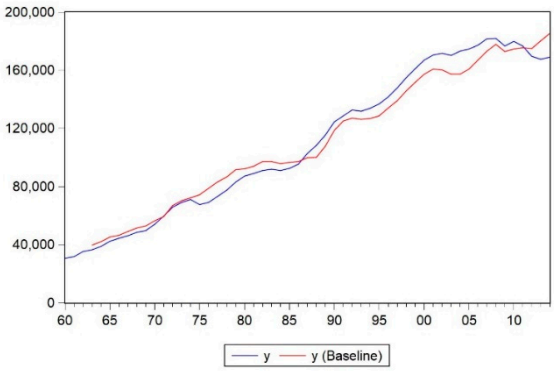

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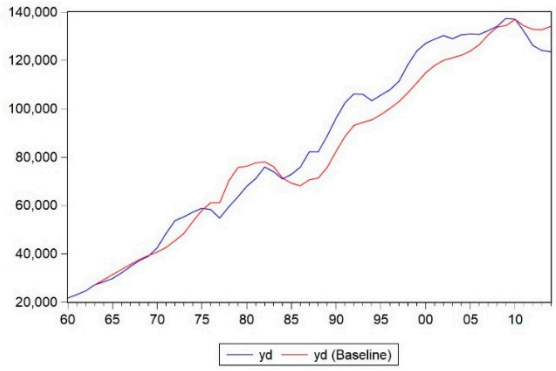

ur
ur (Baseline)

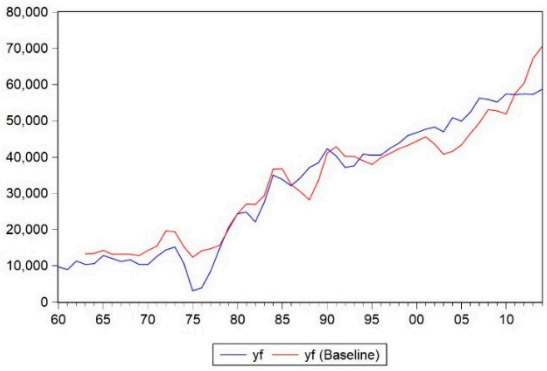

120,000
100,000
80,000
60,000
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20,000
0
60 65 70 75 80 85 90 95 00 05 10
w
w (Baseline)


11
10
9
8
7
6
5
4
3
2
60 65 70 75 80 85 90 95 00 05 10
w_hour
w_hour (Baseline)


80,000
70,000
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50,000
40,000
30,000
20,000
10,000
0
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x
x (Baseline)


200,000
160,000
120,000
80,000
40,000
0
60 65 70 75 80 85 90 95 00 05 10
y
y (Baseline)


140,000
120,000
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40,000
20,000
60 65 70 75 80 85 90 95 00 05 10
yd
yd (Baseline)


80,000
70,000
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50,000
40,000
30,000
20,000
10,000
0
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yf
yf (Baseline)

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