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This paper investigates evidence on the effect of dollar depreciation on the US tourism balance of trade. Export revenue and import spending functions are estimated separately with structural vector autoregressive methods to better capture the dynamic adjustment to exchange rate shocks. Quarterly data cover the period of floating exchange rates from 1973 through 2007. Depreciation raises long term US export revenue but there is no effect on import spending.

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Tourism is a growing component of the US balance of trade. The present paper separates tourism export revenue and import spending to analyze adjustments to the dollar exchange rate. The structural vector autoregressive model examines quarterly data during the floating exchange rate period from 1973 through 2007.

International tourism has grown over the last three decades and has become a major source of income for a number of countries. The US has had a trade surplus in tourism since the 1990s and tourism receipts accounted for 5% of export revenue in 2007. Worldwide, the US ranks first in export revenue and second in import spending (UNWTO, 2008).

The balance of trade following depreciations may exhibit J-curve adjustments, first falling due to set contracts but then rising over time. Empirical results in the J-curve literature are mixed. Studies have investigated the J-curve with disaggregated industrial trade data but none have explicitly examined tourism.

The following section discusses the theoretical framework with tourism spending a function of income and the exchange rate, followed by a brief review of the J-curve literature focused on disaggregated data. The third section presents the econometric model followed by sections discussing results and concluding.

1. Tourism Balance of trade

Socher (1986) points out that tourism as a trading service had not been explicitly integrated into trade theory but this has been recently done by Hazari and Ng (1993), Hazari (1995), Hazari and Nowak (2003), and Hazari and Sgro (2004). The main distinction of tourism relative to other traded products is that importers have to visit the exporting country.

Tourism is a luxury good with income elasticity exceeding one in the literature that includes Harrop (1973), Rosensweig (1988), Crouch (1994), Song, Witt and Li (2009), and

Dupont, Ghandi, and Weiss (2008) in a long term study of US tourism imports covering 1820 to 2000.

Vogt (2008) separates US tourism exports and imports with data from 1973 to 2002. Error correction models on annual data find that US tourists are more sensitive to the exchange rate while foreign tourists to the US are more sensitive to income. The present study focuses on adjustment patterns in quarterly data and results differ. Specifically, foreign tourists to the US are more sensitive to the exchange rate and US tourists more sensitive to income in the present structural vector autoregressive method.

International and domestic tourism are imperfect substitutes especially for cultural and natural resource attractions. The assumption of imperfect substitutes follows the literature including Rhomberg (1973), Magee (1975) Goldstein and Khan (1985), and Rose and Yellen (1989). Consumers choose between international and domestic tourism according to preferences and constrained by income Y.

Dollar depreciation, an increase in the price E of foreign currency, raises the foreign tourism price in US dollars and lowers the US tourism price in foreign currency. Domestic demand D_m for tourism abroad and foreign demand D_m^* for tourism in the US also depend on respective incomes.

Demand functions in general functional form are

$$D_m = D_m(\overset{+}{Y}, \overset{+}{p}, \overset{-}{Ep^*}) \text{ and } D_m^* = D_m^*(\overset{+}{Y^*}, \overset{-}{p/E}, \overset{+}{p^*}). \qquad (1)$$

where Y is US income, Y* foreign income, p the price of tourism in US, and p^* the price of tourism abroad. Positive cross price effects reflect imperfect substitutes. Dollar depreciation lowers US demand D_m for tourism abroad and raises foreign demand D_m^* for tourism in the US.

Supplies of US and foreign tourism S_x and S_x^* are positive functions of price

$$S_x = S_x(\overset{+}{p}) \text{ and } S_x^* = S_x^*(\overset{+}{p^*}). \qquad (2)$$

Equilibrium quantities of international tourism are determined in the markets where $D_m = S_x^*$ and $D_m^* = S_x$. The present analysis does not include p and p^* explicitly given the lack of data on prices tourists pay but prices are implicitly included in export revenue X and import spending M.

Export revenue for the home country is $X = pq_x$ where qx is tourism quantity,

$$X = X(\overset{+}{Y^*}, \overset{+}{E}). \tag{3}$$

Dollar depreciation lowers the tourism price in the US, increasing the quantity q_x and export revenue X.

Similarly, import spending by the home country is $M = Ep^*q_m$ reducing to

$$M = M(\overset{+}{Y}, \overset{?}{E}). \tag{4}$$

Depreciation raises the price Ep^* of foreign tourism, lowers the quantity q_m, and lowers import spending M if import demand is elastic.

Separate export revenue and import spending are estimated in log linear form as

$$\ln X = a_0 + a_1 \ln Y^* + a_2 \ln E + \varepsilon \tag{5}$$

$$\ln M = b_0 + b_1 \ln Y + b_2 \ln E + \nu. \tag{6}$$

If the Marshall-Lerner condition holds, depreciation raises the balance of trade. The sum of absolute values of elasticities of export and import demands must exceed unity, $|\eta_x|(X/M) + |\eta_m| > 1$ where η_x and η_m are elasticities of export and import demands. The Appendix shows the coefficients in (5) and (6) are related to these elasticities as $a_2 = -\eta_x$ and $b_2 = \eta_m + 1$.

The effect of depreciation on the balance of trade is also examined and the literature includes various measures. Volume indices are examined by Goldstein and Khan (1978) and Rosenweig and Koch (1988) and real export revenue and import spending by Houthakker and Magee (1969), Senhadji (1998a), and Senhadji and Montenegro (1999). The difference between export revenue and import spending B = X – M is examined by Rose (1991) or Bahmani-

Oskoosee and Malixi (1992) and the ratio of net exports to national income B/Y by Demirden and Pastine (1995) and Senhadji (1998b).

Haynes and Stone (1982) propose the ratio X/M as utilized by Bahmani-Oskoosee and Brooks (1999), Boyd, Caporale and Smith (2001), and Onafowora (2003). The present model also utilizes B = X/M or in natural logs,

$$\ln B = \ln X - \ln M. \tag{7}$$

Substitute (5) and (6) into (7) to find

$$\ln B = (a_0 - b_0) + a_1 \ln Y^* - b_1 \ln Y + (a_2 - b_2)\ln E + (\varepsilon - \nu) \tag{8}$$

or more simply

$$\ln B = c_0 + c_1 \ln Y^* - c_2 \ln Y + c_3 \ln E + \mu. \tag{9}$$

The J-curve effect is the hypothesis that the balance of trade falls immediately following a depreciation due to previously arranged contracts but rises after an adjustment lag as developed by Magee (1973) and Junz and Rhomberg (1973). The J-curve literature is reviewed by Bahmani-Oskooee and Ratha (2004). Methodology has developed over the years but empirical results remain mixed.

Some studies investigate sector specific responses to depreciation. Meade (1988) finds no J-curve adjustment for non-oil industrial supplies, capital goods excluding automobiles, and consumer goods. Doroodian, Jung and Boyd (1999) report a J-curve effect for agriculture but not manufacturing. Yazici (2006) finds an S-curve for the balance of trade in Turkish agriculture, rising initially before falling and finally increasing. Ardalani and Bahmani-Oskooee (2007) use export and import data for 66 US industries and find the J-curve for only six in an error correction model. Goldstein and Khan (1985) point out that aggregation across different products may result in biased estimates and certainly could disguise different underlying adjustments.

The present paper investigates the balance of trade in tourism including short and long term dynamics with a structural vector autoregression SVAR and impulse response functions. Tourism is a small fraction of international transactions and its contemporaneous effect on the exchange rate is negligible. Though foreign income may affect the exchange rate, its short term effect would be negligible since tourists must plan ahead for international travel and restrictions are imposed in the SVAR model based on prior knowledge.

2. The Econometric Model

Consider the structural vector autoregressive SVAR process of integrated variables

$$\mathbf{A}\mathbf{y}_t = \mathbf{B}(L)\mathbf{y}_{t-1} + \mathbf{u}_t , \tag{10}$$

where $\mathbf{A}$ is an $m \times m$ square matrix, $\mathbf{y}_t$ is an $m \times 1$ vector of m difference stationary variables, $\mathbf{B}(L)$ is a matrix lag polynomial, and $\mathbf{u}_t$ is $m \times 1$ vector of m structural shocks. Shocks have zero means, unit variance, and are mutually independent,

$$E\mathbf{u}_t = \mathbf{0} \text{ and } E\mathbf{u}_t\mathbf{u}_t^{'} = \mathbf{I} , \tag{11}$$

where $\mathbf{0}$ is an $m \times 1$ null vector and $\mathbf{I}$ is an $m \times m$ identity matrix.

The structural form system of (10) is represented by the following reduced form system of equations,

$$\mathbf{y}_t = \mathbf{C}(L)\mathbf{y}_{t-1} + \boldsymbol{\varepsilon}_t , \tag{12}$$

where

$$\mathbf{C}(L) = \mathbf{D}\mathbf{B}(L) ,\ \boldsymbol{\varepsilon}_t = \mathbf{D}\mathbf{u}_t , \text{ and } \mathbf{D} = \mathbf{A}^{-1} . \tag{13}$$

Combining (12) and (13),

$$E\boldsymbol{\varepsilon}_t\boldsymbol{\varepsilon}_t^{'} = E\mathbf{D}\mathbf{u}_t\mathbf{u}_t^{'}\mathbf{D}' = \mathbf{D}\mathbf{D}^{'} = \boldsymbol{\Sigma} \tag{14}$$

where $\boldsymbol{\Sigma}$ is the variance covariance matrix from the reduced form VAR.

Just identifying the system requires $m(m-1)/2$ identifying assumptions. We employ the conventional approach proposed by Sims (1980) and utilize the Choleski decomposition of $\mathbf{\Sigma}$ to find $\mathbf{D}$, an approach that can be useful given prior knowledge on short term relations between variables of interest.

Given the least squares estimates $\mathbf{C}(L)$ and $\mathbf{\Sigma}$ from the reduced form, the structural form VAR is recovered with the identified contemporaneous matrix $\mathbf{D}$ followed by the impulse response analysis for structural shocks to the system.

3. Tourism Balance of trade Results

Data on tourism export revenue and import spending including travel and air fare are from the International Transactions Accounts of the Bureau of Economic Analysis. The nominal exchange rate index is the Federal Reserve nominal major currencies index, a trade weighted index including the euro, Canadian dollar, yen, pound, Swiss franc, Australian dollar, and Swedish krona.

US income is nominal GDP. Foreign income in the rest of the world ROW income is the sum of the nominal GDP of the five major tourist arrival countries, the UK, Canada, Japan, France, and Germany, essentially the countries in the major currencies index. Their nominal GDPs are from the *International Financial Statistics* of International Monetary Fund. Quarterly data run from 1973 through 2007, the floating exchange rate era.

Tourism spending, revenue, and income could be deflated by the price indices but the aggregation bias could result in unreliable estimates as discussed by Goldstein and Khan (1985). The real exchange rate would introduce similar issues and the focus of the present paper remains on nominal variables given the lack of tourism price indices.

Stationarity is pretested to check whether variables are stationary converging to steady state levels. Results of the unit root test from conventional augmented Dickey-Fuller ADF tests are in Table 1. The number of lags is chosen by the Schwarz Information Criterion BIC.

Table 1

The ADF test with an intercept fails to reject the null hypothesis of a unit root for all level variables except US income Y. The ADF test does not reject the null hypothesis of a unit root for all level variables with an intercept and time trend. With lags added to US income, the ADF test fails to reject the unit root null hypothesis. The Y series do not appear stationary in Figure 1.

Figure 1

ADF tests reject the unit root null hypothesis for all differenced variables. All variables are integrated in the first order, and differences in Figure 2 and 3 appear stationary.

*Figure 2*Figure 3*

All variables are I(1) and first differencing can remove nonstationarity. An SVAR with differenced variables provides estimates and for comparison the tourism balance of trade model is also reported.

Contemporaneous relations of each innovation and one unit structural shocks are derived from the estimates. Diagonal element estimates are normalized to one with $Eu_t u_t^{'}$ a diagonal matrix with non unitary variances. Contemporaneous relations of each innovation and 1% structural shocks are derived. The estimated response functions to 1% structural shocks and confidence intervals are obtained taking 5% and 95% percentiles from 10,000 bootstrap simulations.

The order of export revenue of tourism $\mathbf{y}_t = [\Delta E_t \;\; \Delta X_t \;\; \Delta Y_t^*]'$ is chosen assuming the nominal exchange rate is not contemporaneously affected by tourism export or foreign income shocks since tourism involves a small fraction of foreign exchange transactions. Foreign income growth may affect the nominal exchange rate but only in the long term. Tourism export is assumed not to be contemporaneously affected by foreign income growth, reasonable if tourism demand is determined at least a quarter in advance.

From estimates of $\mathbf{D}$ the following contemporaneous relations of each innovation and structural shock are derived,

$$\underset{}{\varepsilon_t^E} = \underset{(0.0008)}{0.0146}\, u_t^E$$

$$\varepsilon_t^X = \underset{(0.0044)}{0.0030}\, u_t^E + \underset{(0.0056)}{0.0558}\, u_t^X$$

$$\varepsilon_t^{Y*} = \underset{(0.0038)}{-0.0162}\, u_t^E + \underset{(0.0029)}{0.0034}\, u_t^X + \underset{(0.0022)}{0.0381}\, u_t^{Y*}$$

with standard errors from 10,000 nonparametric bootstrap simulations. The choice of k = 4 is determined by the Akaike Information Criterion AIC.

Matrix $\mathbf{D}$ is estimated with the diagonal normalized to one to find contemporaneous innovations to 1% structural shocks. Estimated export revenue response functions are reported in Figure 4.

Figure 4

A 1% depreciation shock decreases tourism export revenue contemporaneously followed by an increase after one quarter and converging to equilibrium after six quarters. The short term exchange rate elasticity is insignificant while the long term is marginally insignificant. Tourism export revenue exhibits a robust positive response to foreign income and its own shocks.

Order of the import spending model $\mathbf{y}_t = [\Delta E_t \;\; \Delta M_t \;\; \Delta Y_t]'$ is justified in the same manner. Both AIC and BIC choose k = 1 but to remove any remaining serial correlation k = 4 is utilized as with export revenue.

From the $\mathbf{D}$ estimate, the following relations follow,

$$\varepsilon_t^E = 0.0319\ u_t^E$$
$$(0.0017)$$

$$\varepsilon_t^M = 0.0032\ u_t^E + 0.0442\ u_t^M$$
$$(0.0035) \quad (0.0053)$$

$$\varepsilon_t^Y = 0.0002\ u_t^E + 0.0016\ u_t^M + 0.0068\ u_t^Y$$
$$(0.0006) \quad (0.0005) \quad (0.0008)$$

The estimated import spending response functions are in Figure 5.

Figure 5

Responses are insignificant but import spending would appear to decrease contemporaneously with a 1% depreciation shock, increasing after four quarters, and converging to equilibrium after ten quarters. Import tourism spending also exhibits robust positive responses to home income and its own shocks.

Consolidating results, the tourism balance of trade deteriorates initially following dollar depreciation, improves after one quarter, and converges to the steady state after ten quarters. Short term deterioration of the balance of trade is insignificant while the long term improvement of the balance of trade is within the 90% confidence interval. There is no J-curve but there is a lagged exchange rate effect on export revenue.

For comparison, in the balance of trade model $\mathbf{y}_t = [\Delta E_t \Delta B_t \Delta Y_t \Delta Y_t^*]'$ the order of $\mathbf{y}_t$ is chosen assuming the exchange rate is not contemporaneously affected by shocks to the balance of trade or home or foreign income, and the balance of trade is not contemporaneously affected by shocks to home or foreign income. Home income is assumed not contemporaneously affected by foreign income shocks. While higher foreign income may lead to export demand and income growth in the long term, the effect after a few quarters would be negligible.

From the $\mathbf{D}$ estimate the following relations are derived,

$$\varepsilon_t^E = 0.0147\, u_t^E$$
$$\quad (0.0008)$$

$$\varepsilon_t^B = 0.0008\, u_t^E + 0.0418\, u_t^B$$
$$\quad (0.0041) \qquad (0.0026)$$

$$\varepsilon_t^Y = 0.0169\, u_t^E + 0.0012\, u_t^B + 0.0383\, u_t^Y$$
$$\quad (0.0036) \qquad (0.0032) \qquad (0.0020)$$

$$\varepsilon_t^{Y*} = -0.0002\, u_t^E - 0.0010\, u_t^B + 0.0000\, u_t^Y + 0.0066\, u_t^{Y*}$$
$$\quad (0.0006) \qquad (0.0005) \quad (0.0006) \quad (0.0007)$$

The choice of k = 4 is determined by the AIC. Matrix **D** with diagonal element normalized to one is estimated and the balance of trade response functions are in Figure 6.

Figure 6

The balance of trade appears to increase contemporaneously with a 1% depreciation shock but the response is insignificant. The response becomes significant after four quarters and converges to long term equilibrium after eight quarters. There is no evidence of a J-curve but depreciation raises the balance of trade. The balance of trade exhibits a robust positive response to a positive home income shock that becomes insignificant after four quarters. The balance of trade of tourism also exhibits a robust positive response to shocks to foreign income and itself. The separate estimates provide more detailed response dynamics.

Long term exchange rate elasticities are $a_2 = 0.875$ for tourism export revenue in (5) and $b_2 = 0.122$ for import tourism spending in (6). The derived exchange rate elasticities are $\eta_x = -0.875$ and $\eta_m = -0.878$. The Marshall-Lerner condition is satisfied at the initial balance of trade X/M = 0.591 where $|\eta_x|(X/M) + |\eta_m| = 1.395 > 1$ and at the 1.023 mean X/M where $|\eta_x|(X/M) + |\eta_m| = 1.774 > 1$.

Short and long term exchange rate elasticities and long term income elasticities are summarized in Table 2. There is no evidence of a J-curve but depreciation increases the long term tourism balance of trade. Foreign tourists coming to the US are more sensitive to the exchange rate than US tourists going abroad while US tourists are much more sensitive to their income. Aggregating the trade data disguises the strong income effect for US tourists.

Table 2

4. Conclusion

The present structural vector autoregressive model uncovers long term positive depreciation effects of nominal dollar depreciation innovations on the US tourism balance of trade. Foreign tourists into the US are more sensitive to the exchange rate than US tourists going abroad while US tourists are more sensitive to income. There is no evidence of a J-curve in the US tourism balance of trade.

The separate estimates of export revenue and import spending provide a more detailed picture of the underlying dynamic adjustment to exchange rate shocks. Specifically, the balance of trade estimate disguises the income effect of US tourists going abroad.

Table 1. Unit Root Pretests

Variable	Specification	ADF_c	$ADF_{c,t}$
X	Level	-2.16	-1.15
	Differenced	-12.80***	-13.22***
M	Level	-1.98	-0.91
	Differenced	-14.36***	-14.65***
E	Level	-1.06	-1.86
	Differenced	-10.86***	-10.93***
Y	Level	-4.91***	-2.09
	Differenced	-4.88***	-9.28***
Y*	Level	-2.12	-1.69
	Differenced	-5.30***	-5.48***

Note: The number of lags is chosen by the Schwarz Information Criterion (BIC). ADF_c and $ADF_{c,t}$ refer to ADF-t statistics when an intercept is included and when an intercept and time trend are included. *, ** and *** indicate the null hypothesis of unit root is rejected at 10%, 5% and 1% level. Asymptotic critical values are from Harris (1992).

Table 2. Short and Long Term Exchange Rate and Income Elasticities

Elasticitites	Export Revenue X	Import Spending M	Balance of trade B = (X/M)
E short term	-0.204	-0.101	0.051
90% CI	[-0.769, 0.346]	[-0.309, 0.094]	[-0.445, 0.523]
E long term	0.875	0.122	1.007*
90% CI	[-0.038, 1.900]	[-0.319, 0.530]	[0.085, 2.212]
Y long term	---	1.988*	0.710
90% CI		[0.547, 3.725]	[-1.642, 3.128]
Y* long term	0.633*	---	0.746*
90% CI	[0.190, 1.092]		[0.307, 1.293]

Note: 90% confidence intervals (CI) are obtained by taking 5% and 95% percentiles from 10,000 bootstrap simulations. * represents the coefficients are significant within 90% confidence intervals.

Figure 1. Variable Series

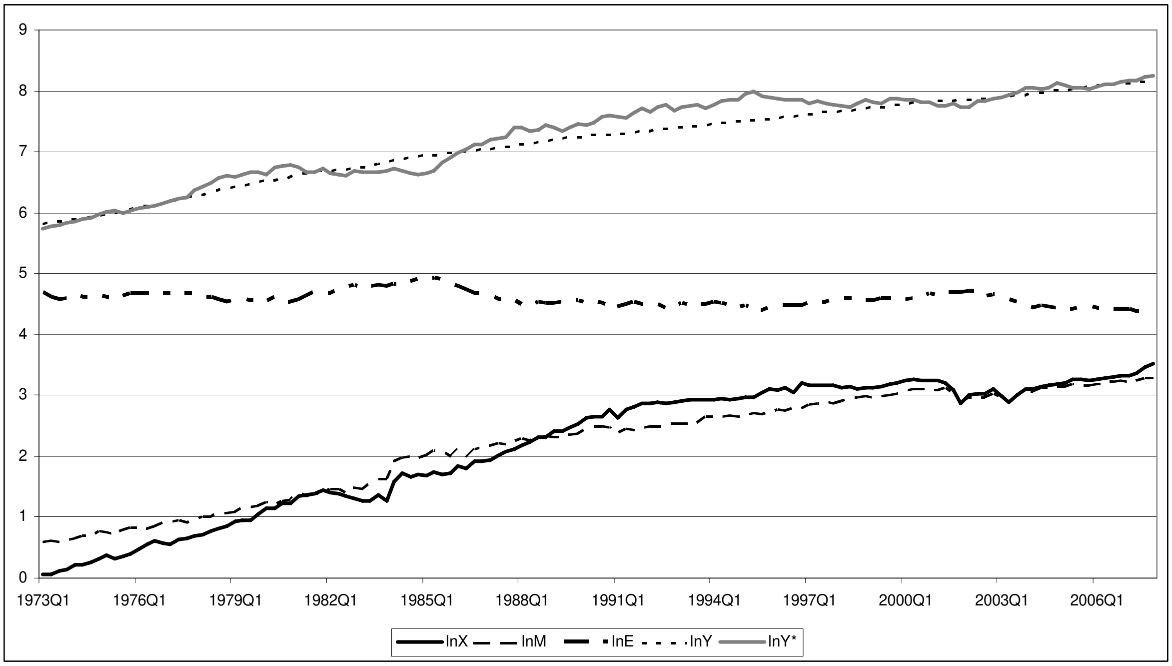


Figure 2. Differences of Variable

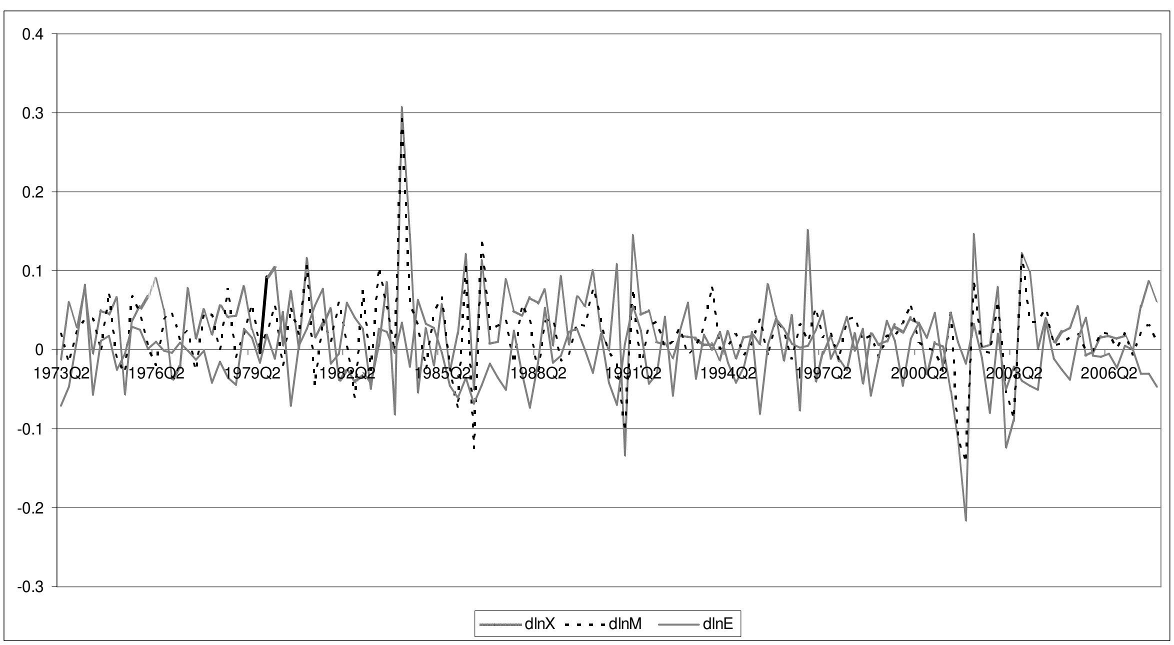


Figure 3. Differences of Variable

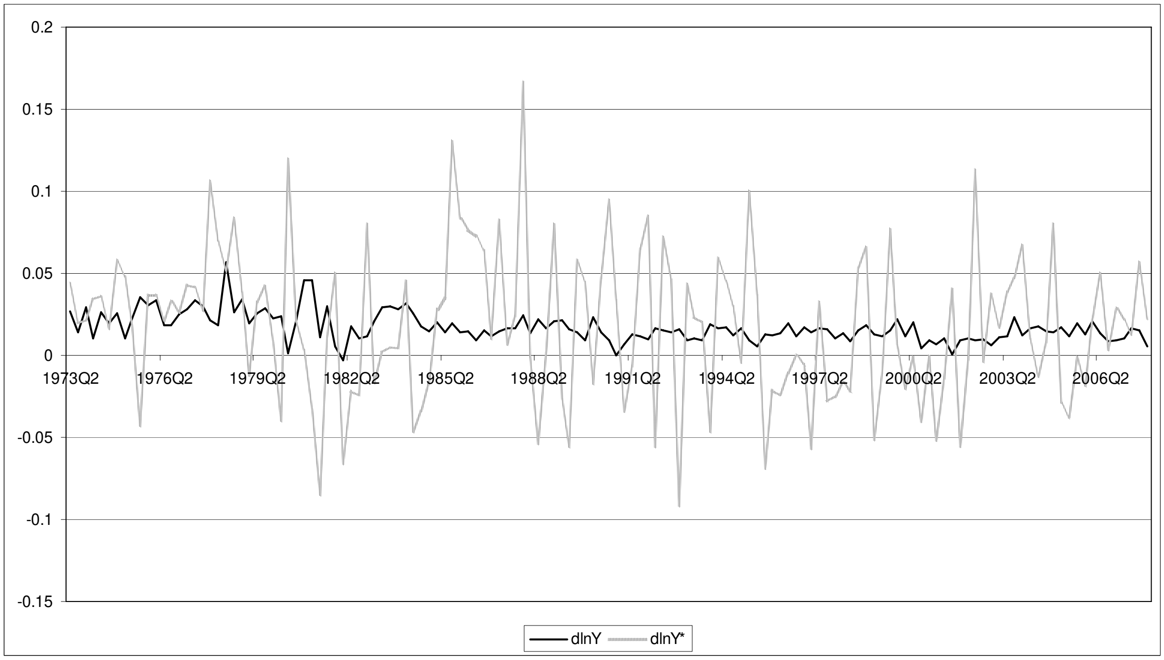
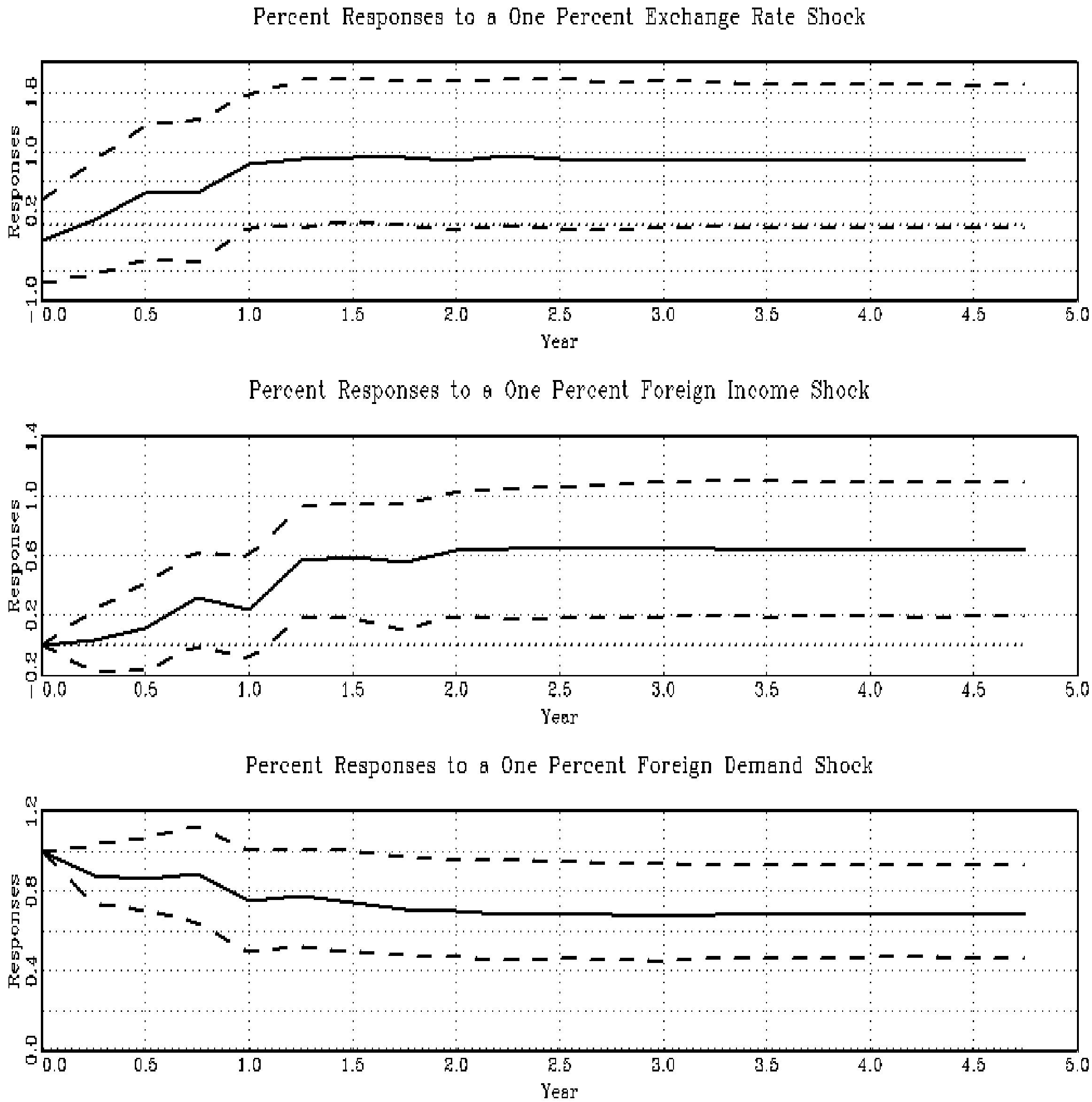
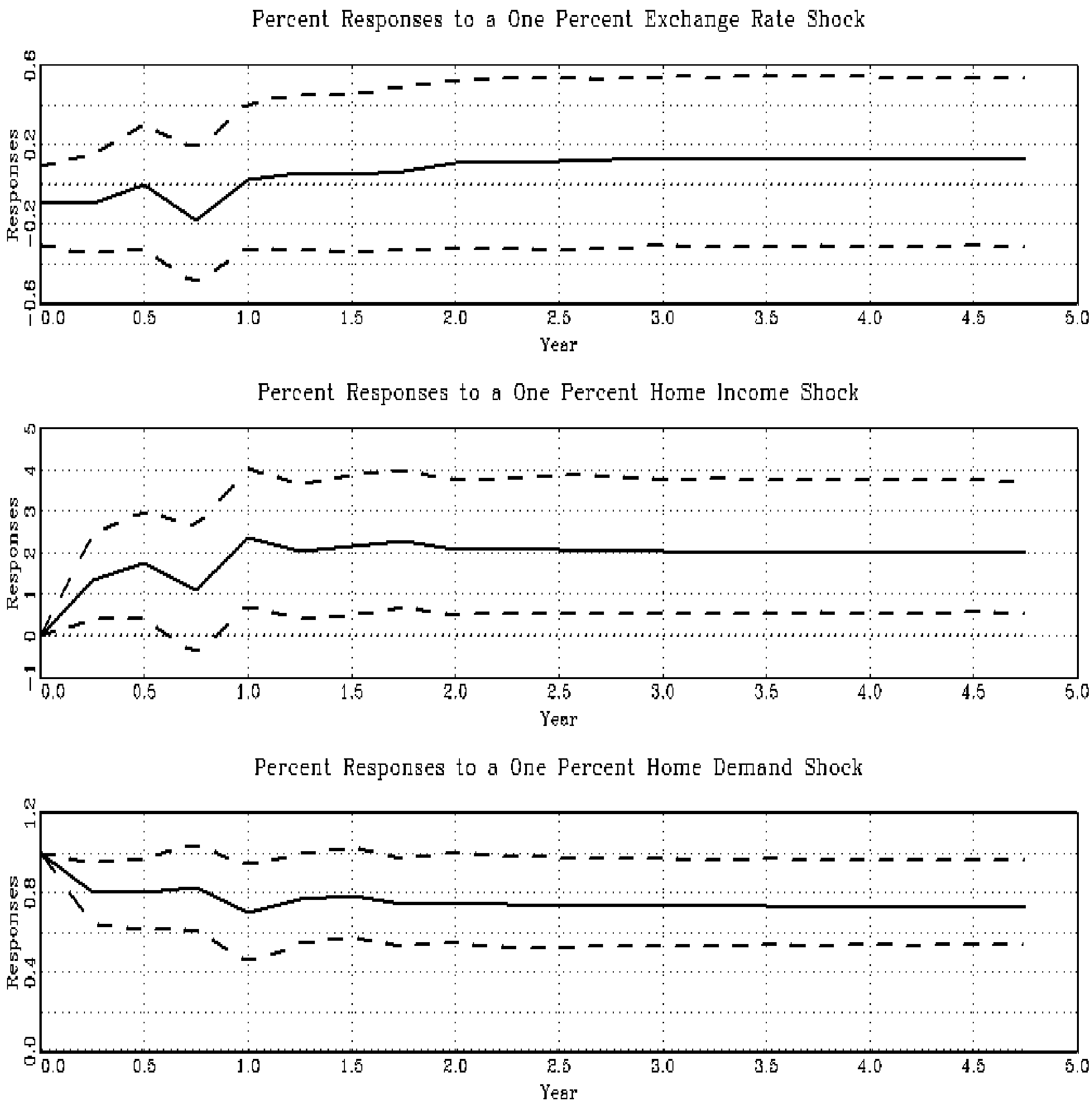


Figure 4. Impulse Response Function Estimates of Export Revenue



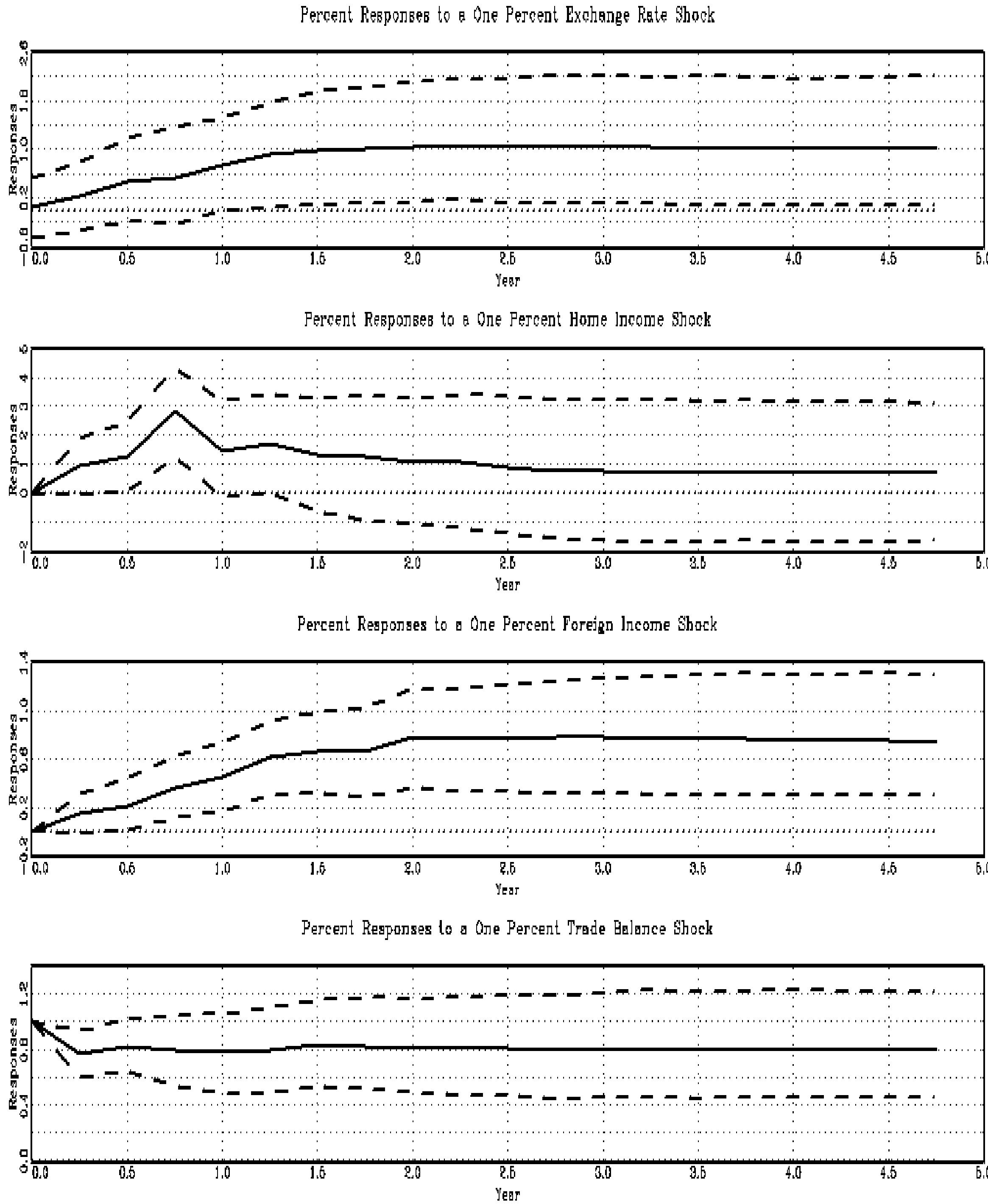
Note: 90% confidence intervals are obtained by taking 5% and 95% percentiles from 10,000 bootstrap simulations.

Figure 5. Impulse Response Function Estimates of Import Spending



Note: 90% confidence intervals are obtained by taking 5% and 95% percentiles from 10,000 bootstrap simulations.

Figure 6. Impulse Response Function Estimates of the Balance of trade



Note: 90% confidence intervals are obtained by taking 5% and 95% percentiles from 10,000 bootstrap simulations.

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Appendix

Tourism export revenue X is the product of the quantity of export in tourism q_x and the price of domestic tourism p. Import spending on tourism M is the product of the quantity of import in tourism q_m and the price of international tourism in term of home currency Ep*.

Export revenue of the home country is

$$X = pq_x \tag{1}$$

Import spending of the home country is

$$M = Ep^*q_m \tag{2}$$

Totally differentiate (1) and (2) to find

$$dX = pdq_x + q_xdp \tag{3}$$

$$dM = Ep^*dq_m + p^*q_mdE + Eq_mdp^* \tag{4}$$

Assume supply prices p and p* of international tourism do not change given perfectly elastic supply curves over the range of quantity changes, dp = dp* = 0.

Elasticities of export and import demand are then

$$\eta_x = \frac{(dq_x/q_x)}{d(p/E)/(p/E)} \tag{5}$$

$$\eta_m = \frac{(dq_m/q_m)}{d(Ep^*)/(Ep^*)} \tag{6}$$

where (p /E) is the foreign price of US tourism and Ep* is the dollar price of international tourism.

Equation (5) is expanded as

$$\eta_x = \frac{(dq_x/q_x)}{((Edp - pdE)/E^2)/(p/E)} = \eta_x = \frac{(dq_x/q_x)}{-(dE/E)} \tag{7}$$

Rearranging (7)

$$dq_x = -\left(\frac{dE}{E}\right)\eta_x q_x \tag{8}$$

Substitute (8) into (3) to rewrite dX in terms of export demand elasticity η_x,

$$dX = -\left(\frac{dE}{E}\right)\eta_x p q_x = -\left(\frac{dE}{E}\right)\eta_x X \tag{9}$$

From (9) the elasticity of export tourism revenue a_2 is related to the elasticity of export demand as

$$a_2 = \frac{(dX/X)}{(dE/E)} = -\eta_x \tag{10}$$

Similarly from (6)

$$\eta_m = \frac{(dq_m/q_m)}{(dp^* E + p^* dE)/(Ep^*)} = \frac{(dq_m/q_m)}{(dE/E)} \tag{11}$$

and rearranging

$$dq_m = \left(\frac{dE}{E}\right)\eta_m q_m \tag{12}$$

Substitute (12) into (4) to rewrite dM in terms of import demand elasticity η_m, to find

$$dM = \left(\frac{dE}{E}\right)\eta_m E p^* q_m + E p^* q_m \left(\frac{dE}{E}\right) = \left(\frac{dE}{E}\right) M(\eta_m + 1) \tag{13}$$

From (13), the elasticity of import tourism spending b_2 is related to the elasticity of import demand as

$$b_2 = \frac{(dM/M)}{(dE/E)} = \eta_m + 1 \tag{14}$$