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Macroeconomic Effects of Terrorist Shocks in Israel

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Abstract:
This paper estimates a structural vector autoregression model to assess the dynamic effects of terrorism on output and prices in Israel over the post-1985 period. Long-run restrictions are used to obtain an interpretation of the effects of terrorism in terms of aggregate demand and supply curves. The empirical responses of output and prices suggest that the immediate effects of terrorism are similar to those associated with a negative demand shock. Such leftward shift of the aggregate demand curve is consistent with the adverse effects of terrorism on most components of aggregate expenditure, which have been documented in previous studies. In contrast, the long-term consequences of terrorism are similar to those related to a negative supply shock. Such leftward shift of the long-run aggregate supply curve suggests the potential existence of adverse effects of terrorism on the determinants of potential output, which have not been considered so far.

Keywords: Goods Market; Output, Price, and Terrorist Indices; Structural Vector Autoregressions; Long-run Identifying Restrictions; Dynamic Responses and Variance Decompositions

JEL Classification: C32, E31, E32

1. Introduction

In recent years, there has been a considerable interest in the empirical assessment of the adverse macroeconomic effects inflicted by terrorism. For this purpose, most studies rely on reduced-form models to document the impact of conflicts on quantities in the goods market. These analyses show that terrorist events tend to have depressing effects on economic activity. Such effects on output are larger in developing economies than in industrialized countries, although terrorist incidents are more frequent in OECD countries (e.g. Blomberg, Hess, and Orphanides 2004; Tavares 2004). Also, terrorism seems to affect most components of the aggregate expenditure through declines in consumption spending, investment expenditures, and net exports (e.g. Eckstein and Tsiddon 2004). In particular, economic resources are diverted away from private investment and towards military and defence spending, as a result of higher interest rates following larger budget deficits financed by government borrowing (e.g. Blomberg, Hess, and Orphanides 2004; Gupta, Clements, Bhattacharya, and Chakravarti 2002; Knight, Loayza, and Villanueva 1996). In addition, terrorism has negative repercussions on net exports since it leads to a significant decrease in the volume of international trade by acting as a substantial implicit tariff (e.g. Blomberg, Hess, and Orphanides 2006; Nitsch and Schumacher 2004).

In contrast to the reduced-form approach adopted in previous studies, this paper relies on a structural analysis to explain the effects of terrorist shocks on goods-market variables. To do so, we use a structural vector autoregression model involving terrorist activities and output, as is frequently done, but also prices. The selection of the model's variables provides a structural interpretation of the effects of terrorism in terms of aggregate demand and supply curves. Also, the model's shocks are intimately related to specific economic concepts. That is, the aggregate supply shock represents an unexpected shift of the long-run aggregate supply curve, the aggregate demand shock is a surprise shift of the aggregate demand curve, and the terrorist shock captures unanticipated changes of terrorist activities. Finally, the model's parameters capture the contemporaneous interactions and the dynamic

feedbacks between variables.

The structural interpretation of the shocks and the econometric identification of the parameters are ensured by the imposition of certain long-run restrictions. One restriction stipulates that the demand shock has no long-run effect on the level of output. This restriction reflects the notion that the long-run aggregate supply curve is vertical. This is frequently imposed in macroeconomic analyses (e.g. Blanchard and Quah 1989; Gali 1992). The other restrictions postulate that the supply and demand shocks have no long-run effect on the level of terrorist activities. These restrictions assume that over the long term, terrorism is not due to economic factors, but rather to social, political, or geographical reasons, for example. This is consistent with the empirical evidence about the determinants of terrorist intensity (e.g. Abadie 2006; Krueger and Maleckova 2003).

The long-run identifying restrictions are used to obtain variance decompositions and dynamic responses. The variance decompositions are useful to assess the importance of each shock, especially the terrorist shock, in the determination of output and prices. The dynamic responses are useful to document the temporal effects of the shocks on our selected variables. In particular, the responses of output and prices provide information about the effects of terrorist events on both the standard and costs of living. Also, the responses of output and prices may be useful to highlight the relevant propagation mechanisms of terrorist activities. For example, a terrorist shock leading to responses of output and prices that are both persistent, but of opposite signs, is akin to a supply shock inducing a shift of the long-run aggregate supply curve. Such a case suggests that terrorism affects the goods market through the determinants of potential output. In contrast, a terrorist shock yielding responses of output and prices which are short-lived and persistent respectively, but of the same sign, is analogous to a demand shock inducing a shift of the aggregate demand curve. In this environment, terrorism could affect the goods market through the components of aggregate expenditure.

Our analysis focuses on the case of Israel for the post-1985 period, as in most single-

country studies (e.g. Eckstein and Tsiddon 2004; Eldor and Melnick 2004; Fielding 2003, 2004; Krueger and Maleckova 2002). Empirically, the variance decompositions reveal that the terrorist shock represents an important source of fluctuations of output and prices. Specifically, the contribution of the terrorist shock to output reaches 35 percent, whereas the contribution to prices attains 55 percent in the long run. Also, the dynamic responses indicate that ouput and prices are substantially affected by a positive terrorist shock. For example, the responses of output and prices are always negative, permanent, and statistically significant. Importantly, these responses are similar to the effects induced by leftward shifts of both the long-run aggregate supply curve and aggregate demand curve. Accordingly, this suggests that a positive terrorist shock acts as a combination of negative supply and demand shocks.

Intuitively, the immediate effects of a positive terrorist shock are likely to be similar to those associated with a negative demand shock, that is, substantial drops in consumption spending, non-military investment expenditures, and net exports. Interestingly, this corroborates the results usually obtained from reduced-form analyses. Also, the long-term consequences of an increase of terrorist activities are similar to those related to a negative supply shock, such as a contraction of physical capital that can be due to a crowding out of private investments, a reduction of technological innovations, a slowdown of immigration, or an increase of emigration that can take the form of a brain drain of skilled labors. Although the crowding-out effect is well-documented in earlier work, this paper suggests the potential existence of alternative propagation mechanisms of terrorism, which have not been considered so far.

This paper is organized as follows. Section 2 presents the structural vector autoregressive model. Section 3 describes the data for Israel. Section 4 reports the basic results obtained from a benckmark specification of our structural model. Section 5 verifies the robustness of the results from several alternative specifications. Section 6 concludes.

2. Structural Model

In this section, we present a structural model designed to primarily assess the dynamic effects of terrorist shocks on output and prices. The model is a q-order stationary structural vector autoregression (SVAR). For expositional purposes, however, we present the first-order version:

$$\mathbf{\Theta x}_t = \mathbf{\Phi x}_{t-1} + \mathbf{u}_t. \tag{1}$$

The vector $\mathbf{x}_t = (\, \tau_t \quad \Delta y_t \quad \Delta p_t \,)'$ contains the variables of interest. These variables are the level of terrorist activities, τ_t, the change of ouput, Δy_t, and the change of prices, Δp_t — where Δ is the first difference operator. The vector $\mathbf{u}_t = (\, u_{\tau,t} \quad u_{s,t} \quad u_{d,t} \,)'$ includes the structural innovations. These innovations correspond to a shock of the intensity of terrorism, $u_{\tau,t}$, a shock shifting the aggregate supply curve, $u_{s,t}$, and a shock shifting the aggregate demand curve, $u_{d,t}$. These shocks are orthogonal and their sizes are normalized to unity (without loss of generality), so that $E\big[\mathbf{u}_t \mathbf{u}_t'\big] = \mathbf{I}$ where $\mathbf{I}$ is the identity matrix. The matrix $\mathbf{\Theta}$ incorporates the parameters capturing the contemporaneous interactions between variables. The matrix $\mathbf{\Phi}$ includes the parameters related to the dynamic feedbacks between variables.

The moving average representation of the SVAR (1) is given by:

$$\mathbf{x}_t = \sum_{k=0}^{\infty} \big(\mathbf{\Theta}^{-1}\mathbf{\Phi}\big)^k \mathbf{\Theta}^{-1} \mathbf{u}_{t-k}. \tag{2}$$

The coefficients of this representation are related to the dynamic responses of the variables to various shocks. These responses are useful to assess the effects of terrorist activities on output and prices. For example, the matrix $\mathbf{\Psi}_k = [\psi_{k,ij}] = \big(\mathbf{\Theta}^{-1}\mathbf{\Phi}\big)^k \mathbf{\Theta}^{-1}$ summarizes the dynamic responses of the variables involved in our structural model k periods after the shocks. In particular, the element $\psi_{k,21}$ measures the dynamic response of the change of output to the terrorist shock (i.e. $\partial \Delta y_{t+k} / \partial u_{\tau,t}$). In addition, the expression

$\sum_{\ell=0}^{k}\psi_{\ell,21}$ corresponds to the dynamic response of the level of output to the terrorist shock (i.e. $\partial y_{t+k}/\partial u_{\tau,t}$), since it cumulates the responses of the change of output. Likewise, $\sum_{\ell=0}^{k}\psi_{\ell,31}$ is the dynamic response of the level of prices to the terrorist shock (i.e. $\partial p_{t+k}/\partial u_{\tau,t}$).

The coefficients of the representation (2) are also related to the variances of forecast errors. Decomposing these variances is useful to gauge the importance of terrorism in the volatilities of output and prices. Let $\boldsymbol{\Upsilon}_k = [\upsilon_{k,ij}]$ be the matrix storing the contributions of the various shocks to the variances of the forecast errors associated with a horizon of k periods. Then, the element $\upsilon_{k,21} = \Big[\big(\sum_{\ell=0}^{k}\psi_{\ell,21}\big)^2/\Big(\big(\sum_{\ell=0}^{k}\psi_{\ell,21}\big)^2 + \big(\sum_{\ell=0}^{k}\psi_{\ell,22}\big)^2+\big(\sum_{\ell=0}^{k}\psi_{\ell,23}\big)^2\Big)\Big]\times 100$ corresponds to the portion (expressed in percentage) of the forecast-error variance for the level of output (the denominator) which is attributable to the terrorist shock (the numerator). Similarly, $\upsilon_{k,31} = \Big[\big(\sum_{\ell=0}^{k}\psi_{\ell,31}\big)^2/\Big(\big(\sum_{\ell=0}^{k}\psi_{\ell,31}\big)^2 + \big(\sum_{\ell=0}^{k}\psi_{\ell,32}\big)^2 + \big(\sum_{\ell=0}^{k}\psi_{\ell,33}\big)^2\Big)\Big] \times 100$ measures the contribution of the terrorist shock to the volatility of the level of prices.

The reduced form associated with the structural model (1) corresponds to:

$$\mathbf{x}_t = \boldsymbol{\Gamma}\mathbf{x}_{t-1} + \mathbf{v}_t. \tag{3}$$

The matrix $\boldsymbol{\Gamma} = \boldsymbol{\Theta}^{-1}\boldsymbol{\Phi}$ includes the coefficients of the reduced form. The vector $\mathbf{v}_t = \boldsymbol{\Theta}^{-1}\mathbf{u}_t$ contains the statistical innovations. These innovations are not orthogonal, so that the covariance matrix $E\big[\mathbf{v}_t\mathbf{v}_t'\big] = \boldsymbol{\Theta}^{-1}\boldsymbol{\Theta}^{-1\prime} = \boldsymbol{\Omega}$ is non-diagonal.

Note that the structural model (1) involves 9 contemporaneous interactions in $\boldsymbol{\Theta}$ and 9 dynamic feedbacks in $\boldsymbol{\Phi}$, for a total of 18 unknown structural parameters which have to be identified. However, the reduced form (3) includes 9 coefficients in $\boldsymbol{\Gamma}$ and 6 distinct covariances in $\boldsymbol{\Omega}$, for a total of 15 parameters which are estimated. As a result, it is necessary to impose 3 restrictions on the SVAR to recover the numerical values of the structural parameters from the estimates of the reduced-form parameters.

For this purpose, we invoke long-run identifying restrictions that preserve the economic interpretations of our structural shocks. The first restriction stipulates that the demand shock has no long-run effect on the level of output. This reflects the notion that the long-run aggregate supply curve is vertical, as is frequently assumed in macroeconomic analyses (e.g. Blanchard and Quah 1989; Gali 1992). The second and third restrictions postulate that the supply and demand shocks have no long-run effect on the level of terrorist activities. This assumes that over the long term, terrorism is not due to economic factors, as is consistent with empirical evidence found from panels of countries and for Israel (e.g. Abadie 2006; Krueger and Maleckova 2003).

Following Blanchard and Quah (1989), we implement the identifying procedure as follows. First, the estimates of the reduced-form parameters $\hat{\mathbf{\Gamma}}$ and $\hat{\mathbf{\Omega}}$ are obtained by Ordinary Least Squares. Second, the estimates of the structural parameters are computed as $\hat{\mathbf{\Theta}} = \hat{\mathbf{\Lambda}}^{-1}\left(\mathbf{I} - \hat{\mathbf{\Gamma}}\right)^{-1}$ and $\hat{\mathbf{\Phi}} = \hat{\mathbf{\Theta}}\hat{\mathbf{\Gamma}}$, where $\hat{\mathbf{\Lambda}}$ is a lower triangular matrix obtained from the Choleski decomposition of $\left[\left(\mathbf{I}-\hat{\mathbf{\Gamma}}\right)^{-1}\hat{\mathbf{\Omega}}\left(\mathbf{I}-\hat{\mathbf{\Gamma}}\right)^{-1\prime}\right] = \hat{\mathbf{\Lambda}}\hat{\mathbf{\Lambda}}'$. The zero elements of $\hat{\mathbf{\Lambda}}$ reflect the three long-run restrictions explained above. Third, the estimates of the responses of the variables to the structural shocks are calculated from $\hat{\mathbf{\Psi}}_k = \left(\hat{\mathbf{\Theta}}^{-1}\hat{\mathbf{\Phi}}\right)^k\hat{\mathbf{\Theta}}^{-1}$, while the estimates of the contributions of the shocks to the volatility of the variables $\hat{\mathbf{\Upsilon}}$ are obtained from $\hat{\mathbf{\Psi}}$.

The estimates related to the dynamic responses and variance decompositions are useful to assess the effects of terrorist shocks and their importance on our selected macroeconomic variables. Also, the signs and persistences of the responses of output and prices may be useful to highlight the relevant propagation mechanisms of terrorist activities. For example, a terrorist shock leading to responses of output and prices that are both persistent, but of opposite signs, is akin to a supply shock inducing a shift of the long-run aggregate supply curve. A leftward shift could occur when terrorism has adverse effects on the determinants of potential output, such as reductions of physical capital, technological innovations in war-unrelated industries, and net immigration. In contrast, a rightward shift could reflect

an accumulation of physical capital in war-related industries and progresses of military technologies.

Also, a terrorist shock yielding responses of output and prices which are short-lived and persistent respectively, but of the same sign, is analogous to a demand shock inducing a shift of the aggregate demand curve. A leftward shift could arise when terrorism has negative effects on the components of aggregate expenditure, such as drops in consumption spending, investment expenditures, and net exports due to a lowering of consumers', firms', and foreigners' confidence. Conversely, a rightward shift could capture a significant increase of military and defence expenditures.

In addition, the estimates of the dynamic responses allow one to assess the effects of macroeconomic shocks on terrorist activities as well as on the levels of output and prices. As mentioned above, our identification hypotheses impose that the long-run responses of terrorism are null following supply and demand shocks, but the short-run responses are unrestricted. In this context, it becomes interesting to evaluate whether demand and supply shocks have short-run effects on terrorism, and if so, whether these effects are similar. Also, the validity of our identification strategy can be verified from the responses of output and prices to macroeconomic shocks. Specifically, a positive supply shock should induce a positive, persistent, response of output and a negative, persistent, response of prices. In contrast, a positive demand shock should yield a positive, short-lived, response of output and a positive, persistent, response of prices.

3. Data

This section describes the data for Israel. This economy is the most frequently analyzed in single-country studies (e.g. Eckstein and Tsiddon 2004; Eldor and Melnick 2004; Fielding 2003, 2004; Krueger and Maleckova 2002). The monthly data cover the 1986:01 to 2003:12 period. The data on terrorist activities are taken from the International Policy Institute for Counter-Terrorism. This rich database on the Arab-Israeli conflict provides information

on 690 incidents that took place on the Israeli ground during the 1970-2003 period. The database includes the following characteristics for each incident: date of incident, type of incident, mode of operation, target, location, the number of people killed, and the number of people injured.

We construct various measures of the level of terrorist activities, τ_t. All our measures are computed by taking the logarithm of the sum of one and the value of a terrorist index. For our benchmark measure, labelled *terror*, the terrorist index is obtained by summing over each month the number of terrorist incidents, the number of people killed, and the number of people injured. This terrorist index is similar to that used in previous studies (e.g. Eckstein and Tsiddon 2004).

As a cross-check, we also compute two alternative measures from different terrorist indices. Our first alternative measure, called *methods*, is obtained by summing over each month the number of incidents for the three main methods of operation: shooting, suicide bomb, and bombing. These methods are the only ones among the twelve methods of operation to account individually for more than five percent of total attacks. Our second alternative measure, *targets*, is computed by summing over each month the number of incidents for the four main targets: civilian, military personnel, transportation (i.e. vehicle, train, bus, ship, and cargo), and public (i.e. shopping center, restaurant, bus stop, marketplace, entertainment facility, plant or factory, airport, school, beach, and hotel). Again, these targets are the only ones to account individually for more than five percent of total attacks.

The data on macroeconomic variables come from the International Financial Statistics, published by the International Monetary Fund. The level of output, y_t, is measured as the logarithm of the industrial production index. The level of prices, p_t, is defined as the logarithm of the consumer price index.

Figure 1 displays the measures of the levels of terrorist activities, output, and prices. It is worth stressing three observations. First, all our measures of the level of terrorist

activities provide similar information. In particular, the terror intensity exhibits an upward trend over the 1991-1994 period despite the Oslo Peace Accords; a slowdown in 1995 coinciding with the Israeli-Palestinian Interim Agreement on the West Banks and Gaza Strip, known as Oslo II; a subsequent steady upward climb until 1998; a sizeable surge in 2000 corresponding to the collapse of the peace negotiations at Camp David and the outbreak of the second Intifada; and its highest level in 2002 as the Israeli government ordered the construction of a separation wall around the West Bank territory.

Second, movements of output partly coincide with terror episodes. For example, the largest decline of output occurred during the first Intifada in 1987; the economic activity deteriorated at the outbreak of the Al-Aqsa Intifada in 2000; and an economic expansion was observed during the first half of the 1990s as the peace process began, as well as a sizeable influx of immigrants from the former Soviet Union, and a global high-tech boom. Third, movements of prices seem to bear little relation with terrorist activities.

Figure 1 also shows the first difference of terrorist activities, output, and prices. From the plots it is difficult to conclude whether the measures of terrorist activities are stationary in level or in first difference, whereas the macroeconomic variables are clearly nonstationary in level but seem stationary in first difference. We follow the procedure outlined by Campbell and Perron (1991) to apply augmented Dickey-Fuller tests on our various measures. For the terrorist activities, we consider both regressions with and without a linear trend. For the macroeconomic variables, we consider only regressions with a linear trend.

Empirically, the null hypothesis of a unit root is statistically rejected at all conventional levels for each measure of terrorist activities. In contrast, the unit root hypothesis is never rejected for output and prices. Thus, these results confirm that the appropriate transformations for the variables are the level of the terrorist activities, τ_t, the change of output, Δy_t, and the change of prices, Δp_t. These transformations are consistent with the specification of our structural model (1).

Note that these findings hold for the 1986:01 to 2003:12 period. In particular, a high inflationary environment started at the beginning of the 1980s to last with Israel's successful stabilization program in mid-1985, where the inflation rate tumbled from over 400 percent to about 15 percent and then gradually declined to the current 1 to 3 percent target range. As a result, the inclusion of the pre-1985 data implies that the change of prices becomes nonstationary, while the second difference of prices is stationary. Admittedly, this case is inconsistent with our SVAR (1). To circumvent this problem, we limit our analysis to the post-1985 period, where the change of prices is stationary. Importantly, this selection of the time period should not lead to serious mismeasurements of the effects of terrorist shocks on macroeconomic variables, since our database accounts for few attacks during the pre-1985 period. Similar time periods have been selected in early work (e.g. Eckstein and Tsiddon 2004; Eldor and Melnick 2004; Fielding 2004).

4. Basic Results

In this section, we report the basic results of the macroeconomic effects of terrorist shocks in Israel. These results are obtained from our benchmark specification of the SVAR (1). This specification measures the level of terrorist activities from the index *terror*. The specification also involves the variables expressed in level for the terrorist activities and in changes for output and prices, as suggested by our results of the Dickey-Fuller tests. The specification further includes three lags for each variables, as selected by the Akaike Information Criterion.

Figure 2 displays the dynamic responses of the levels of each variable following the various shocks. Similarly, Figure 3 shows the variance decompositions of the levels of each variable attributable to the different shocks. As is standard practice, the 68 percent confidence intervals associated with the dynamic responses and variance decompositions are computed from the double-bootstrap percentile method (Nankervis 2005; Kilian 1998). In the first level of resampling we generate 1000 bootstrap samples of the residuals of the reduced

form (3) and, for each of these, in the second level of resampling we obtain 500 bootstrap samples.

A positive, one standard deviation, terrorist shock implies that the response of terrorism is postive, persistent, and statistically significant for all the horizons considered (i.e. up to 24 months after the shock). More precisely, the terrorist intensity substantially increases at impact, sharply declines for the following month, slightly increases for the next two months, and gradually decreases through time to converge to its level prevailing before the shock. Also, the response of output is negative, permanent, and significant for all horizon, except at impact. The economic activity decreases initially, and continues to smoothly decline over time to diverge from its original level. This accords with findings obtained from reduced forms, where production significantly and persistently declines after terrorist events, as well as external and internal conflicts (e.g. Blomberg, Hess, and Orphanides 2006). Moreover, the response of prices is negative, permanent, and significant for all horizons. Prices decrease instantaneously, and continue to gradually decline to diverge from their pre-shock level.

Importantly, the responses of output and prices following a positive shock are analogous to the effects obtained under leftward shifts of both the long-run aggregate supply curve and aggregate demand curve. Specifically, a negative, persistent, response of output (rather than a short-lived response) occurs when the leftward shift of the long-run aggregate supply curve (rather than the aggregate demand curve) determines the dominant effects for production. In contrast, a negative, persistent, response of prices (rather than a positive response) arises when the leftward shift of the demand curve (rather than the aggregate supply curve) is the prime driver for prices. Accordingly, these findings suggest that a positive terrorist shock acts as a combination of negative supply and demand shocks.

The variance decompositions reveal that the contribution of the terrorist shock to terrorism is substantial for all horizons. It is around 90 percent for a horizon of one month, drops to 70 percent for the two-month horizon, and quickly increases back to converge to nearly

100 percent. This convergence is the result of our identifying restrictions imposing that terrorism is only affected in the long run by the terrorist shock. Also, the contribution to output is large for most horizons. It is almost null for the one-month horizon, sharply increases to 20 percent for the two-month horizon, declines to 10 percent for the three-month horizon, and then monotonically increases to reach 35 percent. In addition, the contribution to prices is almost always large. It is around 10 percent for the one-month horizon, slightly decreases for the two- and three-month horizons, and then smoothly increases to attain 55 percent. These variance decompositions reveal that the contributions of the terrorist shock are always substantial in the long run, as they systematically exceed 35 percent. In this sense, the terrorist shock represents an important source of fluctuations of terrorism, output, and prices.

A positive, one standard deviation, supply shock yields a response of terrorism that is mainly negative, short-lived, and significant for the horizons between one and three months after the shock. The zero long-run response of terrorism reflects our identifying restriction stating that terrorism is not affected in the long run by the supply shock. The response of output is positive, permanent, and significant for all horizons. The response of prices is negative, persistent, and significant for the first three months after the shock. Importantly, the responses of output and prices are consistent with the expected effects induced by a rightward shift of the long-run aggregate supply curve. This suggests that this shock can be interpreted as a supply shock, in accordance with our identifying assumptions.

The contribution of the supply shock to terrorism is systematically modest, peaking at 13 percent for the horizon of two month and rapidly declining to nearly zero percent. The contribution to output is large for all horizons, attaining a maximum of 90 percent for the one-month horizon and smoothly converging to 65 percent. The contribution to prices is always small, peaking at 8 percent for the one-month horizon and quickly declining to less than one percent. These findings reveal that the supply shock mainly explains the variability of output.

A positive, one standard deviation, demand shock implies that the response of terrorism is positive, short-lived, and significant for horizons covering the first four months after the shock. The zero long-run response of terrorist activities is the consequence of our identifying restriction imposing that terrorism is not altered in the long run by the demand shock. Also, the response of output is positive, short-lived, and significant for the first three months following the shock. Again, the zero long-run response of output is due to our identifying assumption postulating that production is not determined in the long run by the demand shock. Furthermore, the response of prices is positive, persistent, and significant for all horizons. Interestingly, the responses of output and prices are in line with the effects associated by a rightward shift of the aggregate demand curve. This suggests that this shock can be interpreted as a demand shock, as in our identifying strategy.

The contribution of the demand shock to terrorism is quite modest, peaking at 17 percent for the two-month horizon and rapidly converging to two percent. The contribution to output is also small for all horizons, attaining a maximum of 9 percent for the one-month horizon and fastly declining to almost zero percent. The contribution to prices is always substantial, peaking at 84 percent for the one-month horizon and smoothly converging to 45 percent. These findings reveal that the demand shock mainly explains the fluctuations of prices.

In sum, these findings reveal that the terrorist shock substantially and persistently affects the terrorist intensity itself, as well as output and prices. The results further indicate that a positive terrorist shock acts as a combination of negative demand and supply shocks. The induced leftward shift of the aggregate demand curve suggests the presence of adverse effects of terrorism on the components of aggregate expenditure. The leftward shift of the long-run aggregate supply curve suggests the existence of negative effects of terrorism on the determinants of potential output. Finally, the supply and demand shocks have marginal influences on terrorist incidents, but substantial effects on output and prices which display the expected signs.

5. Extensions

This section verifies the robustness of our basic results from several extensions. These extensions amend in different ways our benchmark specification of the SVAR (1). The extensions systematically imply that a positive supply shock yields a positive, persistent, response of output and a negative, persistent, response of prices, and contributes mostly to the variability of output. Also, the alternative specifications always imply that a positive demand shock systematically induces a positive, short-lived, response of output and a positive, persistent, response of prices, and contributes primarily to the determination of prices. These findings are consistent with our basic results. All results are avalaible upon request.

For briefness, however, we report exclusively the effects of the terrorist shock and its contributions to the fluctuations of the various variables. Figure 4 displays the dynamic responses of the levels of each variable following the terrorist shock obtained under each alternative specification. Similarly, Figure 5 shows the variance decompositions of the levels of each variable attributable to the terrorist shock for each alternative specification.

The first two alternative cases are identical to the benchmark specification, except for the lag structure. In one case, we include one lag for each variable, as selected by the Bayesian Information Criterion. In the other case, we insert six lags for each variable, as suggested by the likelihood ratio test. Including more lags implies that the response of the terrorist intensity becomes more persistent through time, the response of output is sligthly more negative for most horizons, and the response of prices is a bit more negative for all horizons. Also, inserting additional lags yields a contribution to terrorism that is a bit smaller for some horizons, a contribution to output that is larger for most horizons, and a contribution to prices that is slightly larger for all horizons. Importantly, the alternative lag structures yield responses and contributions of similar shapes, magnitudes, and levels of significance than those obtained from our benchmark specification. Accordingly, our results are robust to the selection of the lag length. That is, the positive terrorist shock

induces a leftward shift of the long-run aggregate supply curve which remains the dominant effect for the determination of output, and it also leads to a leftward shift of the aggregate demand curve that constitutes the prime driver for prices.

The next two cases are similar to the benchmark specification, except for the transformation of the variable for terrorist activities. In one case, we express the measure *terror* in first difference. Although this transformation is formally rejected by the Dickey-Fuller tests, we nevertheless use it to check the robustness of our results. In the other case, we express the measure *terror* in deviation from its means, computed for the subsample ending in August, 2000, and for the subsample starting in September 2000. This transformation assumes the existence of two distinct regimes of terrorist activities, where the exogenous, deterministic, structural break coincides with the Al-Aqsa Intifada. Empirically, the transformation involving the first difference induces a positive, permanent, response of the level of terrorist activities, whereas the transformation reflecting two regimes generates a positive, but transitory, response of terrorism. Yet, these alternative transformations yield similar negative, persistent, significant responses of output and insignificant responses of prices. Moreover, both the first-difference and two-regime transformations lead to subtantial and significant contributions to terrorism and ouput, but to insignificant contributions to prices over all horizons. Thus, the alternative transformations yield similar results for output and different findings for prices, relative to those obtained from our benchmark specification. Interestingly, this remains consistent with the notion that the positive terrorist shock induces leftward shifts of both the long-run aggregate supply curve and aggregate demand curve. But this time, the relative magnitudes of the shifts are such that the effects on prices cancel out, so that the response of prices becomes insignificant.

The last two cases are the same as the bechmark specification, except for the measure of the level of terrorist intensity. In one case, we use the measure *targets*. In the other case, we rely on the index *methods*. These alternative measures of the terrorist intensity yield almost identical responses of terrorism, output, and prices. Likewise, the alternative measures lead to similar contributions to terrorism, output, and prices. In addition, the

alternative cases yield responses and contributions of similar shapes, magnitudes (except for the impact response of terrorism), and levels of significance than those obtained from our benchmark specification. Accordingly, our results are robust to the measurement of the terrorist intensity.

Overall, the extensions reveal that terrorism is a very persistent phenomenon, that output systematically declines persistently after a terrorist event, and that prices almost always decrease significantly following a conflict. These results strongly accord with the findings obtained from our benchmark specification.

6. Conclusion

In this paper, we estimated a structural vector autoregression model to assess the dynamic effects of terrorism on output and prices in Israel over the post-1985 period. Long-run restrictions are used to obtain an interpretation of the effects of terrorism in terms of aggregate demand and supply curves.

The empirical findings are robust to alternative specifications of our structural model, involving different lag structures, transformations of the terrorist index, and measures of terrorist activities. The results indicate that fluctuations of output and prices are largely attributable to the terrorist shock. Also, the responses of output and prices suggest that the immediate effects of terrorism are similar to those associated with a negative demand shock. Such leftward shift of the aggregate demand curve is consistent with the adverse effects of terrorism on most components of aggregate expenditure, which have been documented in previous studies. In contrast, the long-term consequences of terrorism are similar to those related to a negative supply shock. Such leftward shift of the long-run aggregate supply curve suggests the potential existence of adverse effects of terrorism on the determinants of potential output, which have not been considered so far. Future research could perform direct tests designed to verify whether these effects hold in the data, especially those involving a reduction of technological innovation and a slowdown of net immigration.

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Figure 1. Data

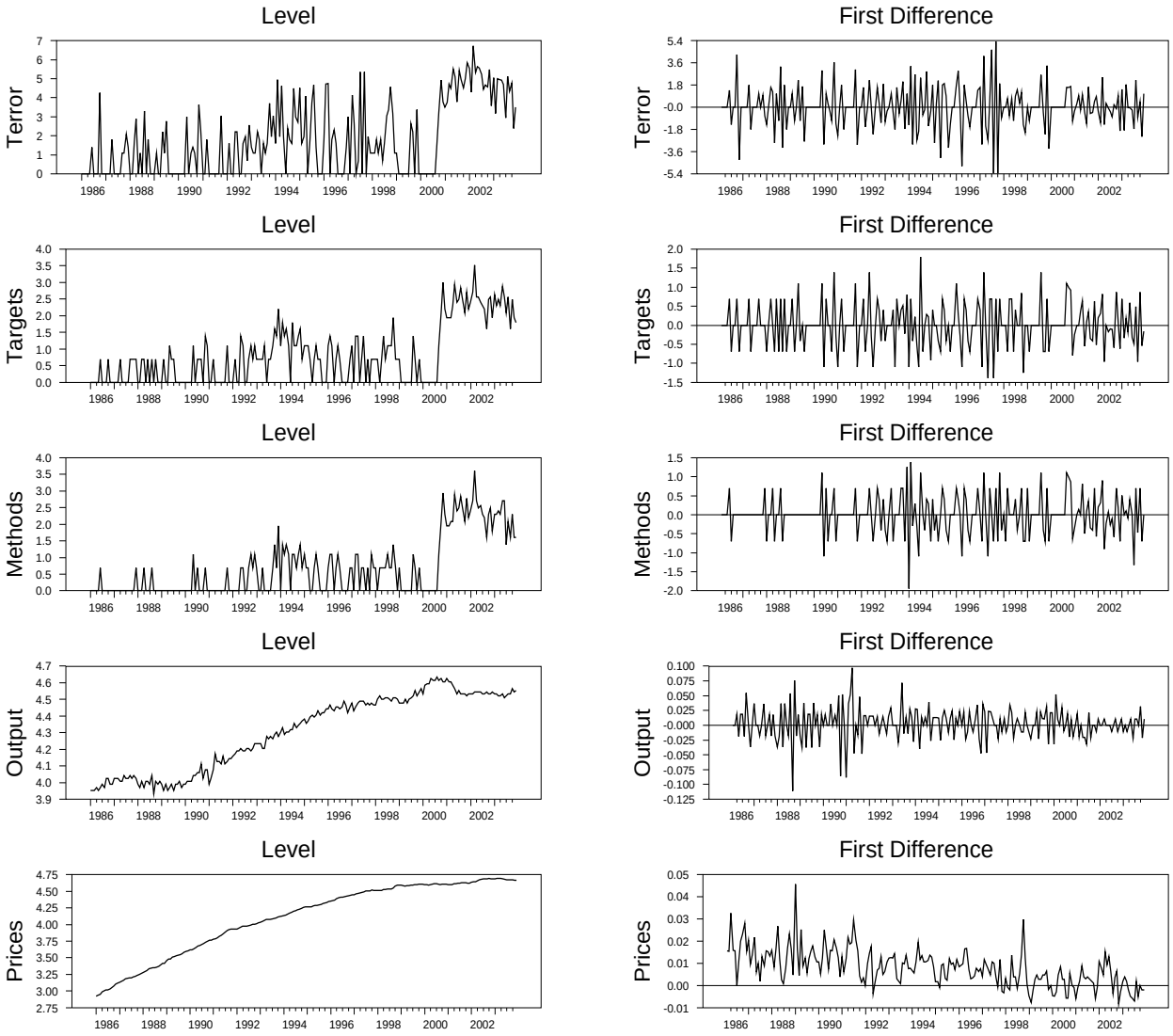
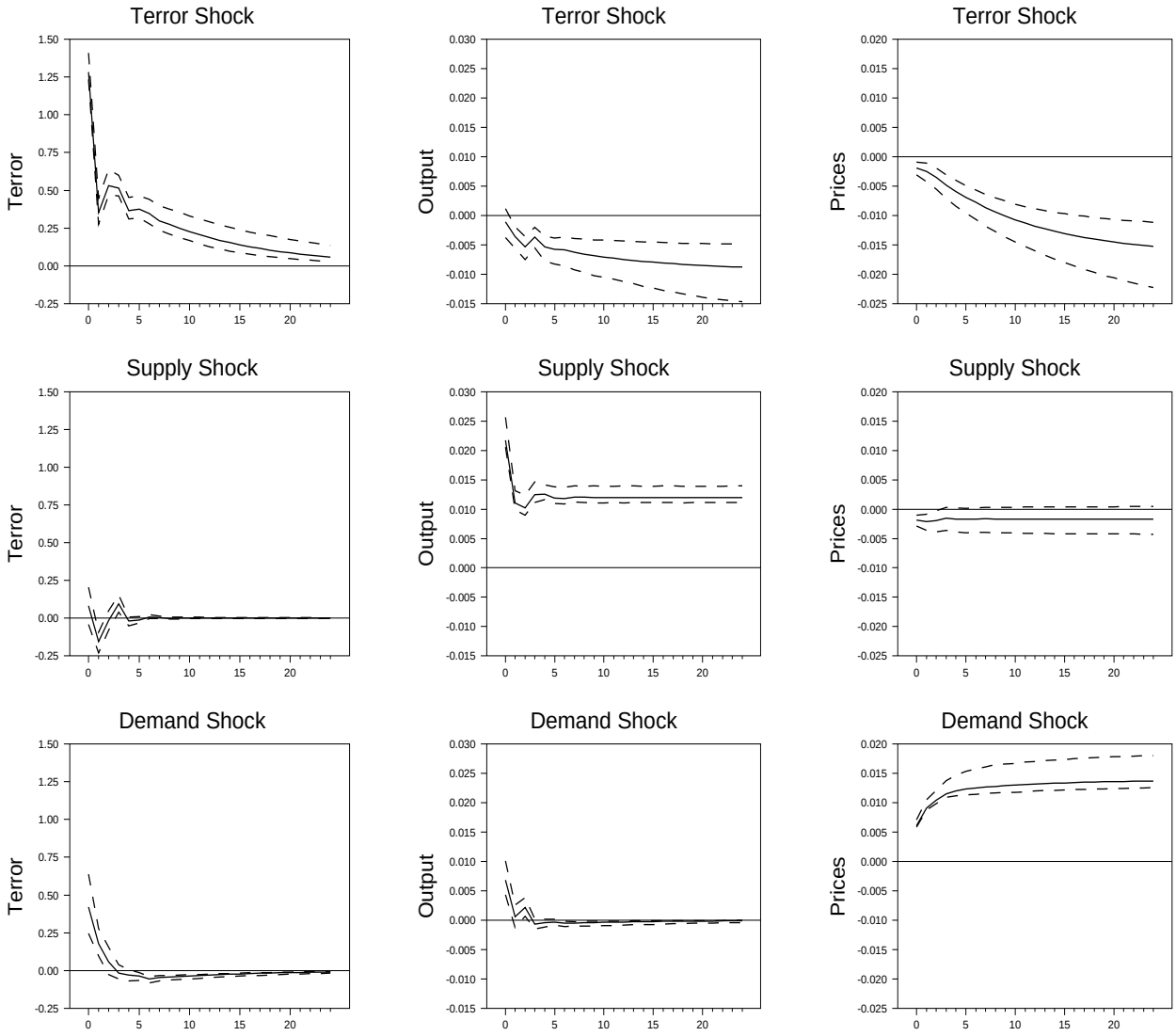
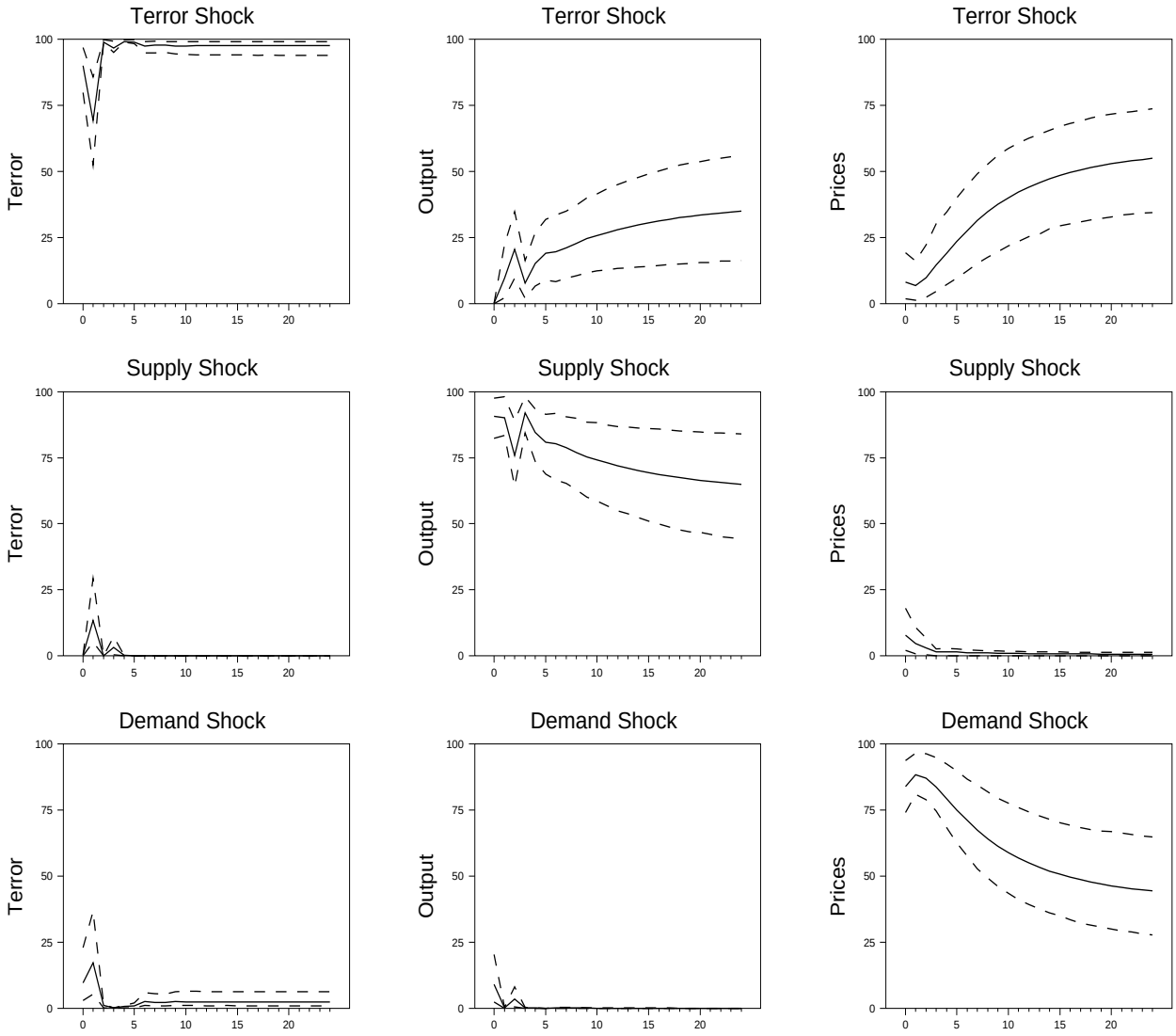


Figure 2. Basic Results: Dynamic Responses



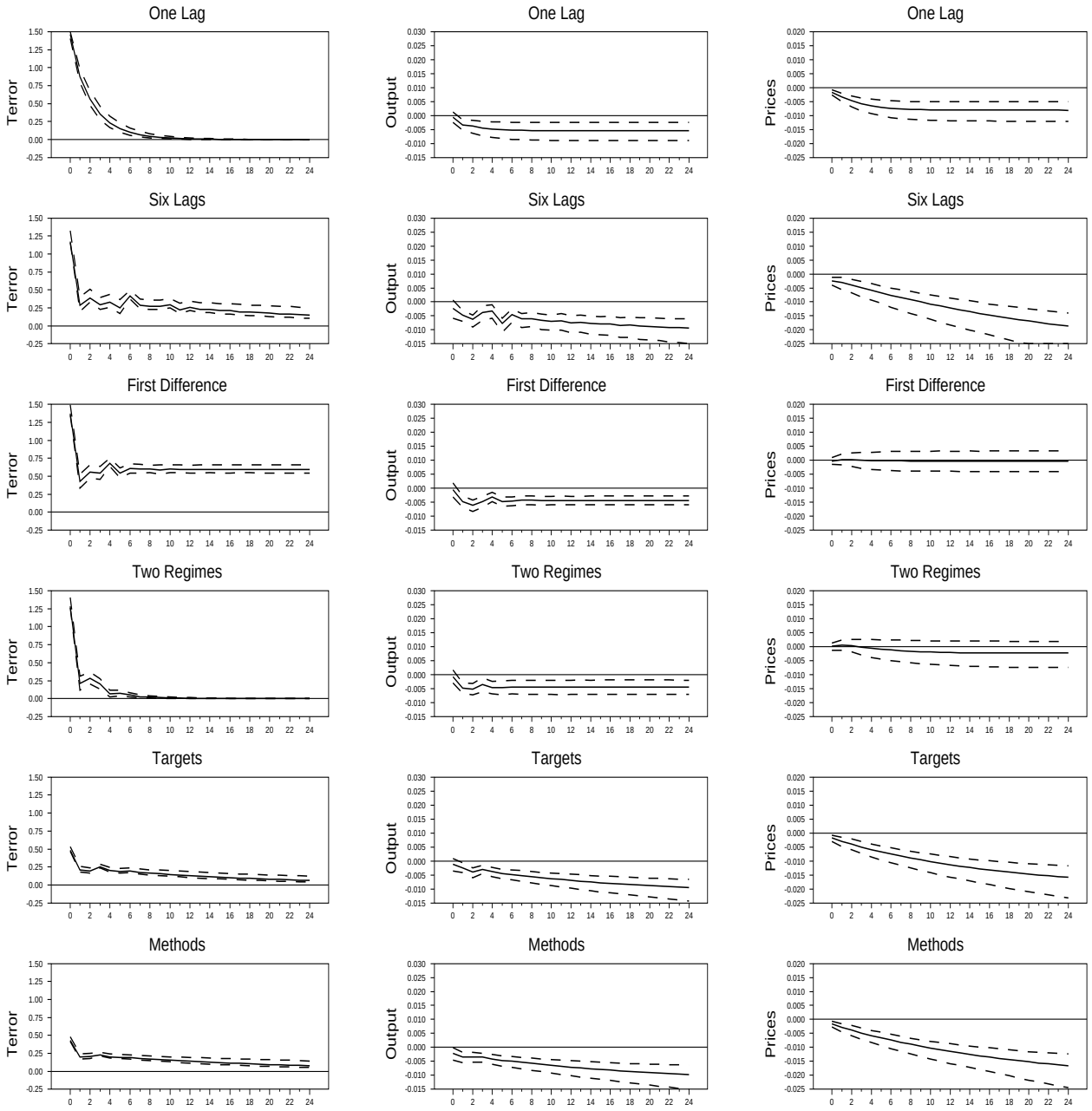
Note: The solid (dotted) lines correspond to the dynamic responses (confidence intervals) of the levels of each variable to the terrorist shock (first line), the supply shock (second line), and the demand shock (third line) for the benchmark specification.

Figure 3. Basic Results: Variance Decompositions



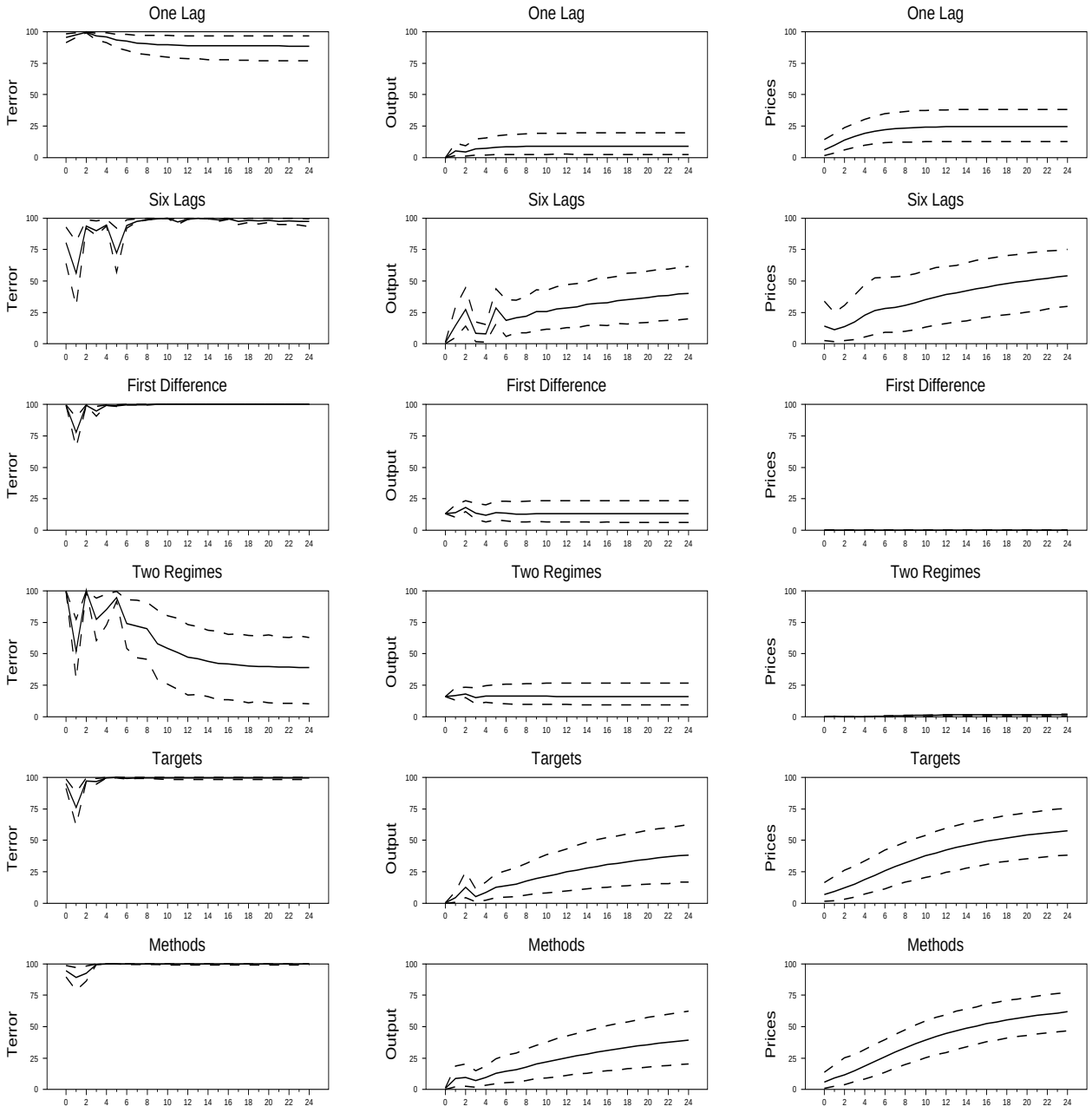
Note: The solid (dotted) lines correspond to the variance decompositions (confidence intervals) indicating the portions of the volatility of the levels of each variable attributable to the terrorist shock (first line), the supply shock (second line), and the demand shock (third line) for the benchmark specification.

Figure 4. Extensions: Dynamic Responses



Note: The solid (dotted) lines correspond to the dynamic responses (confidence intervals) of the levels of each variable to the terrorist shock for the alternative specifications. These specifications are identical to the benchmark specification, except for the lag structure (first two lines), the transformation of the variable for terrorist activities (next two lines), and the measure of the level of terrorist intensity (last two lines).

Figure 5. Extensions: Variance Decompositions



Note: The solid (dotted) lines correspond to the variance decompositions (confidence intervals) indicating the portions of the volatility of the levels of each variable attributable to the terrorist shock for the alternative specifications. These specifications are identical to the benchmark specification, except for the lag structure (first two lines), the transformation of the variable for terrorist activities (next two lines), and the measure of the level of terrorist intensity (last two lines).