

The Journal of Economics and Politics

Volume 22 | Issue 1

Article 6

2015

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IS CAPITAL EXPENDITURE CONTAGIOUS? AN ANALYSIS OF UCC DATA FROM OHIO AND ITS NEIGHBORS

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ABSTRACT

ECONOMIC CONDITIONS ARE OFTEN OBSERVED TO BE CORRELATED ACROSS SPACE AND TIME. ONE INTERPRETATION OF THIS PHENOMENON IS THAT ECONOMIC ACTIVITY IS “CONTAGIOUS.” THAT IS, GOOD OR BAD CONDITIONS IN ONE ECONOMIC AREA MAY LATER CAUSE SIMILAR CONDITIONS TO OCCUR IN NEARBY AREAS. THE PREVALENCE AND EXTENT OF THESE RELATIONSHIPS IS IMPORTANT TO UNDERSTAND FOR THOSE SEEKING TO FOSTER REGIONAL ECONOMIC DEVELOPMENT.

WE FOCUS ON CAPITAL EQUIPMENT SPENDING AT THE STATE LEVEL AT A MONTHLY FREQUENCY. THIS IS POSSIBLE GIVEN OUR ACCESS TO A UNIQUE DATA SET, THE RANDALL-REILLEY CAPITAL INVESTMENT INDEX (RRCII). THIS INDEX MEASURES CAPITAL EXPENDITURE USING UNIFORM COMMERCIAL CODE (UCC) FORMS FILED EACH MONTH WITH EACH STATE’S SECRETARY OF STATE. THE DATA IS CLASSIFIED INTO THREE INDUSTRIES: AGRICULTURE, CONSTRUCTION, AND MACHINE TOOLS, AS WELL AS A COMPOSITE MEASURE. IN THIS STUDY, WE UTILIZE THE INDEX’S STATE-LEVEL DATA FOR OHIO AND ITS NEIGHBORS: MICHIGAN, INDIANA, KENTUCKY, WEST VIRGINIA, AND PENNSYLVANIA.

OUR METHODOLOGY CONSISTS OF TYPICAL TIME SERIES TECHNIQUES: GRANGER CAUSALITY TESTS, VECTOR AUTOREGRESSIONS, AND THEIR ASSOCIATED IMPULSE RESPONSE FUNCTIONS. OUR INITIAL RESULTS SUGGEST THAT MICHIGAN IS THE ONLY STATE WITH A SIGNIFICANT RELATIONSHIP WITH OHIO AT THE COMPOSITE LEVEL, BUT THAT PENNSYLVANIA AND WEST VIRGINIA SHOW SOME RELATIONSHIP WITH OHIO IN CONSTRUCTION, AS DOES INDIANA WITH MACHINE TOOLS.

INTRODUCTION

Understanding the economic relationships among adjoining geographical areas is significantly important when trying to foster development in these areas. One view is that the areas may be in competition with one another, suggesting that a given area should try to distinguish itself as it competes for firms, trained workers, and other resources. An alternative view holds that the development of adjoining regions provides positive spillovers to neighboring areas, and that developmental policies that recognize this relationship and emphasize regional cooperation may be advantageous. A mixture of the two views is likely, with different effects in different developmental dimensions complicating the issue. Furthermore, the developmental effects may occur concurrently, with a lag, or with an anticipatory lead.

While a significant amount of econometric research focuses on these relationships, it suffers from limitations in available data at the local level. When it is available, quality data is often limited to only a few aspects of the economy (such as employment and housing), and often can only be obtained at a low frequency (annual or perhaps quarterly, rather than monthly). These limitations make understanding the potential mixture of competitive and complementary developmental relationships difficult, as well as obscuring any correlations across time.

In this paper we report on innovations in these dimensions. We use a UCC form-derived proprietary index that measures state-level expenditures on capital expenditures in three vital industries at a monthly frequency. We focus on capital expenditure in Ohio, and analyze its relationship to capital spending in its neighboring states of Michigan, Indiana, Kentucky, West Virginia, and Pennsylvania.

Our results suggest that only Michigan has a significant (and complementary) relationship when the composite of capital expenditure is examined, while Pennsylvania, West Virginia, and Indiana exhibit relationships with Ohio only in specific sectors.

The next section of this paper provides a brief literature review, followed by a description of the data. The methodology and results are then presented, and a brief discussion concludes the paper.

LITERATURE REVIEW: COMPETITION VS. COMPLEMENTARITY

The theory and practice of local economic development often is characterized as either competitive or complementary. Competitive is different jurisdictions competing to attract new facilities and their attending capital and employment, and complementary is local areas working together to attract clusters of economic activity, with suppliers, transportation, and support industries locating across several political boundaries. The competitive view is based on the simple logic that if a facility locates in one locality, it cannot also locate in another. Papers that fall into the competitive camp include Bowman (1988), Cable and Feiock (1998), and Buss (2001). Several authors criticized competitive policies designed to attract industry to a particular area as a “race-to-the-bottom” (see for example, Goetz et al., (2011)) or “smokestack chasing” (see for example, Turner (2003)). Other authors note that attracting a facility to an area may benefit adjoining areas, as the economics of agglomeration cause related firms to locate not only in the initial firm’s location, but also those adjacent. Authors in this category include Audretsch and Feldman (1996), Porter (2000), and Cowell (2010). Of course both of these forces are likely to exist in any particular situation, depending on the distance among the localities, the strength of incentives, and the strength of agglomeration. Examples of authors finding this mixture include Goetz (1993), Hawkins (2010), and Delgado et al. (2012).

DATA

The recent empirical literature on this topic faced restrictions on the availability of useful data. A primary concern is the frequency of available data, with some authors limited to coarse annual data (see for example Rey and Montouri (1999) or Beenstock and Felsenstein (2007)). More recently others have improved on this by utilizing quarterly data (for example Owyng and Wang (2009), Kueth and Pede (2011), and Brady

(2014)); however, even a quarterly frequency may obscure important temporal relationships when sequential events occur in the same quarter. Moreover, as Chung (2013) points out, the lower the frequency of the data used, the more likely an analysis might mistakenly attribute any movement to a common national-level shock. To their credit, a limited number of analyses obtained and used data at a monthly frequency (Park and Hewings (2012), Chung (2013)).

Regardless of the frequency used, this literature also suffers from a lack of variables that accurately describe an area's economy. While a plethora of data may exist at the national level, state-level data is often limited to employment, income, and housing. Often authors will focus on one variable of interest such as Rey and Montouri (1999), who focus on income; or Brady (2014), who examines housing prices. Some authors construct and estimate multivariate models. Kueth and Pede (2011) make use of income, unemployment, and housing prices; while Beenstock and Felsenstein utilize earnings, population, housing price, and housing stock. Other authors choose to use or construct coincident indices (Park and Hewings 2012) or use dynamic factor models (Chung 2013) to collapse several variables (typically measures of employment and building permits) into one. Note, however, that none of these models incorporate measures of capital stock or capital expenditure into their analysis (see Chung 2013 for a discussion).

METHODOLOGY

The treatment of spatial relationships is a relatively new econometric endeavor. Initial work in this domain can be traced to Anselin (1988) and Blanchard et al. (1992). More sophisticated and formal treatments are due to LeSage (1999), Rey and Mourtouri (1999), and Anselin (2003). In recent years some authors sought to adapt vector autoregression (VAR) techniques to incorporate spatial concerns. These are sometimes referred to as spatial vector autoregressions (SpVAR). In these models past shocks to adjoining areas are posited to affect the area of concern. Recent work includes Beenstock and Felsenstein (2007), Holly et al. (2010), Keuth and Pede (2011), and Marquez et al. (2013). All of these models rely on severe restrictions on parameter values, as without the restrictions the number of free parameters exceeds the number of observations. Other endeavors make use of dynamic factor models (Bai and Wang (2012), Chung (2013)) to reduce the number of variables considered. These authors typically use MCMC techniques to avoid under-identification. Finally, recent work by Brady (2014) relies on spatial panel data techniques, although he restricts his analysis to a single endogenous variable.

GEOGRAPHIC FOCUS

Two recent papers applied these techniques to Midwestern states. Park and Hewings (2012) examine Michigan, Ohio, Indiana, Wisconsin, and Illinois. Their Granger-causality tests suggest that economic fluctuations in Ohio cause and are caused by fluctuations in the other four states. They find that employment fluctuations in these states, with the exception of Illinois, coincides with national trends, but that Illinois fluctuations lag the national trend by a few months. They hypothesize that the mix of industries in these states explains this pattern, with Illinois, relatively heavy in the service sector, responding to its manufacture-heavy neighbors with a lag. Chung (2013) adds Minnesota to the list of states above. The impulse response functions derived from his complicated MCMC estimation suggest that shocks to Ohio have positive spillover effects in the other states (although the effects are muted when a more complicated multifactor approach is used); and that there are mixed results in the other direction: Shocks to Michigan, Illinois, and Minnesota actually create weak negative effects on Ohio (although this result is dependent on the specification), while Wisconsin generates a positive effect, and Indiana's effect on Ohio varies with the specification of the model.

DATA: THE RRCII

Equipment Data Associates (EDA) is a division of Randall-Reilly Publishing, headquartered in Charlotte North Carolina. They purchase UCC data from every state and the District of Columbia as soon as their Secretaries of State make the data available. They then enter the data into a searchable database that can be

queried in a variety of methods, primarily by location and equipment type. EDA sells access to this database to sales and marketing departments, dealerships, and service providers, which use the information to increase sales.

An example of a UCC form appears in Illustration 1. This form comes from Tennessee, and describes a loan made by Allied Industrial Equipment to Ozburn Hessey Logistics LLC, for two stand-up riders, several batteries, and two lift trucks. Note: The form was filled out by hand and then scanned by the State of Tennessee before being sent to EDA. The staff at EDA then entered the data from the form in a standardized format. Another example appears in Illustration 2. This UCC comes from Missouri and describes a loan made to Renita Segar by the Third National Bank for a Bobcat Skidsteer. Also note that the format of this UCC is electronic, which decreases the time it takes for the data to be transmitted, as well as decreasing the effort needed to enter accurate data.

The methodology used to construct this index is fairly straightforward. It begins with the extraction of the number of units for a large amount of classifications of equipment in the agricultural, construction, and machine tool industries. Data from all states except Nevada (which is chronically years tardy in their UCC reporting) are utilized. A dollar value for each type of equipment is assigned based on EDA's best estimate of the value of that particular machine's classification using prices that prevailed in 2010. Thus, 2010 is selected as the base year for the evaluation of the index so that changing values for the equipment do not create false trends in the index due to inflation in equipment prices. In each month, for each of the three sectors, the total number of units is multiplied by this fixed set of prices, and aggregated across states, to compute the total value of the equipment in these three industries covered by UCC filings. This value is then divided by the average value for 2010 and multiplied by 100 to create an index. Separate indices are constructed for each sector, as well as another index that combines the sectors. In a final step, the X12 ARIMA deseasonalization procedure (commonly used in many government statistics) is applied to create seasonally adjusted indices.

The values for recent months are problematic. States differ on how quickly they make the UCC forms available: for recent months some states have reported all of their activity, some have reported part of the month's activity, and some have not reported any. Furthermore, most states include late filers in their data, so that numbers may change several months later. In a separate work (VanderHart, Yeh, and Zeng (2012)) we describe a procedure to adjust for these late filers, and construct preliminary, revised, and finalized numbers for the most recent months; however, in this paper we avoid most of these issues by only examining the data through July 2013.

Figure 1A displays the composite (combined agriculture, construction, and machine tools) RRCII nationwide from July 2001 through July 2013, a total of 145 observations. The boom of the early 2000s, the bust of 2007-2010, and the recent recovery in capital expenditure are apparent in the index. Disaggregations by industry are displayed in Figures 1B - 1D, and provide interesting details. Expenditure on agricultural equipment follows a positive trend through the period considered, while construction equipment is much more cyclical and has not even returned to the levels seen in the early 2000s. Machine tool spending is slightly less cyclical than construction, and has recovered more robustly.

VARIABLE CONSTRUCTION

Our focus in this paper is not the national level of capital expenditure, rather that of Ohio and its neighbors. Figures 2A-F show seasonally adjusted levels for the 6 relevant states. Each of these figures generally mimics Figure 1A – the national pattern – and does not appear to be stationary. This resemblance indicates that these levels of capital expenditure follow an underlying national trend. This national trend, obviously, is driven by business cycles: the 2001 and the 2008-2009 recessions, which discouraged capital spending nationwide, as well as the 2002 and 2006 economic expansions, which resulted in booming capital spending. We found that the existence of the national trend creates spurious relationships in state-level capital spending.

Our solution to this problem is to use state-to-national capital expenditure ratios for each state. If we let K_S represent the level of capital expenditure in a specific state, s , then the ratio for, say, Ohio could be denoted as:

$$\frac{K_{OH}}{\sum_S K_S}$$

Doing so essentially creates series containing “shares” of national capital expenditures for each state. Thus this variable identifies state deviations from the national trend. It captures the unique behavior of each state’s capital spending given the business cycle fluctuations, and greatly improves the stationarity of our data.

Figures 3A - 3F plot the composite share in percentage for each state considered. Ohio has one of the higher shares of capital expenditure, usually fluctuating between 3 and 4 percent with no discernible trend.¹ West Virginia takes the lowest share and does not appear to have bounced back from the most recent crisis. The shares of the remaining four states, on average, are slightly below that of Ohio.

MODELS AND IDENTIFICATION

Our goal is to detect the effects of shocks in capital spending emanating from surrounding states to Ohio, and outward from Ohio to its surrounding states. Perhaps the best way to accomplish this would be to construct a model that includes all 6 states, and let all states have direct and indirect effects on one another. This approach is problematic, however, as the number of estimated parameters is large relative to the number of observations. (This difficulty leads those in the SpVAR literature to make extreme restrictions on parameter values.) Rather than adopt this approach, and because our focus is on Ohio, we instead estimate pairwise relationships, with Ohio always being one of the two states paired.

We first perform Granger Causality tests on each relevant pair of states. These tests are designed to determine whether past values of one variable can be used to forecast values of another variable. If we denote Ohio’s share to be S^{OH} and another state’s share to be S^{XX} , and limit ourselves to 2 lags (as in the results below, based on the Akaike Information Criterion) then the equations for the tests are written:

$$S_t^{OH} = \alpha_1 + \beta_{11}S_{t-1}^{OH} + \beta_{12}S_{t-2}^{OH} + \gamma_{11}S_{t-1}^{XX} + \gamma_{12}S_{t-2}^{XX} + \varepsilon_{1t}$$

$$S_t^{XX} = \alpha_2 + \beta_{21}S_{t-1}^{XX} + \beta_{22}S_{t-2}^{XX} + \gamma_{21}S_{t-1}^{OH} + \gamma_{22}S_{t-2}^{OH} + \varepsilon_{2t}$$

The tests are of joint hypotheses on the γ terms: If we reject the joint hypothesis that all γ terms are 0, then we can conclude that the right-hand side variable Granger-causes the left-hand side variable. Note that there are two of these tests for each pair, and that there could be mutual causation, one-way causation, or no causation at all. For a thorough exposition, see Enders (2010).

While Granger Causality tests are informative, without delving into their underlying parameters they do not provide much information about the direction, magnitude, and timing of possible relationships among the states. We therefore also estimate pairwise Vector Autoregressions (VARs). The relevant equations can be written as:

$$Y_t = a + b(L)Y_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim N(0, Q)$$

¹ The Augmented Dickey Fuller (ADF) test on the Ohio share suggests that it is stationary. Indiana’s share seems to have jumped about a percent during the recent recession, while Michigan’s share dipped prior to the recent recession and appears to have recovered. A unit root is present in these two series according to the ADF tests at 50% and 16% statistical significance levels, respectively. (While the two failures are of some concern for the analyses that follow, a check of the ARMA structure and the possibly affected impulse response functions do not reveal instability in the estimated systems of interest.)

where Y_t is the vector of endogenous variables, and includes Ohio's share, S_t^{OH} , and one of its neighboring states, S_t^{XX} . For the j th ($j = 1, 2$) endogenous variable $y_{j,t}$, its equation is given by:

$$y_{j,t} = a_j + b_j(L)y_{j,t-1} + \epsilon_{j,t}$$

where $b_j(L) = \sum_{k=0}^K b_{j,k}L^k$ is a lag polynomial. As indicated above, the number of lags in the $b_j(L)$ matrix, k , is set equal to 2. Given our specification, the reduced-form VAR can be written as:

$$\begin{bmatrix} S_t^{XX} \\ S_t^{OH} \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} \\ b_{21} & b_{22} & b_{23} & b_{24} \end{bmatrix} \begin{bmatrix} S_{t-1}^{XX} \\ S_{t-2}^{XX} \\ S_{t-1}^{OH} \\ S_{t-2}^{OH} \end{bmatrix} + \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix}, \quad \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix} \sim N(0, \begin{bmatrix} Q_{11} & Q_{12} \\ Q_{21} & Q_{22} \end{bmatrix}).$$

The variance-covariance matrix $Q \equiv \begin{bmatrix} Q_{11} & Q_{12} \\ Q_{21} & Q_{22} \end{bmatrix}$ indicates that we allow ϵ_{1t} and ϵ_{2t} to be correlated with one another. Later in our analysis, when we consider the effects of orthogonal (structural) shocks, we impose a recursive structure so that

$$\begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix} = P \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix}, \quad \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \sim N(0, I)$$

where $P \equiv \begin{bmatrix} P_{11} & 0 \\ P_{21} & P_{22} \end{bmatrix}$ is the implied lower triangular matrix of the Cholesky decomposition of the variance-covariance matrix Q , and, therefore, $PIP' = Q$. With this recursive structure, we know the implied structural shocks $\begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} = P^{-1} \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix}$. Denoting $PP = P^{-1} = \begin{bmatrix} PP_{11} & 0 \\ PP_{21} & PP_{22} \end{bmatrix}$, we can obtain

$$\begin{aligned} u_{1t} &= PP_{11}\epsilon_{1t}, \\ u_{2t} &= PP_{21}\epsilon_{1t} + PP_{22}\epsilon_{2t}. \end{aligned}$$

Note that recursive structure is most commonly used to identify structural shocks in the VAR literature. Such restrictions allow the contemporaneous effect of the first VAR variable, ϵ_{1t} , on the second VAR variable, but shut down the cotemporaneous effect of ϵ_{2t} on the first VAR variable. That way, the structural shocks, u_{1t} and u_{2t} , become identifiable. In our benchmark model we allow neighboring states to have a contemporaneous effect on Ohio, but not vice versa, by ordering Ohio's share as the second variable in the VAR. We also experimented with alternative ordering, and the results did not vary significantly.

As is typical in the literature, we report the results by displaying impulse response functions (IRFs) based on the model estimation and identification described above. IRFs show how a variable is expected to vary over time in response to a shock to another variable (or its idiosyncratic shock). Again, for a more thorough exposition, please refer to Enders (2010).

COMPOSITE SHARES

We first examine interstate relationships for the RRCII's composite measure. Results of Granger Causality tests can be seen in Table 1. These tests suggest that Michigan is an important neighbor to Ohio when it comes to capital expenditure: The capital expenditures in Ohio and Michigan Granger-cause each other at the 5% statistical significance level. This suggests that the previous Ohio capital spending partially explains the Michigan expenditure and vice versa. Somewhat surprisingly, no other states show much of a relationship to Ohio, in either direction, at this level of significance. If we relax our standards slightly to the 10% level, Ohio capital expenditure appears to Granger-cause Kentucky capital expenditure, and West Virginia capital expense appears to Granger-cause Ohio expenditure.

As mentioned above, Granger causality tests may not provide the entire picture of the relationship between two variables, as they ignore contemporaneous effects and do not display the cumulative and indirect effects in the system of equations. We remedy this by estimating pairwise VARs and reporting the resulting IRFs. Figures 4 and 5 show the impulse responses (in percentage deviation) of composite capital expenditure to a one-standard-deviation shock in capital expenditure of another state. Figure 4 focuses on Ohio's response to shocks originating from one of its neighbors, while Figure 5 displays the effect that a shock in Ohio has on its neighbors. The solid lines are the mean estimates of these responses, with the upper- and lower-dashed lines representing the plus/minus two-standard-error bands. Thus if the space between the dashed bands does not include the horizontal axis, we can surmise that there is a statistically significant effect.

Figure 4 displays the estimated response of Ohio to shocks from its neighboring states. The response of Ohio to its own idiosyncratic shock is also included as a reference. Turning to the adjacent states, one observes that an unexpected rise in the capital expenditures of Indiana, Michigan, and West Virginia all result in an increase in the Ohio capital spending, although only Michigan has a clear statistical effect. The positive shock effects from Indiana and Michigan last for approximately 2 years (24 months), while the one from West Virginia kicks in with a one-month lag and dies down in about a year. This finding suggests that expenditures in these three states, at least on average, stimulate capital spending in Ohio, with the effect from Michigan particularly distinct. The effects from the shocks to Kentucky and Pennsylvania, on the other hand, are quite minor and ambiguous on Ohio capital spending.

Figure 5 examines effects in the other direction, specifically the effects of a one-standard-deviation shock to Ohio's capital expenditure on its neighboring states. One observes that such a positive shock has a significant positive effect on capital spending in Indiana and Michigan, while the responses of Kentucky and Pennsylvania are quite small and ambiguous. Interestingly, an increase in Ohio's capital spending causes a slight reduction in the expenditure in West Virginia, although the effect is statistically insignificant and relatively short-lived (less than 7 months).

As a whole, these results suggest a significant bidirectional and positive relationship between capital expenditure in Ohio and Michigan. This is quite consistent with the complementary view of economic development. There appears to be less of a relationship between Ohio and other adjacent states, although there is evidence to suggest a unidirectional positive effect on Indiana, and some slight evidence of a negative effect on West Virginia.

One critique of these results is that the data combines capital expenditure from disparate industries. The "contagion" could be positive for one industry and negative for another, and these effects may cancel each other out when composite measures are used. This could explain the insignificant results for most of the states discussed above. To further explore this issue, we examine the capital expenditure in a few disaggregated industries in the following subsection.

DISAGGREGATED INDUSTRY SHARES

In this section we present results from three industries (machine tools, agriculture, and construction) that form the composite measure. Each state's share is redefined to be its share of national activity in that particular industry. This approach may provide interesting relationships that are hidden by combining industries. Figures 6 and 7 display selected impulse response functions implied by models of disaggregate industries. Note that to preserve space and the reader's patience, we only include those effects that are notable.

Each row of Figure 6 shows the responses of industry-specific capital spending in Ohio to a one-standard-deviation shock to the analogous measure for neighboring states. The first row refers to machine tools and indicates that there is an initial negative relationship between spending on machine tools in Ohio and similar spending in Indiana, Michigan, and West Virginia. An increase in machine tool spending by one of these states results in lower machine tool spending in Ohio, with a statistically significant effect found for Indiana. These results are consistent with the competitive view of state economic growth, rather than the complementary view. A modest negative relationship also is seen in the construction industry between Ohio and Kentucky (see the

middle panel of the third row). Positive effects are in these figures, particularly the statistically significant effects of West Virginia's construction spending on Ohio's construction, and Michigan's agriculture spending on Ohio's agriculture.

In the first column of Figure 6, which plots the responses of Ohio spending to a shock to Indiana spending in three different industries, one observes that the positive effect of an Indiana shock on Ohio in the composite model (recall the top left panel of Figure 4) is mainly driven by the capital expenditures in the construction industry. Spending on agricultural equipment also has a minor but positive contribution. Also in the composite model, the negative effect of shocks to Kentucky and the positive effect of shocks to West Virginia on Ohio (recall the top middle and bottom middle panels of Figure 4) are mainly attributed to construction expenditure rather than the other two sectors.² The agriculture industry, on the other hand, is the most important industry that contributes to the composite effect of shocks to Michigan spending on Ohio. As a whole, these results suggest that disaggregating the types of capital expenditure provides a more complicated and accurate description.

Figure 7 summarizes the industry-specific responses of Ohio's neighbors to analogous shocks originating in Ohio. Again, the shocks with trivial effects are not displayed. The first row, once again, supports the competitive view of capital spending when examining expenditure on machine tools, with the effect being more substantial in Indiana than for the other Ohio neighbors. Positive effects are generally seen for agricultural spending, although the effects are not statistically significant. Finally, note that there appears to be asymmetric effects in construction spending: A shock to Ohio construction spending has a significant and positive effect on Pennsylvania construction spending, but not vice versa.

CONCLUSION

This paper used a specific set of data based on UCC forms to describe capital expenditure relationships between Ohio and its neighbors. For composite capital expenditure, it finds a complementary bidirectional relationship between Michigan and Ohio, and that Ohio's capital activity affects Indiana's, but not vice versa. Ohio and its neighboring states have a competitive relationship with respect to machine tools, but not in other industries. Ohio and Michigan appear to have some degree of complementary relationship with respect to agricultural equipment, and both Pennsylvania and West Virginia construction expenditure has a unidirectional relationship with Ohio's.

Overall the results suggest a mild complementary composite capital expenditure relationship between Ohio and its neighbors, with a fairly strong link between Ohio and Michigan. This is not too surprising given the interconnected auto industry along the Detroit/Monroe/Toledo corridor. The lack of a strong relationship with Ohio and the other states may be indicative of the location of most of Ohio's other major cities in its interior (with the exception of Cincinnati, which has limited corresponding activity across the Kentucky and Indiana borders). Given that, we can conclude that, overall, the states in this area should not view capital expenditure in an adjoining state as a threat, rather it may be a boon because of positive spillovers.

The asymmetric, time-lagged, and industry-dependent relationships discovered in this paper are suggestive of future research directions. One approach would be to expand the model with more states and more industries. Computational issues may pose a challenge with this approach as the number of parameters increases. A different approach may be to consider smaller geographical areas. Although not coded this way by EDA, it is possible to glean more specific location data from the UCC forms, and thus examine the spatial relationships in capital expenditure at a higher resolution. This would allow us to examine the Toledo/Monroe/Detroit corridor separate from the Youngstown/Pittsburgh or Cincinnati/Covington areas.

² The response of Ohio to the Kentucky shock in machine tools is insignificant and not displayed in Figure 6.

FIGURE 1: RANDALL-RILEY CAPITAL INVESTMENT INDICES

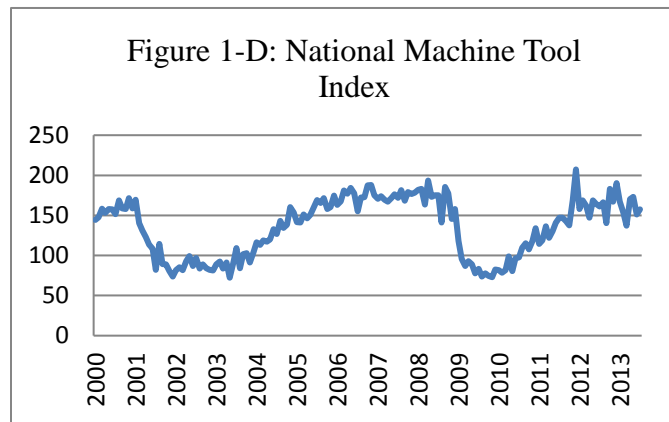
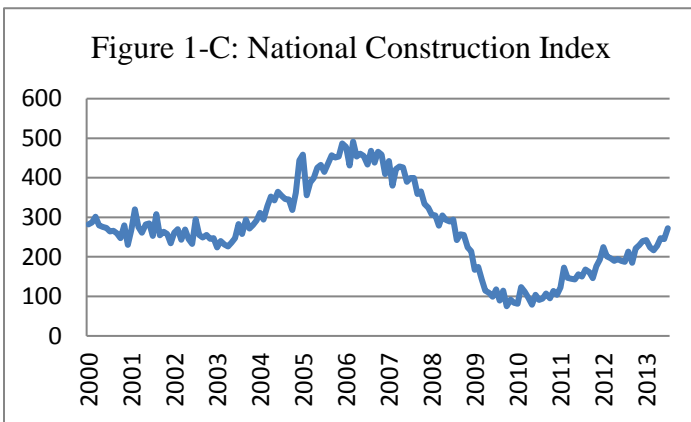
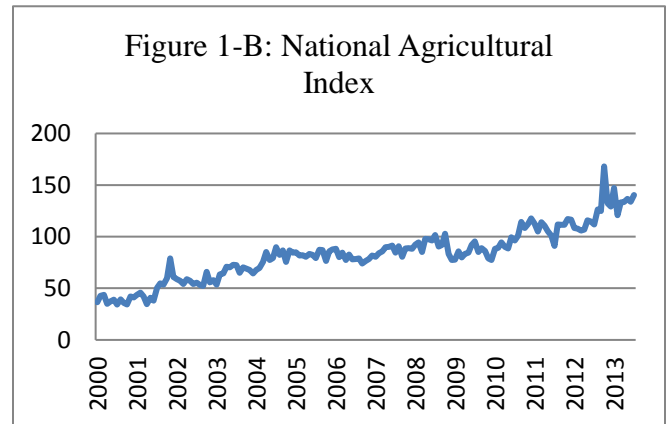
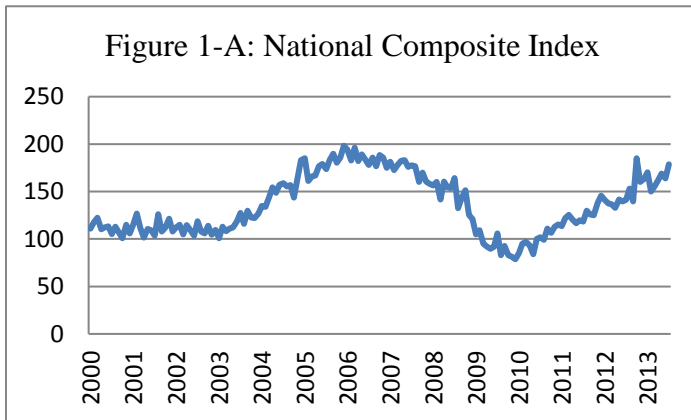


FIGURE 2: COMPOSITE CAPITAL SPENDING BY STATE

Figure 2-A: Ohio Composite Capital Spending

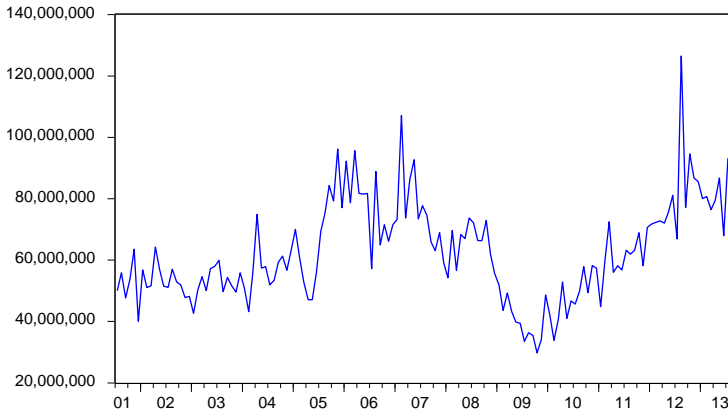


Figure 2-B: Indiana Composite Capital Spending

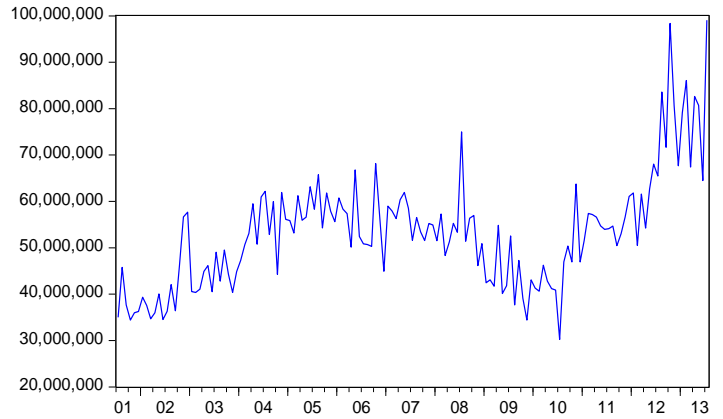


Figure 2-C: Kentucky Composite Capital Spending

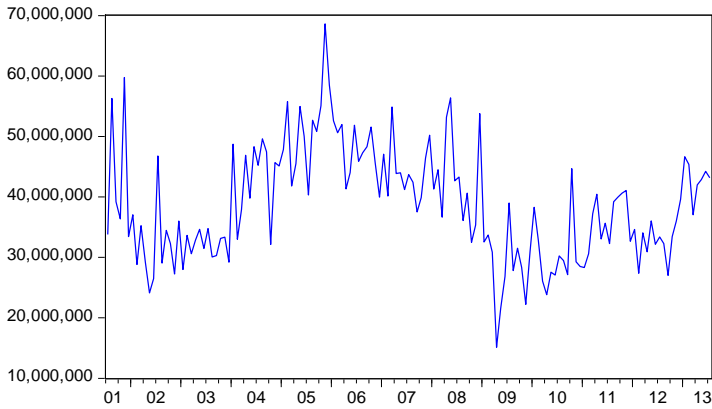


Figure 2-C: Michigan Composite Capital Spending

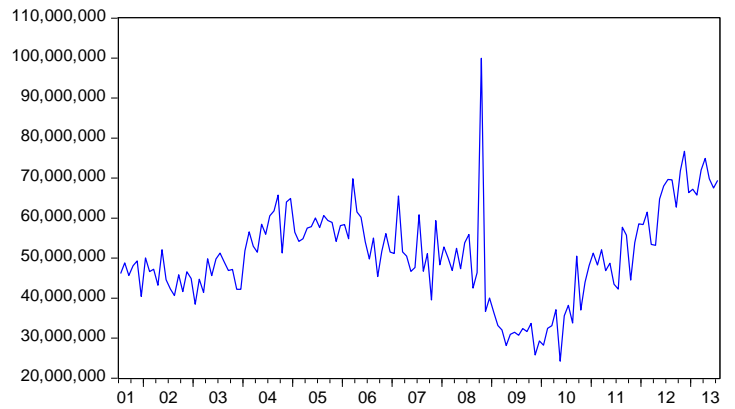


Figure 2-D: Pennsylvania Composite Capital Spending

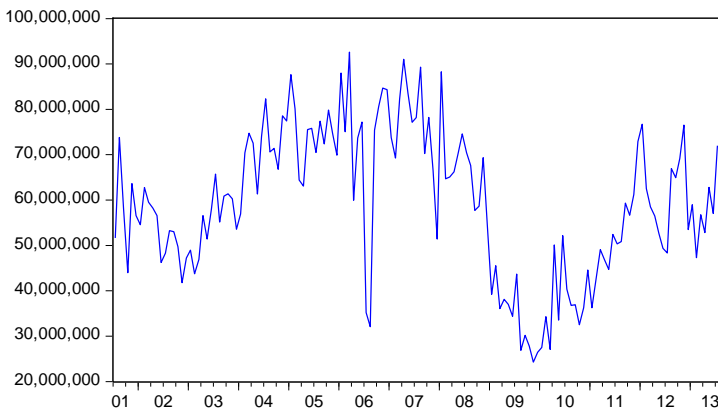


Figure 2-D: West Virginia Composite Capital Spending

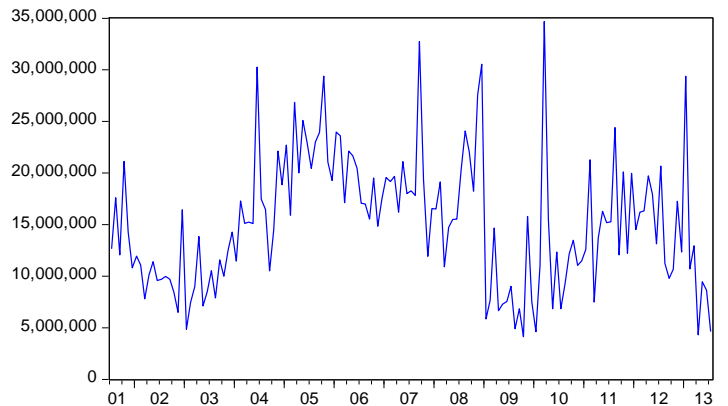


FIGURE 3: STATE-LEVEL CAPITAL EXPENDITURE COMPOSITE SHARES

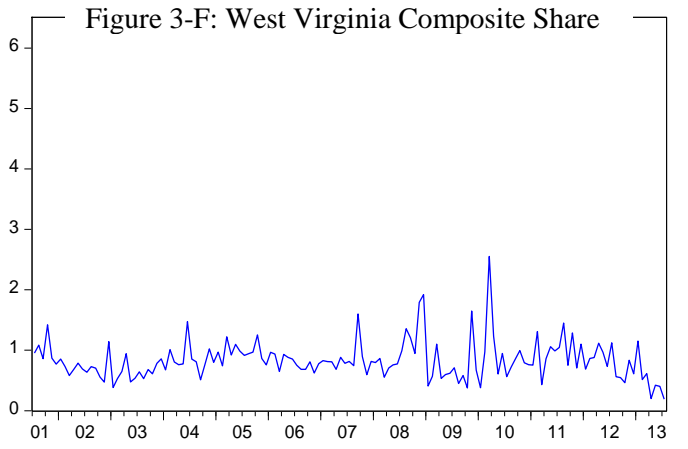
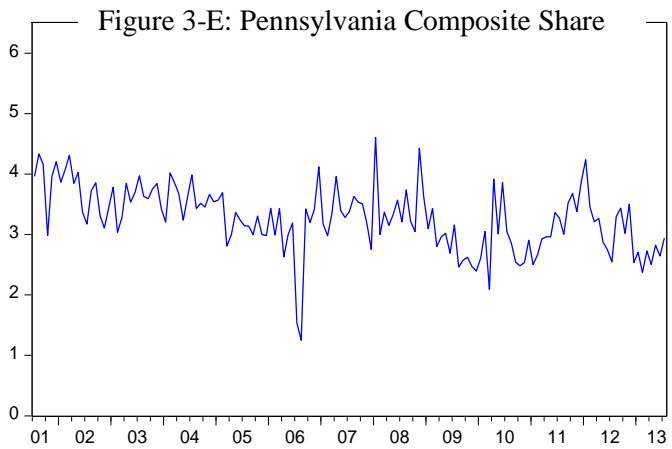
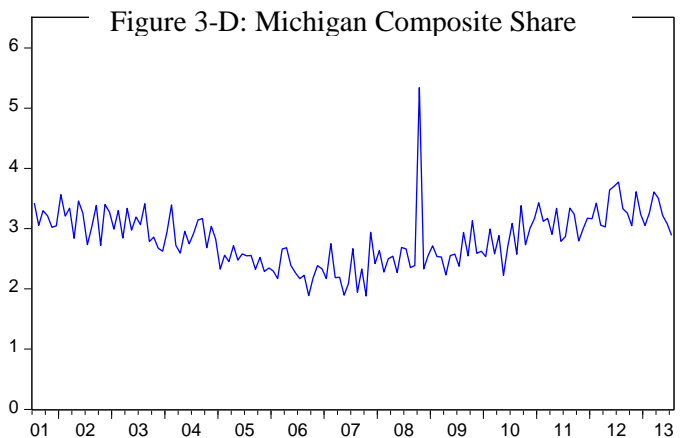
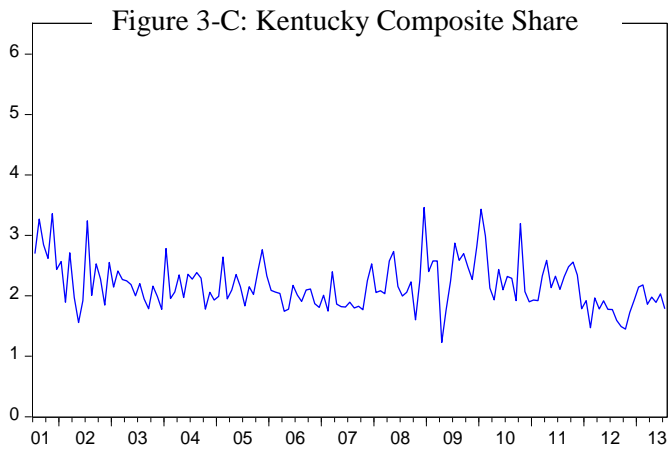
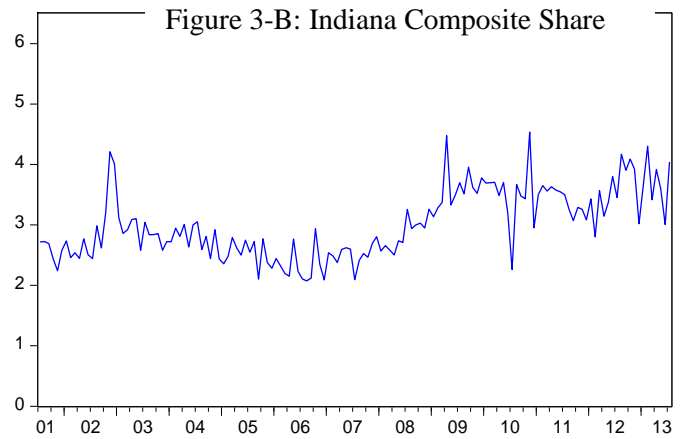
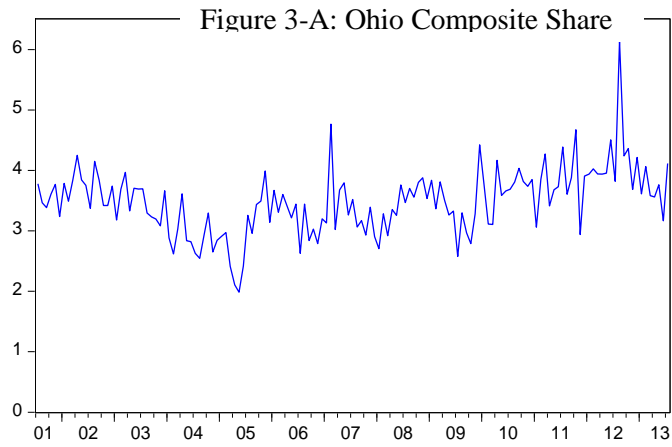
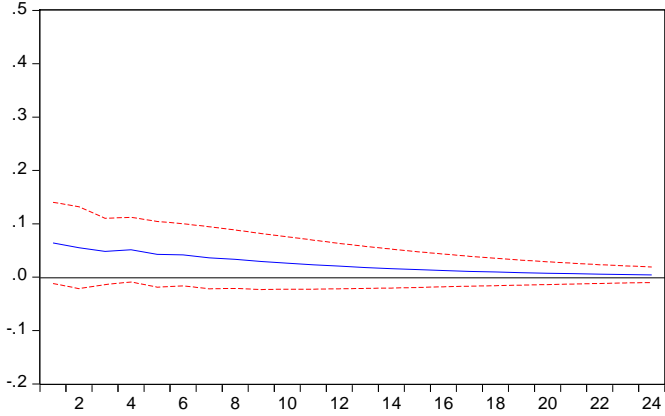
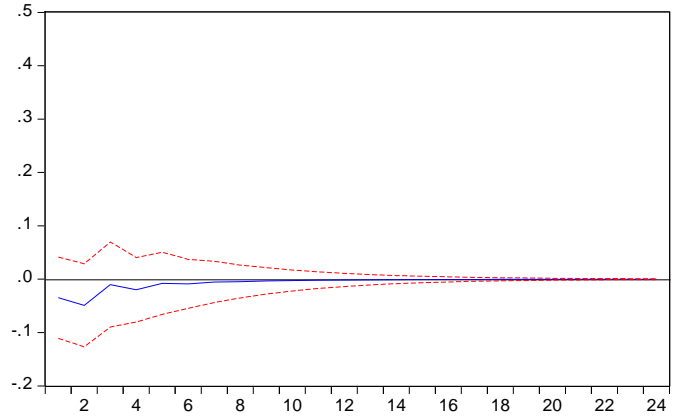


FIGURE 4: IMPULSE RESPONSES OF THE OHIO COMPOSITE SHARE

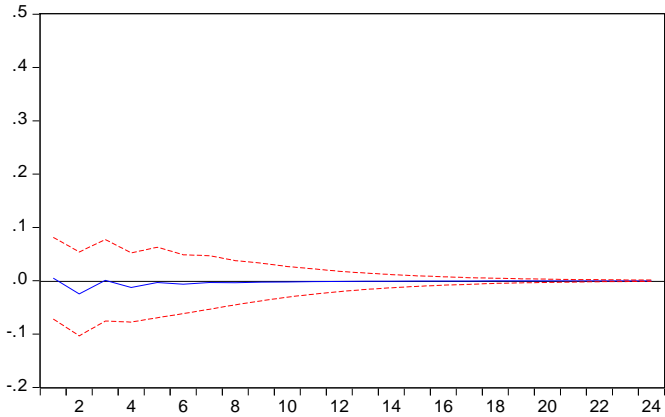
Response of Ohio Share to Cholesky
One S.D. Indiana Share Innovation



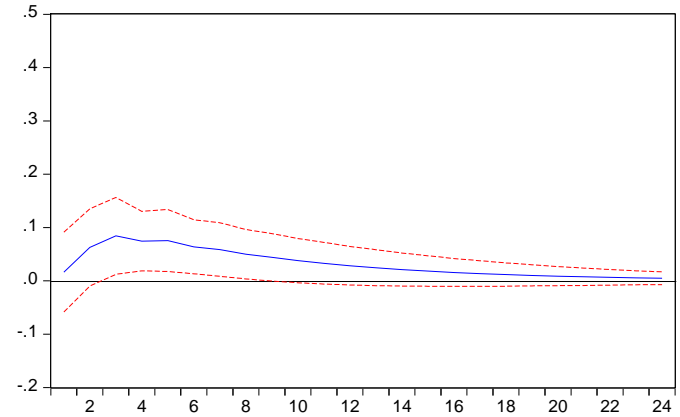
Response of Ohio Share to Cholesky
One S.D. Kentucky Share Innovation



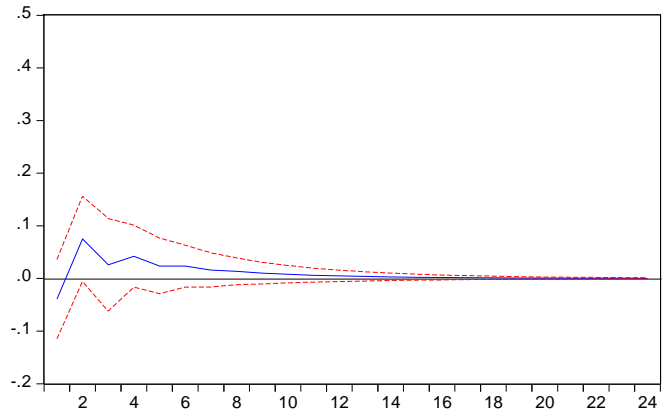
Response of Ohio Share to Cholesky
One S.D. Pennsylvania Share Innovation



Response of Ohio Share to Cholesky
One S.D. Michigan Share Innovation



Response of Ohio Share to Cholesky
One S.D. West Virginia Share Innovation



Response of Ohio Share to Cholesky
One S.D. Ohio Share Innovation

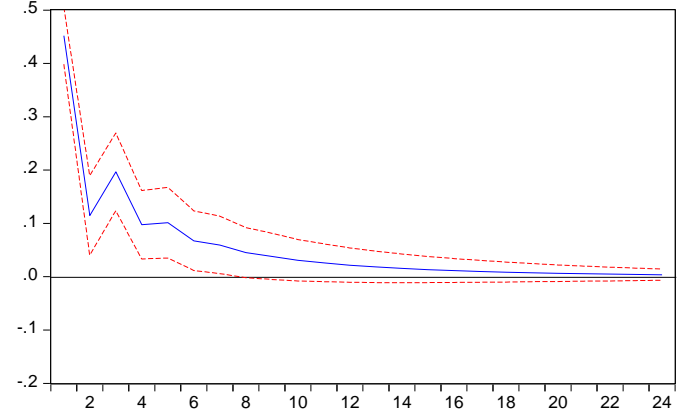


FIGURE 5: IMPULSE RESPONSES OF THE COMPOSITE SHARES OF OHIO NEIGHBORING STATES

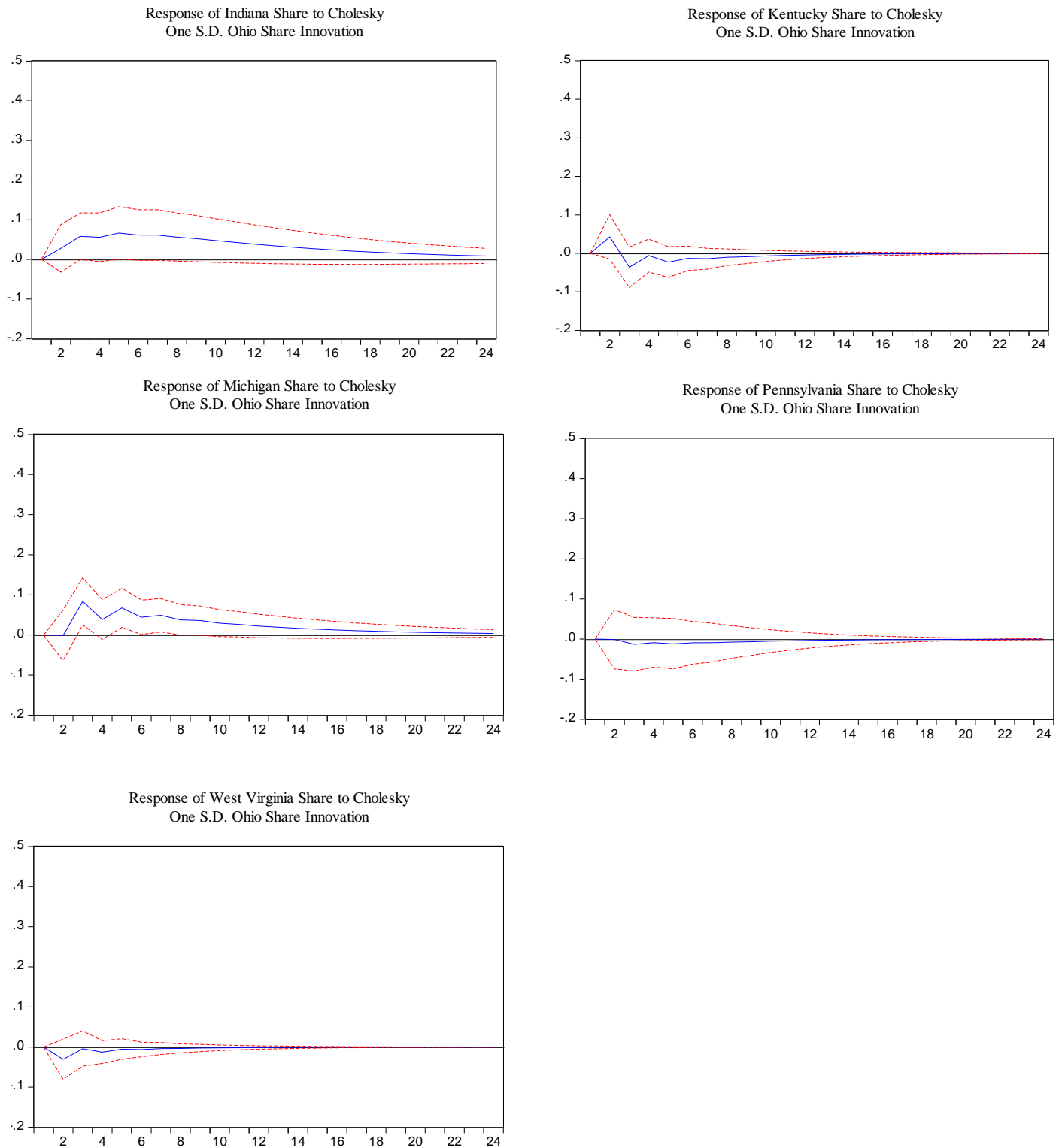
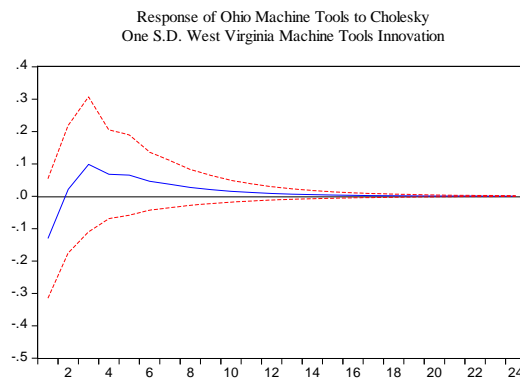
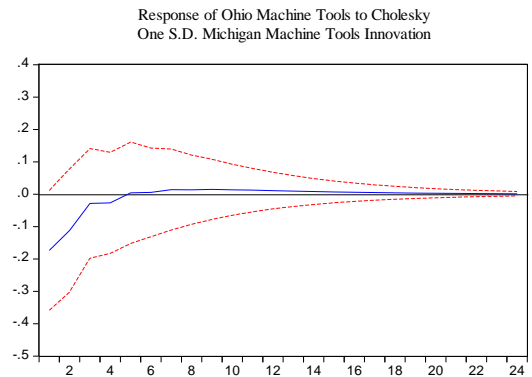
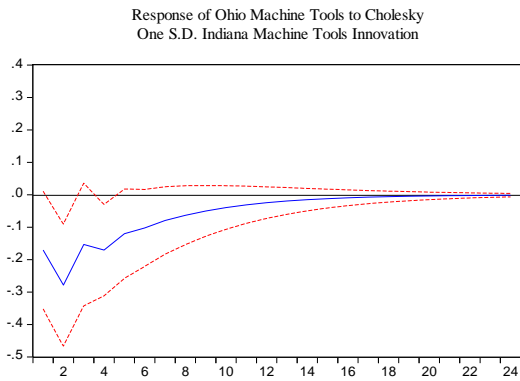
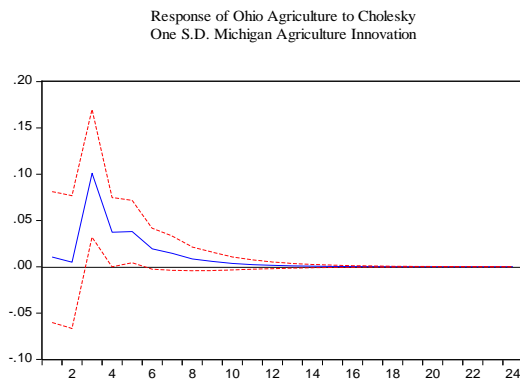
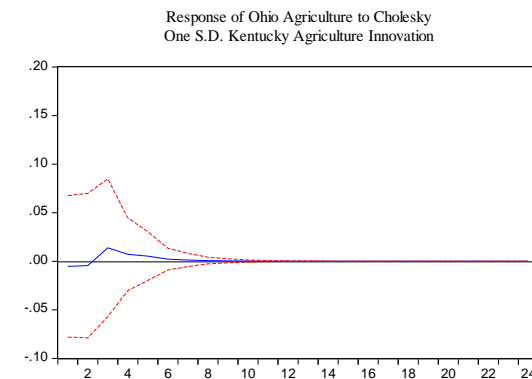
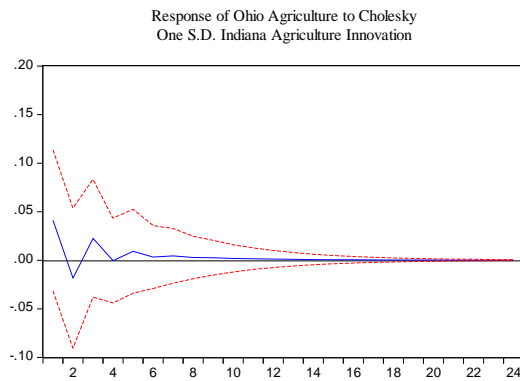


FIGURE 6: IMPULSE RESPONSES OF OHIO DISAGGREGATED SHARES

MACHINE TOOLS



AGRICULTURE



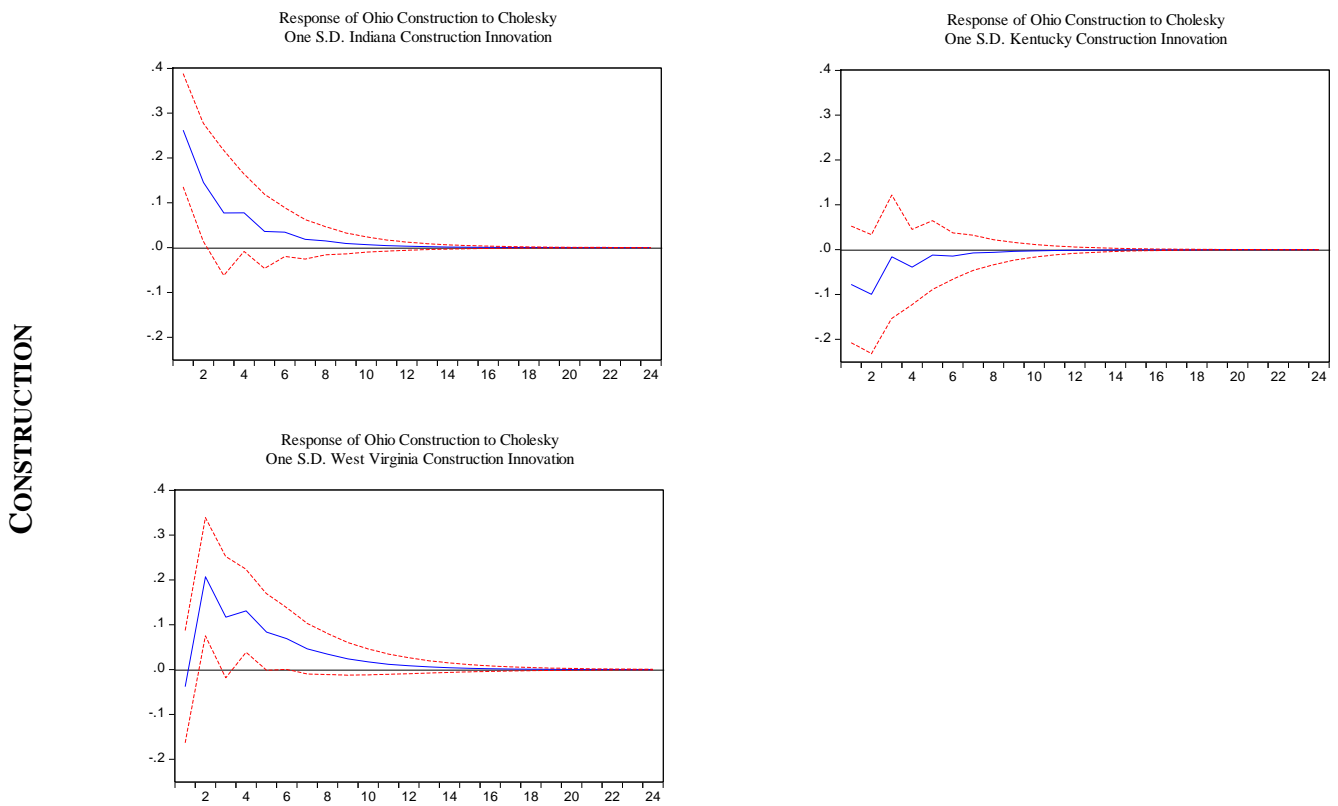
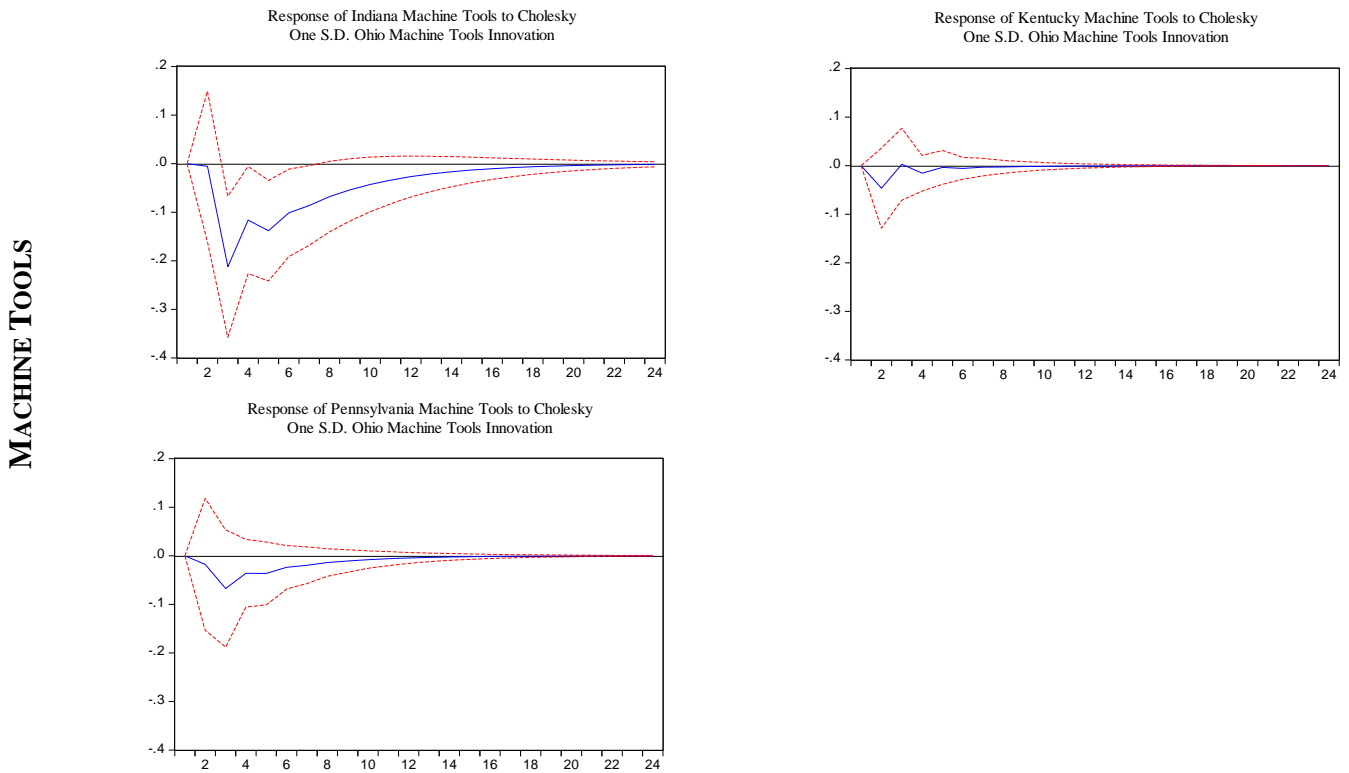
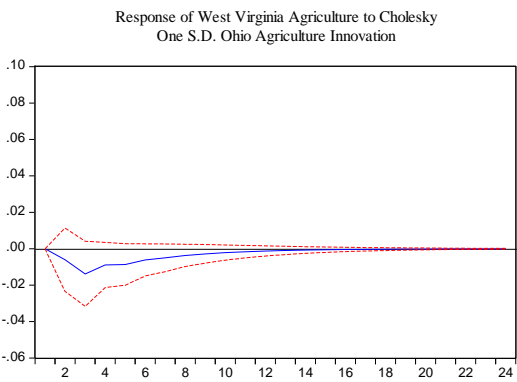
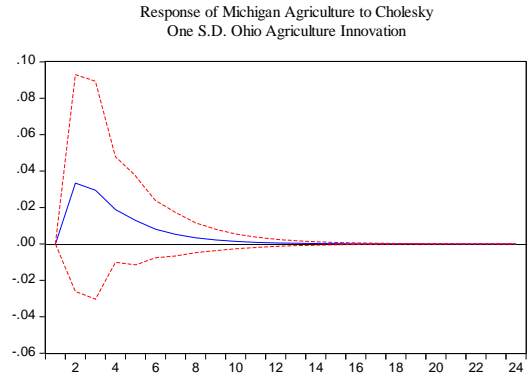
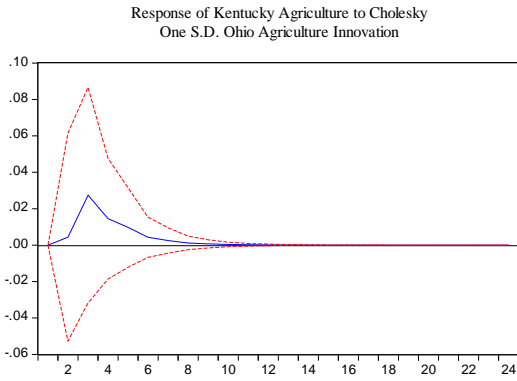


FIGURE 7: IMPULSE RESPONSES OF THE DISAGGREGATED SHARES OF OHIO NEIGHBORING STATES



AGRICULTURE



CONSTRUCTION

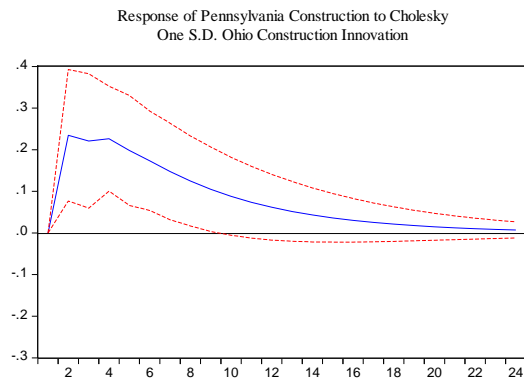
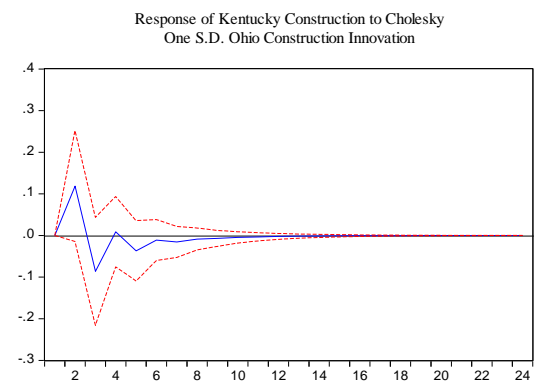
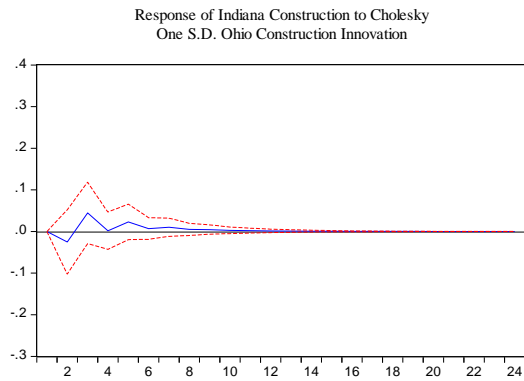


Illustration 1



RECEIVED - TENDERED FOR FILING
 TENNESSEE SECRETARY OF STATE
 02/06/12 01:43 PM
 212-006321

UCC FINANCING STATEMENT

FOLLOW INSTRUCTIONS (front and back) CAREFULLY

A. NAME & PHONE OF CONTACT AT FILER [optional]
 CHARLES HOWES CFO

B. SEND ACKNOWLEDGMENT TO: (Name and Address)

CHARLES HOWES CFO
 ALLIED INDUSTRIAL EQUIPMENT
 978E DIELMAN'S INDUSTRIAL DRING
 ST LOUIS MO 63122

THE ABOVE SPACE IS FOR FILING OFFICE USE ONLY

1. DEBTOR'S EXACT FULL LEGAL NAME - Insert only one debtor name (1a or 1b) - do not abbreviate or combine names

1a. ORGANIZATION'S NAME
 OZBURN HESSEY LOGISTICS LLC

OR

1b. INDIVIDUAL'S LAST NAME FIRST NAME MIDDLE NAME SUFFIX

1c. MAILING ADDRESS CITY STATE POSTAL CODE COUNTRY
 7101 EXECUTIVE CENTER STE 333 SPENTWOOD TN 37227

1d. TAX ID #: SSN OR EIN ADDL INFO RE ORGANIZATION DEBTOR 1e. TYPE OF ORGANIZATION 1f. JURISDICTION OF ORGANIZATION 1g. ORGANIZATIONAL ID #, if any
 LLC TN NONE

2. ADDITIONAL DEBTOR'S EXACT FULL LEGAL NAME - Insert only one debtor name (2a or 2b) - do not abbreviate or combine names

2a. ORGANIZATION'S NAME

OR

2b. INDIVIDUAL'S LAST NAME FIRST NAME MIDDLE NAME SUFFIX

2c. MAILING ADDRESS CITY STATE POSTAL CODE COUNTRY

2d. TAX ID #: SSN OR EIN ADDL INFO RE ORGANIZATION DEBTOR 2e. TYPE OF ORGANIZATION 2f. JURISDICTION OF ORGANIZATION 2g. ORGANIZATIONAL ID #, if any
 NONE

3. SECURED PARTY'S NAME (or NAME OF TOTAL ASSIGNEE OF ASSIGNOR S/P) - Insert only one secured party name (3a or 3b)

3a. ORGANIZATION'S NAME
 ALLIED INDUSTRIAL EQUIPMENT

OR

3b. INDIVIDUAL'S LAST NAME FIRST NAME MIDDLE NAME SUFFIX

3c. MAILING ADDRESS CITY STATE POSTAL CODE COUNTRY
 978E DIELMAN INDUSTRIAL DR. ST. LOUIS MO 63122

4. THIS FINANCING STATEMENT covers the following collateral:

CROWN STAND UP RIDER MODEL R05220-30 SERIAL# 1A267411
 CROWN STAND UP RIDER MODEL R05220-30 SERIAL# 1A267410
 26 V BATTERY SERIAL# 33745N
 EX10E BATTERY SERIAL# UH3024L
 OEX14 BATTERY SERIAL# 4914AR
 EMB BATTERY SERIAL# 00N02425
 DOOSAN LIFT TRUCK MODEL G230P-SLP SERIAL# FE A05-1290-00011
 DOOSAN LIFT TRUCK MODEL G230P-SLP SERIAL# FE A05-1290-00012

Maximum principal indebtedness for Tennessee recording tax purposes is \$ - 0 -

5. ALTERNATIVE DESIGNATION (if applicable) LESSEE/LESSOR CONSIGNEE/CONSIGNOR BAILEE/BAILOR SELLER/BUYER AG. LIEN NON-UCC FILING

6. This FINANCING STATEMENT is to be filed (for record) (or recorded) in the REAL ESTATE RECORDS. Attach Address 7. Check to REQUEST SEARCH REPORT(S) on Debtor(s) (OPTIONAL) ALL Debtors Debtor 1 Debtor 2

8. OPTIONAL FILER REFERENCE DATA

Illustration 2



File Number: 120306456934
Date Filed: 3/6/2012 8:31:36 AM
Robin Carnahan
Secretary of State

UCC FINANCING STATEMENT

FOLLOW INSTRUCTIONS (front and back) CAREFULLY

A. NAME & PHONE OF CONTACT AT FILER [optional]
Sandra McMullin 159(660) 826-3297

B. SEND ACKNOWLEDGMENT TO: (Name and Address)
Third National Bank
PO Box 351
301 West Broadway
Sedalia, 65302-0351

THE ABOVE SPACE IS FOR FILING OFFICE USE ONLY

1. DEBTOR'S EXACT FULL LEGAL NAME - insert only one debtor name (1a or 1b) - do not abbreviate or combine names

1a. ORGANIZATION'S NAME

OR

1b. INDIVIDUAL'S LAST NAME SEGAR	FIRST NAME RENITA	MIDDLE NAME J	SUFFIX	
1c. MAILING ADDRESS 38097 HWY 65	CITY WARSAW	STATE MO	POSTAL CODE 65355-5462	COUNTRY USA
1d. SEE INSTRUCTIONS	ADD'L INFO RE ORGANIZATION DEBTOR	1e. TYPE OF ORGANIZATION	1f. JURISDICTION OF ORGANIZATION	1g. ORGANIZATIONAL ID #, if any <input type="checkbox"/> NONE

2. ADDITIONAL DEBTOR'S EXACT FULL LEGAL NAME - insert only one debtor name (2a or 2b) - do not abbreviate or combine names

2a. ORGANIZATION'S NAME

OR

2b. INDIVIDUAL'S LAST NAME SEGAR	FIRST NAME WILBUR	MIDDLE NAME	SUFFIX	
2c. MAILING ADDRESS 38097 HWY 65	CITY WARSAW	STATE MO	POSTAL CODE 65355-5462	COUNTRY USA
2d. SEE INSTRUCTIONS	ADD'L INFO RE ORGANIZATION DEBTOR	2e. TYPE OF ORGANIZATION	2f. JURISDICTION OF ORGANIZATION	2g. ORGANIZATIONAL ID #, if any <input type="checkbox"/> NONE

3. SECURED PARTY'S NAME (or Name of TOTAL ASSIGNEE of ASSIGNOR S/P) - insert only one secured party name (3a or 3b)

3a. ORGANIZATION'S NAME
THIRD NATIONAL BANK

OR

3b. INDIVIDUAL'S LAST NAME	FIRST NAME	MIDDLE NAME	SUFFIX	
3c. MAILING ADDRESS PO BOX 351	CITY SEDALIA	STATE MO	POSTAL CODE 65302-0351	COUNTRY USA

4. This FINANCING STATEMENT covers the following collateral:

Purchase Money Security Interest In a 773 Bobcat Skidsteer S/N 509636117

5. ALTERNATIVE DESIGNATION (if applicable): LESSEE/LESSOR CONSIGNEE/CONSIGNOR BAILEE/BAILOR SELLER/BUYER AG. LIEN NON-UCC FILING

6. This FINANCING STATEMENT is to be filed [for record] (or recorded) in the REAL ESTATE RECORDS. Attach Addendum [if applicable]

8. OPTIONAL FILER REFERENCE DATA

International Association of Commercial Administrators (IACA)

FILING OFFICE COPY - UCC FINANCING STATEMENT (FORM UCC1) (REV. 05/22/02)

TABLE 1: GRANGER CAUSALITY TEST ON CAPITAL COMPOSITE SHARES

<i>Null Hypothesis</i>	<i>F-Statistic</i>	<i>Prob.</i>
IN does not Granger Cause OH	0.79341	0.4544
OH does not Granger Cause IN	2.02104	0.1364
KY does not Granger Cause OH	0.65165	0.5228
OH does not Granger Cause KY	2.48037	0.0874
MI does not Granger Cause OH	3.73382	0.0263
OH does not Granger Cause MI	4.22695	0.0165
PA does not Granger Cause OH	0.24247	0.785
OH does not Granger Cause PA	0.07631	0.9266
WV does not Granger Cause OH	2.59378	0.0784
OH does not Granger Cause WV	0.75906	0.4701

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