The Navigation Economic Technologies Program

July 1, 2004

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A Study of Short-Run Movements in Grain on the Inland Waterway System

(Revised)

US Army Corps of Engineers®

IWR Report 04-NETS-P-01

Navigation Economic Technologies

The purpose of the Navigation Economic Technologies (NETS) research program is to develop a standardized and defensible suite of economic tools for navigation improvement evaluation. NETS addresses specific navigation economic evaluation and modeling issues that have been raised inside and outside the Corps and is responsive to our commitment to develop and use peer-reviewed tools, techniques and procedures as expressed in the Civil Works strategic plan. The new tools and techniques developed by the NETS research program are to be based on 1) reviews of economic theory, 2) current practices across the Corps (and elsewhere), 3) data needs and availability, and 4) peer recommendations.

The NETS research program has two focus points: expansion of the body of knowledge about the economics underlying uses of the waterways; and creation of a toolbox of practical planning models, methods and techniques that can be applied to a variety of situations.

Expanding the Body of Knowledge

NETS will strive to expand the available body of knowledge about core concepts underlying navigation economic models through the development of scientific papers and reports. For example, NETS will explore how the economic benefits of building new navigation projects are affected by market conditions and/or changes in shipper behaviors, particularly decisions to switch to non-water modes of transportation. The results of such studies will help Corps planners determine whether their economic models are based on realistic premises.

Creating a Planning Toolbox

The NETS research program will develop a series of practical tools and techniques that can be used by Corps navigation planners. The centerpiece of these efforts will be a suite of simulation models. The suite will include models for forecasting international and domestic traffic flows and how they may change with project improvements. It will also include a regional traffic routing model that identifies the annual quantities from each origin and the routes used to satisfy the forecasted demand at each destination. Finally, the suite will include a microscopic event model that generates and routes individual shipments through a system from commodity origin to destination to evaluate non-structural and reliability based measures.

This suite of economic models will enable Corps planners across the country to develop consistent, accurate, useful and comparable analyses regarding the likely impact of changes to navigation infrastructure or systems.

NETS research has been accomplished by a team of academicians, contractors and Corps employees in consultation with other Federal agencies, including the US DOT and USDA; and the Corps Planning Centers of Expertise for Inland and Deep Draft Navigation.

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The NETS program was overseen by Mr. Robert Pietrowsky, Director of the Institute for Water Resources.

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by

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and
Wesley W. Wilson****

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ABSTRACT

A Study of Short-Run Movements in Grain on the Inland Waterway System
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This paper uses time-series techniques, in particular impulse response functions and variance decompositions, to characterize the short-run relationships among seventeen variables in a VAR model designed to trace the short-run interconnections among variables impacting lockages on the Mississippi and Illinois rivers. The model contains five categories of variables, lockages, barge rates, grain bids, rail rates, and rail deliveries. Variance decompositions are constructed which identify barge rates as the most important variable affecting lockages at both short and long horizons. Barge rates are, in turn, explained largely by lockages and rail rates, indicating two-way feedback or bi-directional causality between lockages and barge rates. Impulse response functions are also examined. The variance decompositions indicate that barge rates are important in explaining lockages and the impulse response functions show how lockages and other variables respond to such shocks. In general, there is a substitution away from barge transportation and towards rail transportation when barge rates increase. The results in this paper are useful for illuminating the causal relationships among variables in the model and for understanding behavioral relationships present in the data, and can be used to guide short-run and long-run planning models. For example, many planning models assume that barge traffic does not respond significantly to changes in barge rates, but the results obtained here imply that barge traffic and rail deliveries do respond to such changes. This is a potentially important implication that illustrates the usefulness of the time-series techniques employed in this paper.

1. INTRODUCTION

Forecasts of river traffic over long time horizons play a key role in determining the potential benefits of projects to increase the volume of traffic over time. These forecasts are essential components of infrastructure planning models as they provide information on the costs and benefits of potential projects. Forecasts of river traffic over shorter time horizons are also very useful. These forecasts can be used to manage river traffic within the infrastructure currently in place. In addition, models used to produce the short-run forecasts are helpful in understanding factors that affect short-run river traffic. Understanding the effect that changes in grain prices, barge rates, rail rates, rail deliveries, ocean freight rates, and so on have on river traffic is an essential step towards the design of policies to enhance the efficient use of river resources.

Most previous attempts to forecast river traffic rely upon structural modeling in one guise or another.[1] These models often forecast future demand for river transportation from forecasts of the demand for products that use river transportation such as grains and industrial products.[2] Forecasting the demand for these products requires forecasts for each of the determinants of demand for each of the products that is transported on the river. This is a large and complicated task that often requires questionable simplifying assumptions, a task that is further complicated by lack of available data on each of the many influences on the demand for each of the products transported on the river. Such models often impose assumptions on the data, explicitly or implicitly, with little theoretical support or based upon theory that has not been thoroughly investigated econometrically. This study proposes an alternative approach that avoids structural modeling of complicated real-world behavioral relationships, an approach common in the time-series econometrics literature.

Economists commonly use time-series techniques to understand and forecast variables of interest. These models are used for forecast horizons that extend far into the future and for shorter horizons, as short as days or even minutes in the financial literature. Such techniques often rely upon vector autoregressive (VAR) models. These models are interpreted as general reduced form structural models. The genesis of VAR models[3] arises from the idea that the identification restrictions present in most structural econometric models are arbitrary and not supported by underlying theoretical models. If the identification restrictions used to estimate structural econometric models are suspect, then it is not surprising that these models do not produce reliable multi-step ahead forecasts. An alternative is to rely on a different identification scheme and forego the troublesome identification restrictions present in structural econometric models.

This led researchers to consider VAR models as an alternative to structural modeling. Under the VAR approach, a very general reduced form is posited which allows each endogenous variable to depend upon every other endogenous variable in the

[1] Structural econometric models have as their basic building blocks behavioral equations, equilibrium conditions, and accounting identities derived from theoretical models. This results in restricted models, with the restrictions often in the form of the exclusion of some variables from some equations. Identification restrictions often result in further exclusions, often without theoretical support. Non-structural models do not impose any exclusion restrictions upon the data, instead, they generally rely upon restrictions on contemporaneous causal relationships or assume zero long-run effects of particular types of shocks.

[2] Two examples are Baumel (2000) and Sparks Companies Inc. (2002).

[3] A seminal article in this area is Sims (1980).

model as well as any exogenous variables.[4] Estimation of VAR models allows the data to impose restrictions as required to achieve the best fit. Forecasts of the endogenous variables can then be derived from the estimated VAR models, and simulation of shocks to produce impulse response functions and variance decompositions can be used to understand how the data in the model are interrelated.

The following section presents a seventeen variable VAR model involving lockages on the Illinois and Mississippi rivers, barge rates on these two rivers, the bid price for grains at export points, rail rates for grains to export points, and rail deliveries of grain to these regions. The model is used to produce impulse response functions and variance decompositions. These show how variables of interest in the model respond to unexpected changes in other variables in the model, and how important each type of shock is in explaining variability in the variables in the model.

2. DATA AND ECONOMETRIC MODEL

The preliminary VAR model and associated impulse response functions and variance decompositions are constructed as follows.

First, data on river traffic through each lock and prices of commodities from various geographic regions are obtained from the Lock Performance Monitoring System (LPMS) as reported in the USDA's *Grain Transportation Report*. Commodity price and other data are also in the USDA's *Grain Transportation Report* which is available from September of 1997 onward. From these sources, the data shown in Table 1 are collected weekly from the first week of 1999 through the 20^{th} week (the last week of May) of 2003, the last period for which a consistent set of data are available.

There are five categories of variables in the model, lockages, barge rates, grain bids, grain rail rates, and rail deliveries.[5] These data, in customary log form, are used to estimate a seventeen variable, one lag VAR model.[6] The order of the variables in the VAR model is the same as in the table,[7] and weekly dummies are added as deterministic variables to capture any seasonal effects over the year. In addition, a dummy for lockages at Mississippi lock #15 is constructed that is equal to one when the lock is open, and zero in the weeks it is closed and the value of lockages is zero.[8] For example, the first equation of the VAR model is Total Lockages on the Illinois at Lock #8 regressed upon a constant, the weekly dummies, the Mississippi lock #15 dummy, and one lag of

[4] Thus, there are no exclusion restrictions as would exist under the structural approach.
[5] Data on ocean freight rates for grain are currently being collected and, provided data exists for the time period examined, these data will be added to the model.
[6] One lag is sufficient to remove evidence of serial correlation in the equations constituting the VAR model. This does not, however, necessarily imply that the effects of shocks are short-lived. That depends upon the magnitude of the coefficients on the lag terms more than it does on the number of terms.
[7] The orthogonolization of the shocks in the model is performed in the usual manner using the Choleski decomposition. With this decomposition, the variables least likely to be affected by contemporaneous shocks to other variables are first in the ordering and those variables most likely to be affected contemporaneously are placed last.
[8] An alternative approach where the time periods where the lock was closed are eliminated from the data does not change the results discussed below. In addition, dropping Mississippi lock 15 from the data set altogether so that only lock 27 on the Mississippi and lock 8 on the Illinois are in the data set produces very similar results. Thus, the results appear robust to how the time periods when lock 15 are closed are treated econometrically.

each of the seventeen variables listed in the table.[9] The second equation is Total Lockages on the Mississippi at Lock #15 regressed upon the same set on independent variables, a constant, the weekly dummies, the Mississippi lock 15 dummy, and one lag of each of the seventeen variables in the model, and so on, until the last equation which has Rail Deliveries to the Pacific as the left-hand side variable.

The model is estimated using the data described above and the estimated model is used to produce impulse response functions (IRFs) and variance decompositions (VDCs). The IRFs show the impact that an unanticipated shock to one variable has on the time path followed by another. For example, an IRF can plot the effect that a change in the barge rate between two points has on the amount of traffic through a particular lock as well as other locks. Because a shock to any one variable can affect all other variables, there are (17)(17)=289 impulse responses. Thus, this discussion will focus on a subset of the responses.[10] The VDCs complement the IRFs. The IRFs show the pattern over time of the response of one variable brought about by a shock to another variable. The VDCs assess the importance of the shock in explaining the variance of the responding variable at each point in time. Thus, the IRFs give the sign and the pattern of the response while the VDCs assess the importance of the shock in explaining the variability of a particular variable at each point in time after the shock occurs. The VDCs are also voluminous, so as with the IRFs, only a representative subset is presented.

3. IMPULSE RESPONSE FUNCTIONS

There are five categories of variables in the model, lockages, barge rates, grain bids, grain rail rates, and rail deliveries. As just noted, because the complete set of results is too voluminous to present in its entirety, representative examples from each category are shown. First, IRFs for shocks to prices (barge rates, grain bids, and rail rates) will be presented and discussed followed by the IRFs for shocks to quantities (lockages and rail deliveries).

A. Shocks to Barge Rates

The first example examines impulse responses to a shock to barge rates. The particular example is a shock to the barge rate for the Lower Ohio. The four graphs in Figure 1 show the responses of lockages at lock #8 on the Illinois River, lock #15 on the Mississippi, rail deliveries to Mississippi, and rail deliveries to the Pacific to a shock to the barge rate on the Lower Ohio. The graphs show that an increase in the barge rate of approximately 4%[11] generates around a 3% decline in lockages on the Illinois at lock #8, a 3% decline in lockages on the Mississippi at lock #15, a 5% increase in Mississippi rail deliveries, and around a 2.5% increase in rail deliveries to the Pacific. Though not shown

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[9] The variables are Total Lockages on the Illinois at Lock #8, Total Lockages on the Mississippi at Lock #15, Total Lockages on the Mississippi at Lock #27, Barge Rates for the Mid-Mississippi (Percent of Tariff from Davenport IA), Barge Rates for the Illinois (Percent of Tariff for the Illinois River, Peoria, IL), Barge Rates for St. Louis-Cairo (Percent of Tariff from St. Louis) , Barge Rates for Lower Ohio (Percent of Tariff from Lower Ohio) , Barge Rates for Cairo-Memphis (Percent of Tariff from Cairo) , The Bid Price for Portland HRW, The Bid Price for Gulf HRW, The Bid Price for Gulf SRW, The Bid Price for LA Corn, The Tariff Rail Rate for Wheat from Kansas City to Houston, The Tariff Rail Rate for Wheat from Kansas City to Portland, Rail Deliveries to Texas, Rail Deliveries to Mississippi, and Rail Deliveries to the Pacific.

[10] The entire set of responses is available in an appendix that can be obtained from the authors.

[11] The size of the shock in all cases is, as usual, one standard deviation.

in the figure, the complete results show that grain prices and rail rates show little response to the shock to the barge rate. The duration of the responses is approximately two to three weeks except for lockages at lock #15 on the Mississippi where the response is more drawn out.

These results suggest that an increase in the Lower Ohio barge rate causes a substitution away from river transportation towards rail transportation.[12]

B. Shocks to Grain Bids

The second example shows the response to a shock to grain bids. In particular, Figure 2 presents the response of lockages and rail deliveries to a shock to the Portland HRW price of approximately 2%. The figure shows that the response of lockages at Illinois lock #8 is positive and approximately 2.5%, while the response of lockages at Mississippi lock #15 is negative and of similar magnitude. The effects persist for a number of weeks. In addition, the IRF for Mississippi lock #27 (not shown in the figure) shows that lockages at lock #27 respond insignificantly to this shock. Turning to rail deliveries, the increase in the bid price of HRW in Portland causes around a 4% decline in rail deliveries to Texas. Rail deliveries to the Pacific initially decline, then, after around three weeks there is a large and sustained increase in deliveries to the Pacific. The complete results show a large decline in rail deliveries to Mississippi as well. Also, the complete results show that rail rates exhibit little response to the change in grain bids and that barge rates generally increase.

C. Shocks to Tariff Rail Rates

Figure 3 shows how lockages and rail deliveries respond to an increase in the Kansas City to Houston rail rate for wheat. The figures show that a positive shock of approximately .5% to the tariff rail rate for wheat per ton causes nearly a 2% decline in lockages on the Illinois lock #8, and around a 3% increase at lock #15 on the Mississippi. The detailed results show that lockages at Mississippi #27 also increase, but not as much. In the case of the Illinois response at lock #8, the negative response is delayed by two weeks, but the response is persistent once the effects begin. The response of lockages at lock #15 also persists for many weeks. Rail deliveries to Texas generally decline, both immediately and over a longer time period. The pattern of the response is an immediate drop of nearly 2.5%, a return to zero after about six weeks, and then a sustained fall. Rail deliveries the Pacific move in the opposite direction, increasing immediately with the positive effect sustained for many weeks.

Piecing it all together, an increase in the rail rate from Kansas City to Houston causes a substitution towards Mississippi lock #15 and towards rail deliveries to the Pacific, and away from Illinois lock #8 and rail deliveries to Texas.

D. Shocks to Total Lockages

Figure 4 shows how lockages at Illinois lock #8, Mississippi lock #27, and rail deliveries to Texas and the Pacific change in response to around a 25% increase in

[12] The IRF for Texas rail deliveries in the appendix available from the authors shows an interesting pattern for the response. In the first week after the shock, there is a large decline in Texas rail deliveries, but in the second week and for many weeks thereafter, Texas rail deliveries increase.

lockages on the Mississippi at lock #15.[13] The figures show nearly a 3% drop in lockages at Illinois lock #8 and a quick return to pre-shock levels, a 5% increase in lockages at Mississippi lock #27, an effect that peaks in the second week and, though the effect is somewhat persistent, the peak tapers substantially after around four weeks. Rail deliveries to Texas increase 5%, and rail deliveries to the Pacific increase almost 4%. The pattern of rail deliveries to the Pacific shows an initial strong response in the first week, a decline back to zero or negative values, then a sustained increase. Thus, it appears that the increase in traffic on the river causes a substitution towards rail deliveries.

E. Shocks to Rail Deliveries

The final example is a shock to rail deliveries, in particular a shock of approximately 14% to rail deliveries to the Pacific. The figures show a muted response of lockages at Illinois lock #8 which, after a delay of three weeks, falls slightly then returns to pre-shock levels. The response at Mississippi lock #15 is much stronger with an initial decline of around 4% followed by a slow return to pre-shock levels. As for rail deliveries, rail deliveries to Mississippi rise by about 5% after a delay of two weeks and Texas rail deliveries decline by around 2% after a two week delay then quickly return to pre-shock levels.

4. VARIANCE DECOMPOSITIONS

Impulse response functions document how variables in the model respond over time to their own shocks and to shocks to other variables. However, impulse response functions do not tell us how important the shocks are in explaining variation in the variable under consideration. For example, the top half of Figure 1 shows how lockages respond to a shock to the Lower Ohio barge rate at various time horizons up to one year after the shock. But among all seventeen shocks identified in the VAR system, how important is this particular shock in explaining variation in lockages at these time horizons? Does a shock to the Lower Ohio barge rate cause more or less variation in lockages than, say, a shock to the Portland HRW bid price? Variance decompositions (VDCs) can be used to answer these and other questions.

A. Variance Decompositions for Lockages

Variance decompositions decompose the variance of a particular variable, say lockages at Illinois lock #8, at each forecast step (from one to fifty-two in the figures) into the fraction of the variance attributable to shocks to each of the seventeen variables in the model. The first two panels of Table 2 present variance decompositions for two of the three lockage variables, Mississippi lock #15 and Mississippi lock #27, at steps of 1, 2, 4, 8, 12, 20, 26, 40, and 52.[14] The VDCs have been accumulated by category of

[13] Because lock 15 closes in the winter, there is a large variance in lockages so that a one standard deviation shock is relatively large.

[14] Space does not permit listing the complete set of variance decompositions for all seventeen variables in the model. Only those VDCs that are noticeably different from others in the same category are presented. For example, the VDCs for Illinois Lock #8 and Mississippi Lock #27 are very similar, so only the

variable. For example, consider the entry of .12 under the heading Barge Rates for step 8 of the decomposition for Mississippi Lock #27. This indicates that 12% of the variance in lockages after 8 steps can be explained by the combined effect of shocks to barge rates, where the combined effect is the sum of the individual VDC entries for the five barge rate variables.

Several conclusions emerge from examination of the VDCs. First, the largest factor affecting the variance of lockages is shocks to lockages. This is the usual outcome for VDCs, i.e. that the largest fraction of the variability at all horizons is explained by a variables' own shocks. Second, setting aside the large fraction of the variance of lockages explained by shocks to lockages, the most important factor affecting variation in lockages in both the short-run and longer run is shocks to barge rates. For example, after 8 weeks the combined effect of shocks to barge rates explains 12% of the variation in lockages at Mississippi lock #15 and 9% of the variation of Mississippi lock #27.[15] Third, lockages at Mississippi lock #15 are more sensitive to shocks to rail rates and rail deliveries than are lockages at the other two locations examined. For instance, after 12 weeks, shocks to rail rates and rail deliveries explain 18% (9% each) of the variation in lockages at Mississippi lock #15, but only 6% of the variation at Illinois lock #8 and 6% of the variation at Mississippi lock #27.

The result that barge rates are an important factor in explaining lockages is noteworthy because river transportation planning models assume that lockages are invariant to changes in barge rates.

B. Variance Decompositions for Barge Rates

Since shocks to barge rates play a prominent role in explaining variation in lockages, it is worthwhile to examine the VDCs for barge rates to see which variables in the model have the most influence on variation in barge rates. The third panel of Table 2 presents VDCs for the St. Louis-Cairo barge rate. Results for the other four barge rates are very similar. In the short-run, lockages and rail rates play the largest role in explaining variation in barge rates, and together account for about 12% of the variation. As the time horizon increases, bid rates and rail rates begin to matter more with grain bid rates accounting for 16% of the variation and rail rates around 6%. In addition, shocks to lockages and rail rates continue to affect the variability of barge rates with their combined effect accounting for 13% of the variation at the 52 week horizon.

C. Variance Decompositions for Grain Bid Prices

Barge rates explain a large fraction of the variability in lockages and grain bids are an important factor in explaining barge rates, especially at longer horizons. Thus, VDCs for grain bids are examined next. The VDC for the Portland HRW Bid Price shown in Table 2, which is very similar to the VDCs for the other grain bids in the model, reveals that barge rates have the largest impact on the bid price in the short-run, 9% after one week and increasing to 23% after 4 weeks, and that lockages, which account for 9%

Mississippi Lock #27 results are shown. As with the IRFs, the complete set of VDCs can be obtained in a appendix available from the authors.

[15] For Illinois Lock #8, which is the detailed results but not in the table, the figure is 5%.

of the variation after four weeks, are the most influential variables. As the horizon is extended towards 52 weeks, these variables remain important and rail rates become increasingly important moving from 1% after two weeks to 31% after 52 weeks. At 52 weeks, all variables except rail deliveries exert a strong influence on variation in grain bids with barge rates and rail rates playing the largest role. Thus, over long time periods, transportation costs exert a large influence on grain bids, more so than in the short-run. However, even in the short-run the effect of transportation costs on grain bids is non-trivial. This is potentially significant because many models assume that bid prices are invariant to the types of shocks examined here.

D. Variance Decompositions for Rail Rates

The next to last panel in Table 2 shows the VDC for the Kansas City-Portland rail rate which is very similar to the VDC for the Kansas City-Houston rate. In the short-run, lockages play the largest role, explaining 14% at the one week horizon, followed by barge rates which explain 8%, and grain bids which explain 6%. Interestingly, there is no impact from variation in rail deliveries in the short-run. In the longer run, rail deliveries do play a role explaining 6% of the variation at 52 weeks, about the same as lockages which explain 7%. The largest fraction is explained by barge rates at 23% and grain bids at 17%. Thus, over long time periods, all variables in the model appear to affect rail rates with barge rates exerting the largest influence.

E. Variance Decompositions for Rail Deliveries

At the one week horizon, grain bids and rail rates have a large impact on variation in rail deliveries explaining 7% and 18% of the variation, a quarter of the total variation. As the horizon is extended the impact of these two variables on rail deliveries continues at about the same percentage, at 52 weeks grain bids explain 11% of the variation in rail deliveries and rail rates explain 19%. As the horizon is extended, barge rates increase in importance reaching 9% at the 52 week horizon. Thus, at 52 weeks, the most important variables are, in order by percentage explained, rail rates, grain bids, and barge rates. Lockages exert very little influence.

5. CONCLUSIONS

This paper uses time-series techniques, in particular impulse response functions and variance decompositions, to characterize the short-run relationships among seventeen variables in a VAR model designed to trace the short-run interconnections among variables impacting lockages on the Mississippi and Illinois rivers. The model contains five categories of variables, lockages, barge rates, grain bids, rail rates, and rail deliveries. Variance decompositions are constructed which identify barge rates as the most important variable affecting lockages at both short and long horizons. Barge rates are, in turn, explained largely by lockages and rail rates, indicating two-way feedback or bi-directional causality between lockages and barge rates.

In addition, impulse response functions are also examined. The variance decompositions indicate that barge rates are important in explaining lockages and the impulse response functions show how lockages and other variables respond to such shocks. In general, there is a substitution away from barge transportation and towards rail transportation when barge rates increase.

The results in this paper are useful for illuminating the causal relationships among variables in the model and for understanding the behavioral relationships present in the data, and can be used to guide short-run and long-run planning models. For example, many planning models assume that barge traffic does not respond significantly to changes in barge rates, but the result obtained here imply that barge traffic and rail deliveries do respond to such changes. This is a potentially important implication that illustrates the usefulness of the time-series techniques employed in this paper.

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4. Sparks Companies Inc., "Upper Mississippi River and Illinois Waterway Navigation Study," May 1, 2002.

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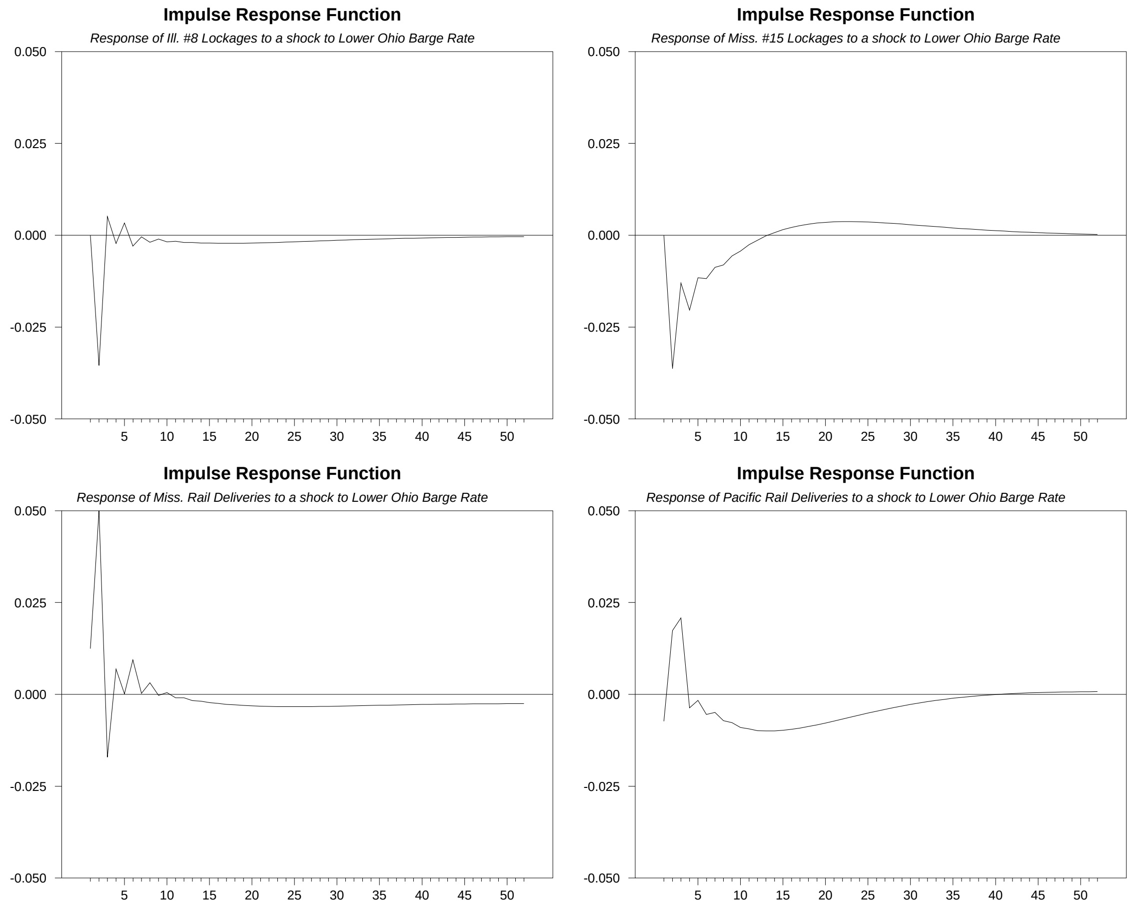

FIGURE 1 Responses of Lockages at Illinois #8, Mississippi #15, and Rail Deliveries to Mississippi and the Pacific to a Shock to the Lower Ohio Barge Rate

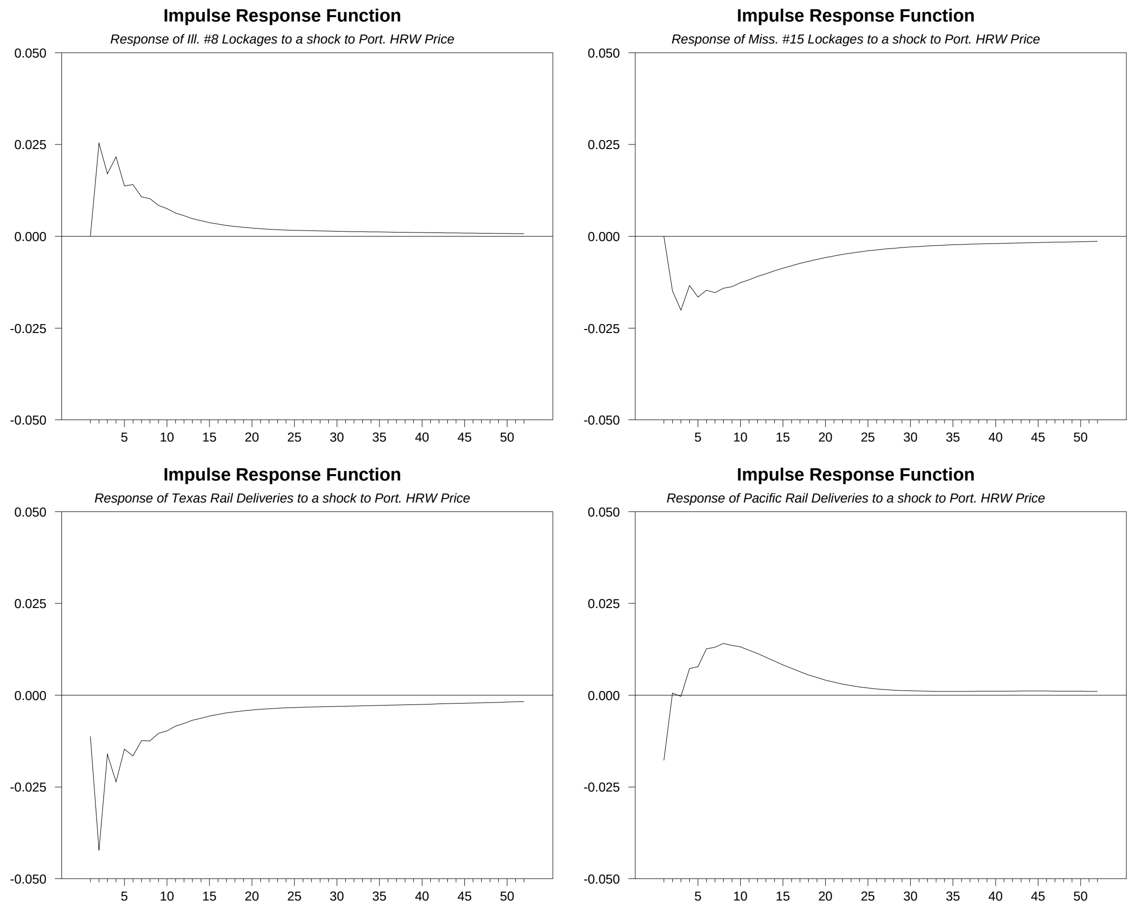

FIGURE 2 Responses of Lockages at Illinois #8, Mississippi #15, and Rail Deliveries to Texas and the Pacific to a Shock to the Portland HRW Price

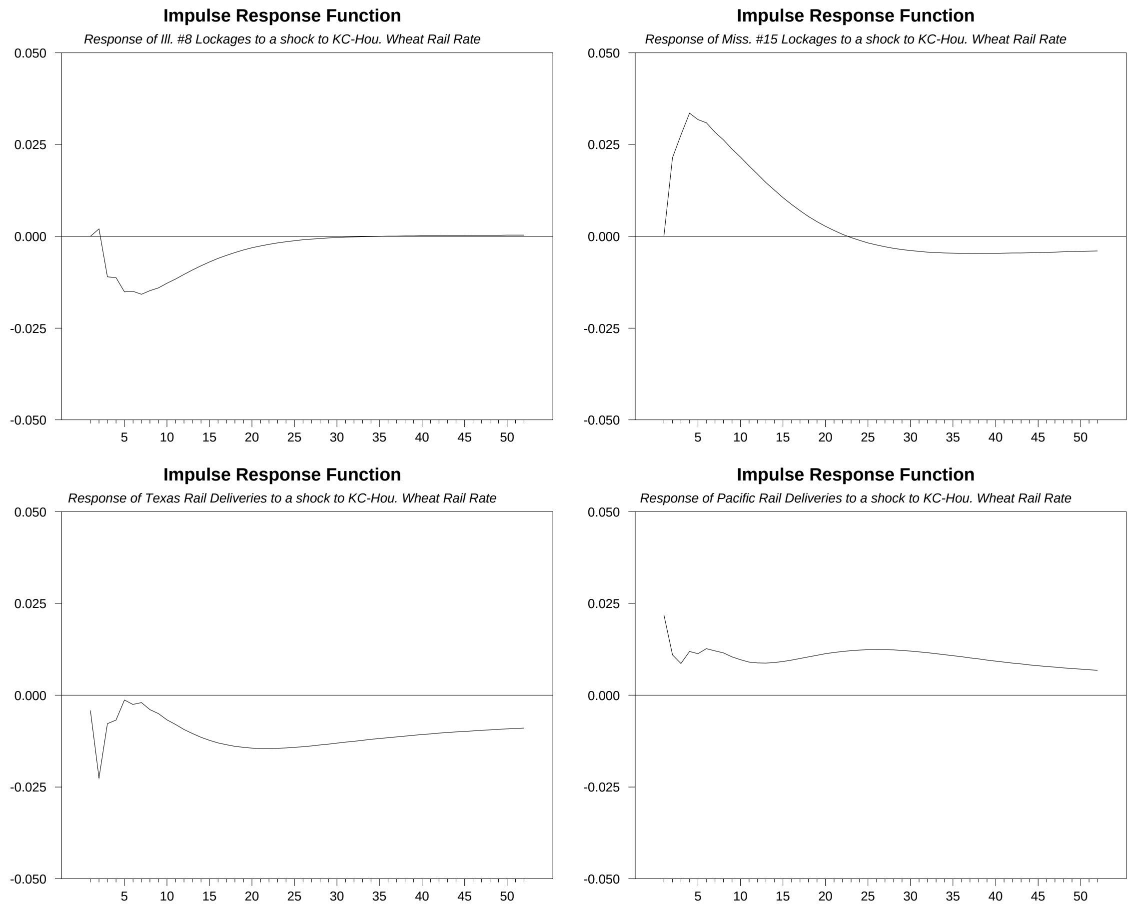

FIGURE 3 Responses of Lockages at Illinois #8, Mississippi #15, and Rail Deliveries to Texas and the Pacific to a Shock to the Kansas City-Houston Rail Rate for Wheat

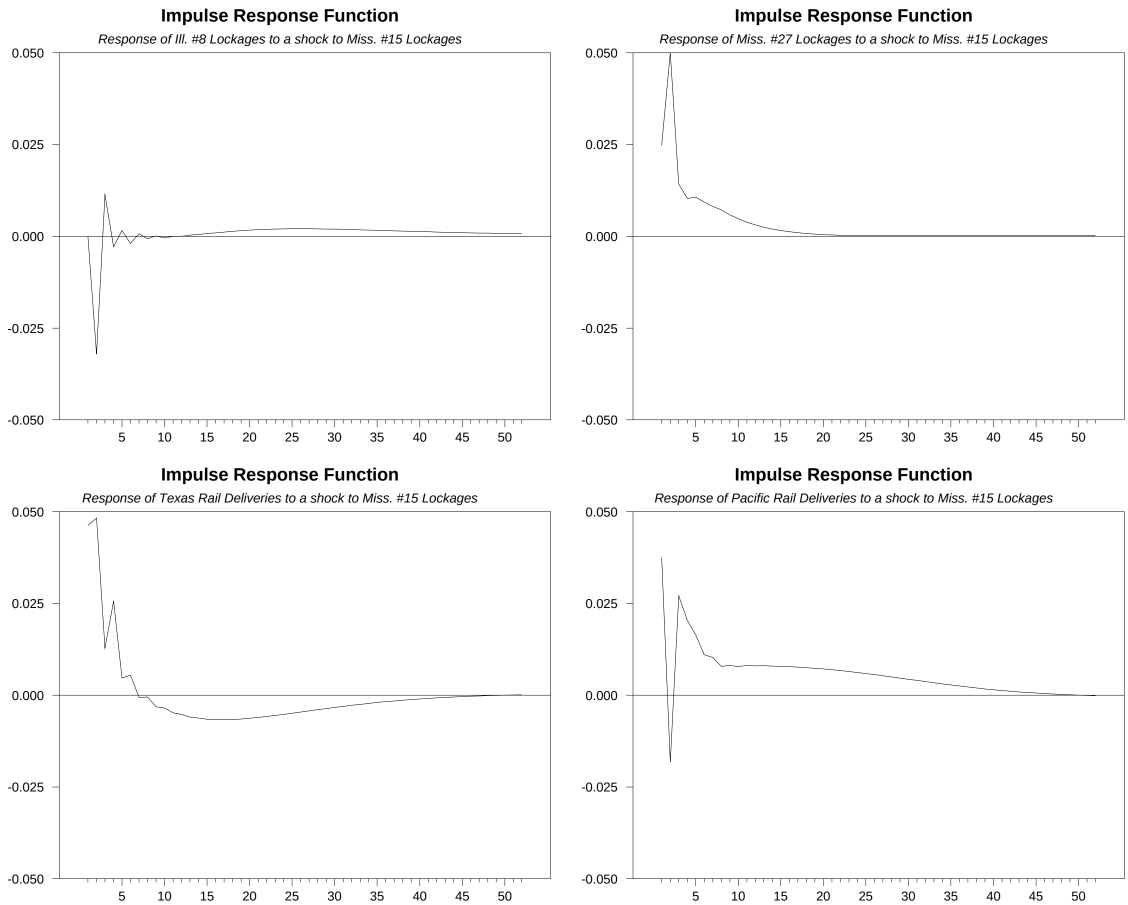

FIGURE 4 Responses of Lockages at Illinois #8, Mississippi #27, and Rail Deliveries to Mississippi and the Pacific to a Shock to Texas Rail Deliveries

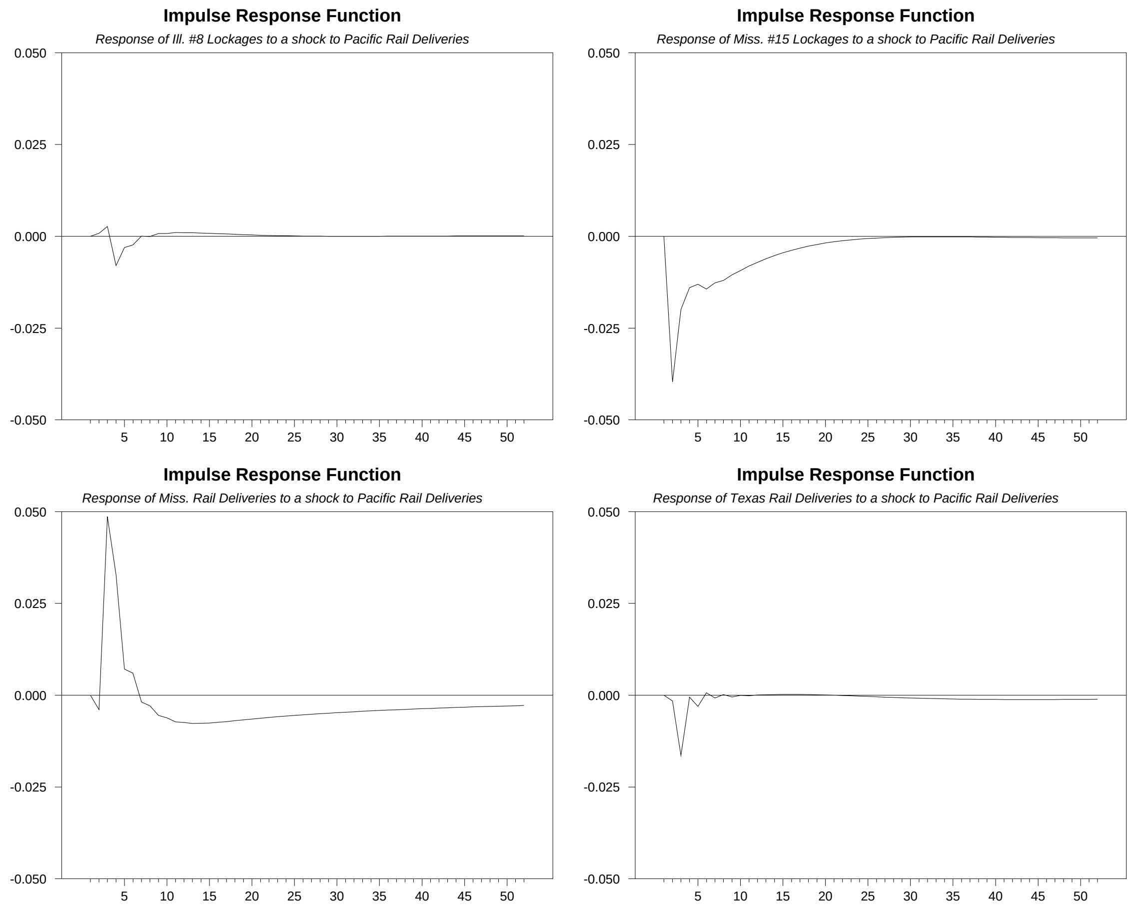

FIGURE 5 Responses of Lockages at Illinois #8, the Cairo-Memphis Barge Rate, and Rail Deliveries to Texas and the Pacific to a Shock to Lockages at Mississippi #2

TABLE 1 Weekly Data from 1999:01 through 2003:20 Collected from the USDA's Grain Transportation Report Used in the VAR Model

A. Lockages

Total Lockages on the Illinois at Lock #8
Total Lockages on the Mississippi at Lock #15
Total Lockages on the Mississippi at Lock #27

B. Barge Rates

Barge Rates for the Mid-Mississippi (Percent of Tariff from Davenport IA)
Barge Rates for the Illinois (Percent of Tariff for the Illinois River, Peoria, IL)
Barge Rates for St. Louis-Cairo (Percent of Tariff from St. Louis)
Barge Rates for Lower Ohio (Percent of Tariff from Lower Ohio)
Barge Rates for Cairo-Memphis (Percent of Tariff from Cairo)

C. Grain Bid Prices

The Bid Price for Portland HRW
The Bid Price for Gulf HRW
The Bid Price for Gulf SRW
The Bid Price for LA Corn

D. Tariff Rail Rates

The Tariff Rail Rate for Wheat from Kansas City to Houston
The Tariff Rail Rate for Wheat from Kansas City to Portland

E. Rail Deliveries

Rail Deliveries to Texas
Rail Deliveries to Mississippi
Rail Deliveries to the Pacific

TABLE 2 Variance Decompositions

Mississippi Lock #15

Step	River Locks	Barge Rates	Grain Bids	Rail Rates	Rail Deliv.
1	1.00	.00	.00	.00	.00
2	.84	.05	.01	.01	.10
4	.77	.09	.02	.03	.10
8	.69	.12	.03	.07	.09
12	.66	.13	.04	.09	.09
20	.63	.14	.05	.09	.09
26	.63	.14	.05	.09	.09
40	.62	.14	.05	.10	.09
52	.62	.14	.05	.10	.09

Mississippi Lock #27

Step	River Locks	Barge Rates	Grain Bids	Rail Rates	Rail Deliv.
1	1.00	.00	.00	.00	.00
2	.91	.07	.01	.01	.01
4	.84	.08	.02	.02	.03
8	.82	.09	.03	.03	.03
12	.81	.09	.04	.03	.03
20	.80	.10	.04	.04	.03
26	.80	.10	.04	.04	.03
40	.80	.10	.04	.04	.03
52	.80	.10	.04	.04	.03

St. Louis-Cairo Barge Rate

Step	River Locks	Barge Rates	Grain Bids	Rail Rates	Rail Deliv.
1	.00	1.00	.00	.00	.00
2	.06	.86	.01	.01	.06
4	.06	.79	.06	.02	.07
8	.06	.72	.12	.03	.07
12	.06	.69	.14	.04	.07
20	.06	.67	.15	.05	.07
26	.06	.67	.16	.05	.07
40	.06	.66	.16	.05	.07
52	.06	.66	.16	.06	.07

Portland HRW Bid Price

Step	River Locks	Barge Rates	Grain Bids	Rail Rates	Rail Deliv.
1	.02	.09	.89	.00	.00
2	.05	.13	.79	.01	.01
4	.09	.23	.61	.05	.03
8	.13	.28	.46	.09	.03
12	.14	.29	.39	.14	.03
20	.15	.29	.33	.21	.02
26	.14	.28	.30	.25	.02
40	.13	.28	.28	.29	.03
52	.12	.28	.27	.31	.03

Kansas City-Portland Rail Rate

Step	River Locks	Barge Rates	Grain Bids	Rail Rates	Rail Deliv.
1	.14	.08	.06	.73	.00
2	.18	.09	.07	.63	.03
4	.18	.11	.08	.60	.03
8	.14	.15	.10	.57	.04
12	.12	.18	.12	.53	.05
20	.10	.20	.15	.50	.06
26	.09	.21	.16	.48	.06
40	.08	.22	.17	.47	.06
52	.07	.23	.17	.47	.06

Texas Rail Deliveries

Step	River Locks	Barge Rates	Grain Bids	Rail Rates	Rail Deliv.
1	.01	.02	.07	.18	.72
2	.02	.06	.09	.17	.66
4	.02	.06	.09	.17	.65
8	.03	.07	.10	.16	.64
12	.03	.07	.10	.17	.63
20	.03	.08	.11	.17	.62
26	.03	.08	.11	.18	.61
40	.03	.08	.11	.18	.59
52	.03	.09	.11	.19	.58

Pacific Rail Deliveries

Step	River Locks	Barge Rates	Grain Bids	Rail Rates	Rail Deliv.
1	.14	.04	.19	.02	.61
2	.17	.09	.17	.04	.53
4	.17	.24	.15	.03	.41
8	.14	.38	.12	.04	.32
12	.13	.41	.12	.04	.29
20	.13	.41	.13	.05	.28
26	.13	.41	.13	.06	.27
40	.13	.40	.13	.08	.26
52	.13	.40	.13	.08	.25

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The NETS research program is developing a series of practical tools and techniques that can be used by Corps navigation planners across the country to develop consistent, accurate, useful and comparable information regarding the likely impact of proposed changes to navigation infrastructure or systems.

The centerpiece of these efforts will be a suite of simulation models. This suite will include:

- A model for forecasting international and domestic traffic flows and how they may be affected by project improvements.
- A regional traffic routing model that will identify the annual quantities of commodities coming from various origin points and the routes used to satisfy forecasted demand at each destination.
- A microscopic event model that will generate routes for individual shipments from commodity origin to destination in order to evaluate non-structural and reliability measures.

As these models and other tools are finalized they will be available on the NETS web site:

http://www.corpsnets.us/toolbox.cfm

The NETS bookshelf contains the NETS body of knowledge in the form of final reports, models, and policy guidance. Documents are posted as they become available and can be accessed here:

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