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ABSTRACT

This paper tests a non-survey dynamic I-O model against parallel econometric models using reduced form equations. In particular, we estimate regional steady state multipliers from the two methodologies for 13 sectors, and compare them.

The input-output multipliers are derived from a dynamic intersectoral model of the state of Kansas. The model is export-driven, and endogenizes consumption, regional government, and investment. The model includes expectational variables, capacity constraints and disinvestment constraints; it is solved to yield steady state export multipliers, assuming perfect foresight.

Conceptually similar total income multipliers are estimated econometrically from a model using reduced form equations, SUR, AR(1), and constrained positive multipliers. Some versions of the model use export proxies, which lead to econometric estimates of Kansas regional exports. The estimated multipliers are found to be relatively insensitive to the lag structure.

Multipliers derived from the two approaches are found to be modestly similar. The mean absolute differences are of the order of 35% to 50%. However, the multipliers are significantly correlated across methodologies and have similar group distributions. Chi-square tests cannot reject the hypothesis that all differences can explained by three sources of error: (1) estimation errors in the econometric model; (2) 20-25% random errors in the non-survey model; (3) a downward bias in some of the econometric estimates using proxies.

Suggestions are made for improving the robustness of the econometric model, and also for improving the proxies and the resulting econometric estimates of state exports.

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I. INTRODUCTION.

A mainstay of regional input-output analysis is the claim that the size and composition of the regional economy is determined by linear multipliers of its exports and interregional transfer payments and other exogenous and predetermined income. This paper tests this concept, while jointly testing a non-survey dynamic input-output model against a parallel econometric model. In particular, we directly estimate regional export multipliers, using a reduced form econometric analysis disaggregated into 12 productive sectors, plus exogenous income, and compare these estimates with multipliers calculated from the input-output model. If both methodologies are correct, then these two very different approaches and data sources should lead to similar results.

McNulty [1977] and others cited therein have argued that export multipliers make the most sense as long run concepts, because of the time required for investment activities as well as for population movements. Although McNulty's empirical work was flawed (see Gerking and Isserman [1981]), his theoretical argument remains persuasive to us. Indeed, Andrews and Tate [1988] and others cited therein give evidence that export multipliers do require several years to take their full effect. Moreover, the dynamic I-O model we develop below contains some rather arbitrary assumptions about short-run lags, but these assumptions do not affect the long run multipliers. Accordingly, we will examine only the long-run multipliers; that is, the eventual or steady state increase in flows in other sectors which results from a permanent increase by one unit in the flow of exports in a given sector.

The two multiplier models we develop below take into account several effects: not only intermediate product demands and import leakages, but also the effects of local consumption and state and local government expenditures which are induced by an increase in state income, and in addition the effects of state and private capital investment needed to replace the depreciation associated with a permanent expansion in output. Since these various effects occur over various lengths of time, a long-run concept of the multiplier would seem to be appropriate.

Both econometric time series and I-O techniques for measuring multipliers have inspired a substantial literature in regional analysis. (An extensive survey of regional I-O multiplier methods was given by Richardson [1985].) There have been a few direct empirical comparisons of the two approaches, generally using static or short-run models. Terry [1965] compared aggregate multipliers derived from an I-O model of St. Louis under various assumptions, including one multiplier he interpreted as simulating the result of a time series regression; however, no actual time series was used. Garnick [1969] made some indirect comparisons between economic base multipliers calculated using locational quotients, and those based on I-O; he also gives citations to two comparisons which are more direct.

Rosen and Mathur [1973] compared short-run aggregate econometric employment multipliers with multipliers derived from locational quotients, without developing an explicit I-O model; they found that the econometric multipliers produced much better forecasts than the locational quotient multipliers. Mulligan and Gibson [1985] compared economic base multipliers from direct survey data to those based on cross-sectional econometric measures. Kuehn, Procter, and Braschler [1985] compared non-survey I-O multipliers to economic base multipliers derived from pooled regressions. Merrifield [1987] discusses the mathematical equivalence between the economic base and I-O multipliers. Masih's dissertation [1988] compared econometric multipliers with direct survey I-O multipliers for a university town.

There is another literature consisting of multiplier comparisons which do not include econometric estimates among the items under comparison. In particular, a number of papers have compared non-survey I-O multipliers to I-O multipliers based on direct surveys; for example, Bourque [1988]. These papers are interesting and useful, but also rather narrow. These papers tend to assume that direct survey I-O models are the appropropriate benchmark of accuracy; for empirical evidence to the contrary, see Weddleton [1988]. More fundamentally, these papers compare cross-sectional data from one source to similar data from another source, and fail to test the causal assumptions which underlie input-output modeling.

Our comparison of multipliers is distinctive in several respects. First, we estimate disaggregated econometric multipliers from a fully specified regional model which utilizes inferential estimates of exports based on proxies for each sector. Second, we estimate I-O multipliers derived from a fully dynamic model. Third, we focus on a rigorously defined steady state, and derive comparable multipliers from both models. Fourth, we are careful to include exogenous or predetermined income (such as retirement income and dividends) as an independent part of the "export base".

This study is a joint test of a number of theoretical and methodological claims. A close agreement of the two sets of multipliers would tend to confirm all of the following hypotheses:

1. That the regional economy is linear in its exports and exogenous income. This statement is stronger than the theory of export determination; in particular, it denies that the relationship is non-linear or linear-affine, and hence denies the existence of an autarkic component of the regional economy.

2. That the corresponding linear multipliers can be measured to an acceptable degree of accuracy using non-survey, cross-sectional I-O methods.

3. That the same multipliers can also be measured by means of time series estimates of the reduced from equations, using proxy variables for exports.

4. That the multipliers are reasonably stable across time, so that I-O multipliers using data from one year are comparable

to econometric multipliers based on data from many years. (For an argument that multipliers change over the business cycle, see Pickerill [1984a, 1984b]. For a survey of the literature on secular changes in I-O multipliers, see Miller and Blair [1985, pp. 266-294].)

The input-output multipliers used in this study are based on the Kansas Long Term Model (KLTM), a dynamic input-output model being developed at the Institute for Public Policy and Business Research of the University of Kansas. KLTM is export-driven, and endogenizes consumption, regional government, and investment. The model includes expectational variables, capacity constraints and disinvestment constraints; however, it can be easily solved to yield long run steady state export multipliers under perfect foresight assumptions. In Section II, the model is described briefly, and the steady state multipliers are derived. Appendix 1 gives a description of the data sources used in the current version of the model.

Section III provides reduced form estimates of multipliers from an econometric model of Kansas using quarterly data on Kansas personal income, using twelve endogenous productive sectors plus exogenous income. To the extent possible, the econometric model is specified so as to be fully parallel to the I-O model; in particular, all coefficients (which correspond to multipliers) are constrained to be positive, and the constant term is constrained to vanish. However, we have also introduced a lag structure into the model.

In Section IV, the multipliers derived from the different approaches are compared. As we shall see, the differences are generally rather large, with MAPEs of the order of 30 to 50%. While many factors can be invoked to explain these differences, we show that they could be explained by a combination of three sources of error:

(1) estimation errors in the econometric models;

(2) 20% to 25% random errors in the non-survey I-O model;

(3) a downward bias in some of the estimates based on proxies. This bias can be detected by noting that the estimated multiplier violates a theoretical lower bound given by the exogenous income multiplier.

There is a significantly positive correlation between the two methodologies in most variants of the econometric model. The results support the view that non-survey I-O methods can produce multipliers which are accurate to within some 20 to 40%.

Section V makes concluding remarks, and suggests some further research. Appendix 2 gives regression results, together with a description of the time series data sources used in the ecnometric model.

II. THE STEADY STATE INPUT-OUTPUT MULTIPLIERS.

In this section we derive a set of steady state export multipliers, starting from a rather general inter-sectoral input-output model based on the KLTM. Although the general model has non-linear constraints, in the steady state version there is a simple linear solution. (KLTM is described more fully in Burress, El Hodiri, et al. [1987].)

The model is a regional dynamic input-output model, modified so as to include capacity constraints and investment irreversibility. For simplicity, we assume that each industry produces a single, distinct commodity. We state the capacity constraint as

(1) $X_t = \mathrm{MIN}[\ Z_t\ ,\ D_t]$, where

X_t is the vector of output quantities at time t;

Z_t is the capacity vector (in output units); and

D_t is the level of regional demand at time t.

It is assumed that any excess of demand over capacity Z_t will be imported. (Note: the vector MAX and MIN functions are taken term by term.) Next, we assume that the level of demand is given by

$$(2)\ D_t = AX_t + \gamma\omega' X_t + y\gamma + B\hat{k}\ \mathrm{MAX}[\ 0,\ \hat{\psi}E_tD_{t+1} - Z_t(I-\hat{\delta})] - m[D_t - F_t] + [\hat{\iota}E_tD_{t+1} - Y_t] + F_t,$$ where

F_t is a vector of exogenous, non-negative export demands;

Y_t is the vector of inventory quantities at time t;

E_tD_{t+1} is a vector of expectations or beliefs held by decision makers at time t, concerning the demand next period;

$\gamma\lambda'$ is a non-negative matrix which translates output quantities into induced Kansas demands, assuming constant wage rates, returns to capital, and prices (which are determined outside the region), and also constant ownership shares of property income by Kansans and non-Kansans[1]. These induced demands include not only household consumption purchases, but also state and local government demands[2].

$\mathbf{y}\gamma$ is a vector of exogenous local demands resulting from social security, dividends, and other non-Kansas sources of income.

A is a non-negative matrix of intermediate input demand coefficients.

B is a non-negative matrix of investment coefficients.

$\hat{k}$ is the set of desired ratios of capital to capacity.

m is a non-negative matrix of normal import requirements (i.e., imports required to meet the domestic demand [D - F], under the usual condition of excess capacity).

$\hat{s}$ is a matrix of capacity depreciation rates.

$\hat{\psi}$ is the set of desired ratios of capacity to output.

$\hat{\iota}$ is the set of desired ratios of inventory to output.

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1. Since we have no data on the ownership of capital in Kansas by residency, in most sectors it was assumed that property income was exported from Kansas. (For exceptions, see Appendix 1.)

2. If new residents have the same average propensities to consume as do old residents, then these coefficients also account for the induced effects of population growth. This model assumes that population adjusts instantly; however, imposing a lagged population adjustment similar to the lagged capacity constraint would not affect the resulting steady state multipliers.

This investment model assumes a rather arbitrary gestation period of one year between investment purchases and the resulting increases in capacity and inventory; however, the length of the gestation period has no effect on the steady state multipliers we derive below. Capacity and inventory are assumed to be updated according to plan, leading to the relations

(3) $Z_{t+1} = \hat{\psi} E_t D_{t+1}$, and

(4) $Y_{t+1} = \hat{\iota} E_t D_{t+1}$.

We now impose steady state conditions on the model. First, expectations are assumed to obey perfect foresight, so that

(5) $E_t D_{t+1} = X_{t+1}$ for all $t>0$.

Second, under zero-growth[3] steady-state conditions, all quantities are constant over time, and capacity is never binding. Consequently, we can drop the distinction between demand and output. We also can omit time subscripts. Then the term for desired change in inventory is zero, and the investment term simply replaces the depreciation. Therefore the steady state version of equation (2) can be simplified to yield

(6) $X = AX + \gamma\omega' X + B\hat{k}\hat{\psi}[X - X(I-\hat{s})] - m[X - F] + F + y\gamma$.

Since the regional economy is viable, we assume that $\{I - A - \gamma\omega' - B\hat{k}\hat{\psi}\hat{s} + m\}$ has a positive dominant diagonal. It follows from standard theorems that its inverse exists, and

(7) $X = [\{I - A - \gamma\lambda' - B\hat{k}\hat{\psi}\hat{s} + m\}^{-1}(I + m)]\{F + (I+m)^{-1}y\gamma\}$.

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3. If the regional economy is growing at a constant rate in each sector, then the appropriate multiplier formula is slightly different. However, this effect is numerically unimportant in Kansas, because real sectoral growth rates have recently been substantially smaller than rates of capital depreciation.

The quantity in square brackets is the matrix of steady-state multipliers between exports and output quantities.

Since direct time series data on exports are not available in Kansas, and also since output data are not available on a quarterly basis, it is not possible to measure multipliers comparable to those of equation (7) directly using econometric techniques. A more convenient set of multipliers can be defined by considering the ratio of total additional domestic income induced in Kansas, to the direct increase in domestic income in the exporting sector (where both changes result from a permanent increase in the level of exports). In particular, the total regional income can be related to the regional incomes in exports by multiplying equation (7) by a row vector of regional value added coefficients, λ'. This yields

(8) Total regional income resulting from exports =

$$\lambda' X = [\lambda'\{I - A - \gamma\lambda' - B\hat{k}\hat{\psi}\hat{s} + m\}^{-1}(I + m)\hat{\lambda}^{-1}]\{\hat{\lambda}F\}.$$

The quantity in curly brackets is the column vector of regional income generated while producing the required exports; the quantity in square brackets gives a row vector of multipliers. Similar arguments lead a multiplier for exogenous changes in disposable income:

(9) Total regional income resulting from exogenous income =

$$\lambda' X = [\lambda'\{I - A - \gamma\lambda' - B\hat{k}\hat{\psi}\hat{s} + m\}^{-1}\gamma]y.$$

Multipliers for Kansas calculated according to equations (8) and (9) are given in Table 1. The data sources for these multipliers can be summarized as follows: most of the data were

TABLE 1:

NON-SURVEY DYNAMIC INPUT-OUTPUT MULTIPLIERS FOR KANSAS

Sector	income-income multipliers
1 Wholesale & retail	1.696
2 Mining	2.385
3 Construction	2.342
4 Durable Goods	2.119
5 Nondurable Goods	4.742
6 Transportation & Utilities	2.219
7 FIRE	3.004
8 Services	1.933
9 State & Local Government[4]	1.598
10 Federal Government	1.598
11 Agricultural Services	3.439
12 Agriculture	2.048
13 Exogenous income	1.598
mean multiplier	2.363
standard deviation	0.867

4. The state and local government multiplier, and also the Federal government multiplier, were not explicitly measured in the I/O model. Therefore they were assigned value of the exogenous income multiplier.

based on BEA nation-wide stock and flow estimates for 1981, including their input-output table and capital flows table. Kansas-specific data were used so as to estimate exports and imports, using the 1977 MRIO for material flows, and 1981locational quotients for flows of services. Kansas specific data were also used to estimate 1981 wage coefficients and government demands in Kansas. The multipliers were initially estimated by 48 sectors. For comparability with the econometric model, the multipliers were then aggregated to 11 sectors by prorating on Kansas exports. The data are described in more detail in Appendix 1.

III. THE PARALLEL REDUCED FORM ECONOMETRIC MULTIPLIERS.

In this section we develop a disaggregated time series model for measuring the income-income multipliers. The model has four important features: a generalized lag structure, the use of export proxies, a constrained estimation technique, and the reduced form specification. We will also make AR(1) and SUR assumptions.

A. The problem of measuring exports.

The econometric model must have some way to identify exports, so we can estimate their multipliers. But there are no time series data on Kansas regional exports[5]. The existing literature provides three general approaches to this missing data problem.

The most widely used approach relies on models which ignore cross-hauling, such as locational quotients or minimum or average requirements [as in Braschler, 1972]. This introduces large errors, and tends to cause an upward bias in the multipliers. The RPC approach of Stevens et al. [1983] attempts to correct for this bias using cross-section regressions. However, these methods are theoretically unappealing, nor have they been shown to be sufficiently accurate so as to support time series analysis. Therefore we have avoided them.

A second approach relies on an (arguably arbitrary) prior designation of "export base" sectors [e.g., Moriarty, 1976]. This ignores the potential importance of exports from the so-called non-basic sectors such as transportation, trade and services[6], and also may ignore the local use of locally produced "basic" goods. Consequently, this approach is unable to estimate multipliers for exports from the "non-basic" sectors. However, in the following we give variant multipliers based on this approach.

A third approach used in many studies of aggregate export

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5. As a consequence of the fact that explicit data on exports <u>are</u> available at the national level, the existing macroeconomic literature provides little useful guidance for an effort to construct econometric multipliers at the regional level.

6. Kansas, for example, has substantial exports of retailing from Johnson County to Kansas City, Missouri.

base multipliers employs GNP as a proxy for aggregated regional exports. A disaggregated version of this approach was developed by Rosen and Mathur [1972]. We will extend their approach by developing export proxies in each sector which are based on national activity in that sector. Consequently, both direct export demands and also endogenously generated demands are allowed in each sector.

B. The Theoretical Model.

Our conceptual model is parallel to that adopted in the previous section, with two differences. First, rather than writing out a structural model and then inverting a matrix to get the multipliers, we specify the reduced form multiplier model directly. Second, the lag structure is generalized.

In particular, we assume that the Kansas economy can be described by

$$(10)\quad x_t^i \equiv e_t^i + n_t^i$$

$$(11)\quad n_t^i = \sum_{jn} \mu_n^{ij} e_{t-n}^j + u_t^i, \text{ where:}$$

x_t^i is the total real regional income originating in sector "i" in period t (corresponding to $\lambda_i X_i$).

e_t^i is the direct real regional income (factor payments) from meeting interregional export demands in sector "i". For brevity in the following, we will refer to these terms as "exports"; the reader should keep in mind that exports are measured by the income they produce.

n_t^i is the direct real regional income from meeting endogenous, intraregional demands in sector "i".

u_t^i is a disturbance term.

μ_n^{ij} is a coefficient representing a component of a multiplier.

Note that the total income-income multiplier for sector i is given by summing its own direct effect, plus all its indirect effects on all sectors at all lags:

$$(12)\quad \mu^i = 1 + \sum_{nj} \mu_n^{ij}.$$

Next, since the exports are unobservable, we assume that export demands can be represented as a function of exogenous US GNP in that sector, and perhaps other exogenous variables:

$$(13)\quad e_t^i = \nu^i G_t^i + \sum_k \zeta^{ik} V_t^k + v_t^i, \text{ where}$$

ν_n^i is the marginal share of regional export income in US GNP for that sector.

G_t^i is US GNP in that sector.

ζ^{ik} is a set of regression parameters.

V_t^k is a set of possible additional exogenous explanatory variables for state exports. However, for purposes of brevity, we will not explore these additional proxies in the empirical part of this paper.

v_t^i is a disturbance term.

Substituting (11) and (13) into (10) yields the estimable equations

$$(14)\quad x_t^i = \nu^i G_t^i + \sum_k \zeta^{ik} V_t^k + \sum_{jn} \mu_n^{ij}[\nu^j G_{t-n}^j + \sum_k \zeta^{jk} V_{t-n}^k] + w_t^i,$$

where

$$w_t^i \equiv u_t^i + v_t^i + \sum_{jn} \mu_n^{ij} v_{t-n}^j.$$

Several versions of this model are estimated below; they differ only in the choice of the export proxies and in the estimated error structure of the w_t^i. We also assume a first order autoregressive error structure:

(15) $w_t^i = z_t^i + \rho_i z_{t-1}^i$,

In some variant estimations, z_t^i is assumed to be white noise. In other variants we use Seemingly Unrelated Regressions so as to capture any disturbance correlations across sectors.

There are four important constraints on equation (14). First, for complete identification of the parameters we must have $\mu_0^{ii} = 0$ for all i. In other words, we must assume that exports have no contemporaneous indirect effect on their own sector (but there may be an own-multiplier effect after a lag of at least one quarter). Second, since all demands and all multipliers are non-negative, all estimated coefficients are non-negative (with the possible except of ρ_i). Third, since the economy is assumed linear (rather than linear affine), there are no constant terms in the regressions. Fourth, the "exogenous income" sector (i = 13) is assumed completely exogenous, so that $e_t^{13} = x_t^{13}$, $n_t^{13} = 0$ for all t, and $\mu_n^{13,j} = 0$ for all j,n.

In the following, estimates for several restricted versions of this model are described. All sets of equations were estimated by constrained non-linear least squares[7] using data for 1967(I) through 1987(IV), using data mainly taken from the Indiana US Model data base. All data were income in real 1982

7. Implemented using SAS SYSNLIN software.

terms. Except as noted, data were quarterly and seasonally adjusted. In most sectors, regional income was measured as the wage bill; however, farm proprietor's income was used in the agricultural sector.

In the tables which follow, we report only the total multipliers (which is given by equation (14) as a sum of coefficients from several equations.) We used AR(1) assumptions in all regressions, and consequently first order autocorrelation was not significant in most regressions (with p=.05. The corresponding AR(0) regressions almost always exhibited significant autocorrelation.) Most regressions had R-squared values of .92 to .99; however, R-squares in the farming sector were around .78. Most of the reported regressions were estimated using constrained SUR; in most cases, similar but unreported variants using constrained OLS led to very similar reults. For two variant sets of regressions, the full equations and regression statistics are shown in Appendix 2, where the data are also described in more detail.

C. Multipliers using the Prior Designation of "Export-Oriented" Sectors.

In this section we describe the results of a simple "all or nothing" version of the model, in which each sector is designated as either a purely "export-oriented" (or "basic") sector, or else as a purely "domestic" ("non-basic") sector. In the "export-oriented" sectors, we assume that $e_t^i = x_t^i$ and $n_t^i = 0$; in other words, output is its own contemporaneous export proxy. In the "domestic" sectors, we assume that $n_t^i = x_t^i$ and $e_t^i = 0$. Consequently, for the "domestic" sectors there are no exports and no multipliers could be measured.

One problem with this approach is that there exists no rigorous basis for so designating the sectors; the analyst must rely on some combination of tradition, judgement, and personal knowlege of the regional economy. For purposes of this exercise, we designated the following sectors as "export-oriented": mining; durable manufactures; non-durable manufactures; federal government; agriculture; and exogenous income. The remaining sectors were assumed to be "domestic": transportation and utilities; finance, insurance, and real estate; state and local government; agricultural services; wholesale and retail; other services; construction.

In Table 2, multiplier estimates are reported for six variant sets of regressions; however, our discussion is also based on other estimated variants not reported here.

In the first set, only the contemporaneous exports were included in the regressions (i.e., μ_n^{ij} was set to 0 unless n = 0). In the second set, only the first quarterly lags of exports were included. In the third set, both the contemporaneous and the first lags were included. The fourth set used annual rather than quarterly data, and included only the contemporaneous exports.

The fifth set of specifications was arrived at using a stepwise OLS regression technique over the contemporaneous through the sixth lag of exports[8]. It is noteworthy that this variant replicated the I-O results much more poorly than any other variant (for example, its multipliers are negatively correlated with the I-O results). Therefore we give it little weight in the following discussion.

The sixth variant set of specifications is identical to the second set (using first lags), except that OLS estimation was used instead of SUR.

In most sectors, the estimated multipliers appear to be fairly robust against variant specifications; in particular, the variant multipliers do not differ significantly according to a Z test ($p=.05$). In other words, it appears that the multipliers can be estimated with reasonable accuracy, even if the lag structure is misspecified.

However, multipliers in the non-durable goods sector are more fragile. The estimated multiplier may vary from 1.4 to 3.4, depending on the specification. A possible interpretation is that this results from an aggregation error in designating non-durable manufactures as purely export-oriented. In fact, the Kansas nondurable goods sector does include a substantial amount of production which is probably responsive to domestic consumption demands: bakeries, dairies, newspapers. It is

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8. In particular, for each domestic sector we performed a forward search over the contemporaneous through the sixth lag of each export term, seeking to maximize the adjusted R-squared, subject to the constraints that each coefficient was positive and significant at the $p=.15$ level.

noteworthy that the export-proxy method developed in the next section apparently leads to more stabile values of the non-durables multiplier, clustering around an intermediate value of 2.4.

In the I-O model we developed in Section 2, it is easily shown (by comparing equation (8) to equation (9)) that the exogenous income multiplier is a theoretical lower bound for all the other sectoral multipliers. This holds because the sectoral multipliers have first round consumption effects equal to those resulting from exogenous income, in addition to their intersectoral effects[9]. This theorem is consistent with the Table 2 results in most sectors; that is, the estimated multipliers are either higher or not significantly lower than the exogenous income multiplier (according to a Z test)[10].

The sole exception is the agricultural multiplier, which consistently and significantly violates the exogenous income multiplier lower bound in all variants. In each case, the estimated agricultural multiplier is 1.1 or less. Moreover, the agriculture multipliers derived from export proxies in Section 3C below are equally small. We suspected that this result reflects a bias resulting from errors in the deseasonalized quarterly farm

9. It is possible to formulate I-O models in which this lower bound theorem fails. In particular, one might assume that consumption out of retirement income or other exogenous income has a lower average import coefficient than does consumption out of endogenous wages.

10. Here and subsequently, all statements about statistical significance assume a p=.05 level of significance.

proprietor's income. That is, Kansas farm income may not have a meaningful time structure at a greater than annual frequency. The total amount of annual income in wheat farming, for example, typically becomes known all at once in mid-summer.

To test this "errors in variable" hypothesis, we compared the quarterly results to the contemporaneous version of the model using annual data. Since annual data cuts the sample size by 3/4, the standard errors of all multipliers were larger; however, the estimated multipliers were not significantly different from the quarterly results in most sectors. And in particular, the agricultural multiplier continued to violate the lower bound.

Table 2 also contains percent errors and other group statistics, comparing these multipliers with the corresponding non-survey I-O results in Table 1. We defer a discussion of these comparisons across methodologies to Section 4 below.

D. Multipliers using Export Proxies.

In this section we describe the results of several variant sets of regressions, using US variables as proxies for exports in each sector. The variants reported in Table 3 are similar to those discussed in the previous section and reported in Table 2, except for the use of export proxies. In all cases except agriculture, US wage bill in the sector was used as the export proxy; in agriculture, US farm proprietor's income was used.

The estimated multipliers again seem to be reasonably robust with respect to variation in the assumed lag structure and the assumed error structure. However, there is some sensitivity to specification in the mining sector, where the estimated multiplier varies between 1.8 and 3.5. There are much wider swings, and also very large estimated multipliers (and equally large standard errors), in the agricultural services sector; however, these effects are not statistically significant.

In three of the designated "export-oriented" sectors (mining, non-durables, and agriculture), the estimated multipliers seem to be reasonably robust with respect to use of export proxies, as compared to assuming (as in the previous section) that the entire sectoral output is exported. In the other three designated "export-oriented" sectors (durable goods, federal government, and exogenous income), the multipliers are estimated as significantly lower in most variants ($p=.05$) when using export proxies.

This trend toward lower multipliers under the proxy method may have a purely mechanical explanation. Assume that the "export-oriented" sectors do in fact sell their output mainly for export. Since our regression model explains a positive variable (income) using positive coefficients (multiplier components) times other positive regressors (export proxies), it follows that increasing the number of regressors will tend to reduce the average size of coefficients in the "export-oriented" sectors. That is, the estimated indirect effect of an "export-oriented" sector is likely to be reduced when new proxies are introduced for the "domestic" sectors, because some of the endogenous income is now being explained by the new proxies. Consequently, the observation of these reduced multipliers does not by itself provide any evidence either for or against the use of this export proxy model.

In 8 out of a possible 12 sectors, the lower bound rule for the exogenous income multiplier is not significantly violated. In trade and agriculture, the lower bound is violated significantly in all variants. In durables, construction, transportation & utilities, state and local government, and services, the lower bound is violated in some variants but not in others.

It is tempting to interpret these violations of the lower bound as indicating measurement errors in the corresponding export proxies. Proxy variables do often cause a bias of the estimated coefficient towards zero. Moreover, as we point out in the next section, most of our estimated econometric multipliers are lower than the corresponding non-survey I-O multipliers. This suggests that the present results might be improved by searching for better proxies; for example, by using several disaggregated export proxies for each sector.

In the next section, we compare these results to the non-survey multipliers.

TABLE 2:

MULTIPLIERS USING DESIGNATED "EXPORT-ORIENTED" SECTORS

Sector	non-survey I-O	SUR lag 0	SUR lag 1	SUR lag 0,1	SUR annual	SUR step-wise	OLS lag 0
	Variant Multipliers						
2 Mining	2.385	1.686	2.264	2.104	1.872	1.574	2.060
standard error	0.477	0.297	0.496	0.328	0.276	0.209	0.417
percent error	0.000	-0.343	-0.052	-0.125	-0.241	-0.409	-0.146
4 Durable Goods	2.119	1.311	1.259	1.419	1.597	1.609	1.265
standard error	0.423	0.089	0.093	0.131	0.143	0.067	0.071
percent error	0.000	-0.471	-0.509	-0.395	-0.281	-0.273	-0.504
5 Nondurable Goods	4.742	3.373	3.361	3.373	2.470	1.414	3.323
standard error	0.948	0.358	0.393	0.479	0.404	0.131	0.290
percent error	0.000	-0.337	-0.340	-0.337	-0.630	-1.081	-0.351
10 Federal Government	1.598	1.654	2.197	2.019	1.762	2.516	2.225
standard error	0.319	0.158	0.264	0.254	0.187	0.157	0.195
percent error	0.000	0.034	0.315	0.232	0.097	0.445	0.327
12 Agriculture	2.048	1.021	1.019	1.052	1.081	1.018	1.018
standard error	0.409	0.015	0.016	0.019	0.035	0.006	0.013
percent error	0.000	-0.669	-0.671	-0.642	-0.618	-0.671	-0.671
13 Exogenous income	1.598	1.359	1.304	1.294	1.410	1.505	1.316
standard error	0.319	0.041	0.047	0.053	0.049	0.018	0.036
percent error	0.000	-0.161	-0.202	-0.210	-0.125	-0.060	-0.193
Group statistics:							
mean	2.415	1.734	1.900	1.876	1.698	1.606	1.867
standard deviation	1.077	0.766	0.805	0.768	0.428	0.451	0.782
variance	1.161	0.587	0.649	0.589	0.184	0.203	0.612
MAPE	0.000	0.336	0.348	0.324	0.332	0.490	0.366
Comparisons to I-O:							
F	1.000	1.979	1.788	1.969	6.314	5.705	1.898
Z	0.000	-0.515	-0.382	-0.406	-0.617	-0.692	-0.411
correlation coef.	1.000	0.922	0.795	0.860	0.803	-0.305	0.796
chi squared (6df)	0.000	13.712	14.989	12.234	13.158	28.967	16.151
restricted chi squared	0.000	7.432	8.686	6.332	7.623	22.644	7.034
df	0	5	5	5	5	5	5

NOTES:

standard errors on non-survey I-O multipliers calculated as 20%
percent errors are comparisons to corresponding I-O multipliers
other statistics are explained in text

TABLE 3:

MULTIPLIERS USING EXPORT PROXIES

: Variant Multipliers

Sector		:survey : I-O	SUR lag 0	SUR lag 1	SUR lag 0,1	SUR annual
1 Wholesale & retail	1.696	1.056	1.000	1.000	1.000	1.119
standard error	0.339	0.152	0.	0.	0.	0.198
percent error	0.	-0.465	-0.516	-0.516	-0.516	-0.410
2 Mining	2.385	1.960	2.975	3.446	3.235	2.204
standard error	0.477	0.790	0.544	0.919	0.374	0.877
percent error	0.	-0.195	0.220	0.363	0.302	-0.078
3 Construction	2.342	1.004	1.	1.	2.500	1.
standard error	0.468	0.022	0.	0.	0.612	0.001
percent error	0.	-0.800	-0.803	-0.803	0.064	-0.803
4 Durable Goods	2.119	1.170	1.249	1.175	1.022	1.215
standard error	0.423	0.087	0.101	0.078	0.024	0.093
percent error	0.	-0.577	-0.516	-0.573	-0.698	-0.542
5 Nondurable Goods	4.742	2.447	2.277	2.250	1.609	2.800
standard error	0.948	0.583	0.426	0.452	0.398	0.841
percent error	0.	-0.638	-0.702	-0.712	-0.986	-0.515
6 Transportation & Utilities	2.219	1.105	1.237	1.272	1.023	1.041
standard error	0.443	0.160	0.233	0.229	0.007	0.065
percent error	0.	-0.670	-0.568	-0.542	-0.738	-0.723
7 FIRE	3.004	1.439	2.092	1.761	2.067	1.517
standard error	0.600	0.273	1.142	0.528	0.406	0.319
percent error	0.	-0.704	-0.358	-0.521	-0.369	-0.658
8 Services	1.933	1.362	1.026	1.	1.221	1.333
standard error	0.386	0.176	0.142	0.	0.092	0.209
percent error	0.	-0.346	-0.613	-0.636	-0.451	-0.367
9 State & Local Government	1.598	1.434	1.753	1.712	1.	1.355
standard error	0.319	0.370	0.714	0.654	0.	0.369
percent error	0.	-0.108	0.092	0.068	-0.460	-0.164
10 Federal Government	1.598	1.151	1.310	1.256	1.573	1.091
standard error	0.319	0.167	0.172	0.156	0.338	0.170
percent error	0.	-0.325	-0.198	-0.239	-0.016	-0.377
11 Agricultural Services	3.439	7.062	8.438	10.109	35.472	4.309
standard error	0.687	3.782	6.580	5.726	17.578	1.948
percent error	0.	0.690	0.841	0.984	1.646	0.224
12 Agriculture	2.048	1.014	1.023	1.035	1.030	1.012
standard error	0.409	0.012	0.012	0.016	0.030	0.017
percent error	0.	-0.675	-0.667	-0.657	-0.661	-0.677
13 Exogenous income	1.598	1.137	1.149	1.121	1.161	1.136
standard error	0.319	0.032	0.041	0.042	0.038	0.032
percent error	0.	-0.337	-0.327	-0.351	-0.317	-0.338

TABLE 3 (continued):

Statistic		: survey I-O	SUR lag 0	SUR lag 1	SUR lag 0,1	SUR annual
		Variant Multipliers				
Group statistics:						
mean	2.363	1.795	2.040	2.164	4.147	1.625
standard deviation	0.867	1.572	1.936	2.388	9.066	0.925
variance	0.753	2.471	3.751	5.705	82.209	0.857
MAPE	0.	0.502	0.494	0.536	0.556	0.452
Comparisons to I-O:						
F	1.	3.281	4.980	7.573	109.139	1.13
Z	0.	-0.316	-0.152	-0.078	0.195	-0.581
correlation coefficient	1.	0.533	0.491	0.459	0.376	0.714
chi squared (13df)	0.	44.380	41.344	46.340	49.147	41.499
restricted chi square	0.	21.317	17.806	21.978	21.336	15.870
df	0.	9	9	9	8	8

NOTES:

standard errors on non-survey I-O multipliers calculated as 20%
percent errors are comparisons to corresponding I-O multipliers
other statistics are explained in text

IV. COMPARING THE RESULTS.

The problem of how to compare two different sets of Input-Output parameters has generated an unresolved controversy [reviewed in Round, 1983]. We will content ourselves with presenting some comparisons which seem informative to us, without trying to propose any definitive measures of closeness between the two sets of multipliers[11].

For each variant set of regressions, Tables 2 and 3 give absolute differences between the regression multipliers and the corresponding non-survey multiplier as a percent of their mean. It is apparent from these data that the two kinds of multipliers have some definite resemblance, but the mean absolulte percent errors are of some 35 to 50 percent, depending on the variant regression model.

Although relatively large, we will argue that these error rates are not inconsistent with the view that the linear export-determination theory is generally correct, and both methodologies are unbiased, but one or both methodologies has a large measurement error.

Garhart and Giarratani [1987] have estimated that trade coefficients based on secondary sources, as in our I-O model, can

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11. For convenience, in this paper we have compared N multipliers between export income in one sector and total income. But both of our methods actually provided N^2 multipliers between export income and sectoral incomes. These detailed multipliers may be useful in some cases.

introduce MAPEs averaging up to 15% into the I-O multiplier. That is not enough to explain the differences we observed between the two methodologies. Other articles they cite have argued that trade coefficient errors may be as large as other sources of error. Assuming that other errors are independent and equally large, then net measurement errors in the non-survey model would amount to about $(.15^2 + .15^2)^{.5}$, or about 20%. In the following, we test the assumption of 20% errors in the I-O model.

If this claim is true, then the rather larger discrepencies we observed may reflect errors in the econometric model; or structural shifts over time; or perhaps some more fundamental flaws in the linear export-determination perspective.

We can cast some light on these possibilities using some additional comparisons. In particular, Tables 2 and 3 give several summary group statistics comparing the econometric multipliers to the non-survey multipliers, which are described below.

First, we can reject the null hypothesis that the two kinds of multipliers are completely unrelated. In perticular, the correlation coefficient of the sets of multipliers across methodologies was positive for every econometric variant[12], and in many cases was significantly so. Apparently, there is some fundamental information about multipliers in the Kansas economy which can be derived from two very different kinds of data: cross-sectional, and time series.

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12. Except the stepwise variant.

Second, there is an overall agreement in the general level and distribution of multipliers measured under the two methodologies, in the following sense. If we think of each set of multipliers as an unrelated random sample of items, then a Z test fails to reject the hypothesis that the average of all multipliers drawn from a given econometric variant are equal to the average of all multipliers from the non-survey methodology. Also, an F test fails to reject the hypothesis that the two methodologies lead to multipliers with the same group variances.

Finally, to provide the most restrictive formal comparison of the two sets of multipliers, we used a chi-square test. Our null hypothesis was that the econometric multipliers in a given variant differ from the corresponding I-O multipliers by an amount which can be explained by the estimated standard errors of the econometric multipliers, plus a standard error in the non-survey result calculated as 20% of the multiplier. (We assumed that errors across the two methodologies are uncorrelated.) The resulting Chi-squares are always highly significant. Apparently, differences between the I-O model and the econometric models can NOT be explained as merely resulting from statistical or sampling errors.

However, a closer look showed that the large chi-squares were always dominated by the terms arising in the sectors which violate the exogenous income lower bound. We have already discussed the underlying data problems in those sector. With these sectors omitted, then the restricted chi-squares are not significant (p=.05) in the designated export sector models, and were greatly reduced in the proxy models. Moreover, if the assumed errors in the non-survey I-O were taken as 25% (instead of 20%), then none of the chi-squared statistics were significant (these results are not shown in the tables). That is, for most variants, the differences in the remaining sectors can explained as purely statistical ones, caused by statistical errors in the econometric model and 20-25% errors in the non-survey model.

However, there is nothing either unique or compelling about this interpretation. As an alternative, the discrepancies between the two methodologies might be explained by 20% random errors the non-survey multipliers, plus a systematic downward bias of 25% in all the econometric multipliers (or an upward bias of 25% in the non-survey multipliers). Further research into these issues needed.

The message we draw from these comparisons is that neither the econometric multipliers, whether based on proxies or on designated sectors, nor the non-survey multipliers, are hopelessly out of range. However, in all cases, further work is desirable so as to make these multiplier more precise.

VI. IMPLICATIONS AND FURTHER RESEARCH.

Although the econometric work reported in this paper can and should be extended (perhaps in ways suggested below), what we reported above has several implications:

1. The multipliers based on a non-survey, cross-sectional methodology are at least modestly similar to those based on a range of reduced form econometric methodologies. Consequently, these data do not disconfirm the fundamental linearity assumptions used in I-O modeling.

2. Our results do not disconfirm the usefulness of any of the multiplier techniques we examined. In particular, they lend some support to non-survey multipliers, and also to the econometric multiplier method based on designated "export-oriented" sectors.

3. Our results also lend some support to a new econometric method based on sectoral export proxies, which has the capability of measuring multipliers in the "domestic" as well as in the "export-oriented" sectors. Moreover, our work supports the use of the exogenous income multiplier as a lower bound so as to detect errors in the export proxy variables.

There are a number of opportunities for further research into regional econometric modeling using a parallel I-O specification, including these:

1. improving the export proxies, for example by including multiple, disaggregated proxies in each sector.

2. validating the inferential measure of state exports developed in this paper against direct survey data.

3. using times series data on employment (in place of or in addition to the income information we used).

4. extending the model to allow for secular change over time, for example by using US secular change as a proxy for regional secular change.

5. developing a structural (rather than reduced form) econometric model, using constrained estimation techniques.

6. developing tests for the best lag structure.

The econometric multipliers developed here can also be compared to multipliers from a direct survey, in those cases where surveys exist [including Kansas; see Emerson, 1971, 1988].

In this paper, concepts taken from regional input-output modeling have been used so as to inform the specification of a regional econometric model. But it might be possible to reverse the direction of information flow. If additional research supports the reliability of the econometric multipliers we have proposed, then they might be used so as to benchmark and update a non-survey I-O model.

APPENDIX 1: INPUT-OUTPUT DATA SOURCES.

The following describes how the I-O parameters were estimated. A list of data sources is given at the end of the Appendix.

Description of the Parameter Construction:

The A Matrix:

The A matrix was first inferred for 86 sectors, using the 1981 BEA Make and Use Tables under commodity-based technology assumptions. Large negative coefficients in two sectors were removed by pre-aggregating communications with business services. A few very small negative coefficients in other sectors were simply set to zero. Then the A matrix was aggregated to 48 sectors using 1981 County Business Pattern data on Kansas output.

The B matrix:

Investment coefficients were inferred for 86 sectors from the 1981 BEA capital flows table.

Capital to capacity ratios were calculated for manufacturing sectors by averaging 6 years of data by sector. Capital was taken from the BEA US Tangible Reproducible Wealth series; annual output from the Bea; the ratio of output to preferred capacity from the BEA. The capital stock was then corrected so as to agree with the concepts used in the capital flow table by prorating on 1981 sectoral investment from the two sources.

A similar procedure was used in non-manufacturing sectors, except that capacity was assumed equal to output for each year.

The critical or desired level of capacity utilization was inferred for each manufacturing sector by regressing net investment on capacity utilization; the intercept (point of zero net investment) was then taken to be the critical level of utilization.

Depreciation rates were inferred from the 1981 Tangible Reproducible Wealth series.

The capital coefficients were then aggregated to 48 sectors, prorating on 1981 Kansas outputs.

Exports and imports:

Export and import coefficients were estimated using the 1977 MRIO for material flows, and 1981 locational quotients for flows of services.

Regional income coefficients:

Property income was assumed exported in all sectors except agriculture, where all income was assumed received by Kansans.

BLS wage bill data were used to estimate 1981 wage coefficients. Census of government data were used to infer government demands in Kansas.

The multipliers were initially estimated by 48 sectors. For comparability with the econometric model, the multipliers were then aggregated to 11 sectors by prorating on Kansas exports.

Data Sources:

Kansas Department of Human Resources, Research and Analysis Section. Labor Market Summary. March, 1988. Photocopy.

Transportation in America: A Statistical Analysis of Transportation in the United States. Washington, D.C.: Transportation Policy Associates, March, 1983

U.S. Bureau of the Census. County Business Patterns 1981: United States. Series CBP-81, no. 1. Washington, D.C.: Government Printing Office, 1982.

U.S. Bureau of the Census. County Business Patterns 1981: Kansas. Series CBP-81, no. 18. Washington, D.C.: Government Printing Office, 1983.

U.S. Bureau of the Census. Government Finances in 1980-81. Series GF81, no. 5. Washington, D.C.: Government Printing Office, 1982.

U.S. Bureau of the Census. Government Finances in 1981-82. Series GF82, no. 5. Washington, D.C.: Government Printing Office, 1983.

U.S. Bureau of the Census. 1982 Census of Governments: Compendium of Government Finances. Series GC82 no. 4. Washington, D.C.: Government Printing Office, December, 1984.

U.S. Department of Commerce, Bureau of Economic Analysis. "The Input-Output Accounts of the U.S. Economy, 1981." Survey of Current Business 67, no. 1 (January, 1987): 42-58.

U.S. Department of Commerce, Bureau of Economic Analysis. The National Income and Product Accounts of the United States, 1929-82. Washington, D.C.: Government Printing Office, September, 1986.

U.S. Department of Commerce, Bureau of Economic Analysis. "New Structures and Equipment by Using Industries, 1977." Survey of Current Business 65, no. 11 (November, 1985): 26-35.

U.S. Department of Commerce, Bureau of Economic Analysis. Personal Income by Major Source and Earnings by Major Industry. Table CA5. Washington, D.C.: Bureau of Economic Analysis, April, 1988. Computer Printout.

U.S. Department of Commerce, Bureau of Economic Analysis. Quarterly State Personal Income, 1981:I-1984-IV. Table SQ7. Washington, D. C.: Bureau of Economic Analysis, October 15, 1987. Diskette.

U.S. Department of Health and Human Services. The Multiregional Input-Output Accounts, 1977, by Jack G. Faucett, Linda K. Lent, and Harry J. Chmelynski. Contract Number HHS-100-81-0057. August, 1983. National Archives and Records Service. Computer Tape.

U.S. Department of Labor, Bureau of Labor Statistics. Employment and Wages, Annual Averages 1981. Washington, D.C.: Government Printing Office, November, 1983. Microfiche.

APPENDIX 2: ECONOMETRIC ESTIMATES.

Table 1(1). Parameter Estimates for Basic Industries Model One Lag Of Basic Industries

DEP VARIABLE: Ks. Wage Bill, Wholesale and Retail Trade

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9954

DURBIN-WATSON D 1.909

VARIABLE	PARAMETER ESTIMATE	t FOR H0: PARAMETER = 0
Ks Wage Bill, Mining	0.48361	2.68
Ks Wage Bill, Durables	0.09238	2.46
Ks Wage Bill, Nondurables	0.60248	4.58
Ks Wage Bill, Fed. Gov.	0.31697	3.62
Ks Farm Income	.00622754	1.01
Exogenous Income	0.08939	5.01
1st Order Autocorrelation	0.99461	71.22

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 1(2). Parameter Estimates for Basic Industries Model One Lag Of Basic Industries

DEP VARIABLE: Ks. Wage Bill, Construction

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9175

DURBIN-WATSON D 1.953

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
Ks Wage Bill, Durables	0.07179	1.62
Ks Wage Bill, Nondurables	0.25399	1.79
Ks Wage Bill, Fed. Gov.	0.08010	0.85
Exogenous Income	0.01559	0.91
1st Order Autocorrelation	0.95777	33.50

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 1(3). Parameter Estimates for Basic Industries Model
One Lag Of Basic Industries

DEP VARIABLE: Ks. Wage Bill, Transportatiom Communication & Utilities

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9835

DURBIN-WATSON D 2.155

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
Ks Wage Bill, Mining	0.10906	0.53
Ks Wage Bill, Nondurables	0.43624	4.20
Ks Wage Bill, Fed. Gov.	0.14448	1.89
Ks Farm Income	0.01054	1.50
Exogenous Income	0.05569	4.96
1st Order Autocorrelation	0.90659	13.22

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 1(4). Parameter Estimates for Basic Industries Model
One Lag Of Basic Industries

DEP VARIABLE: Ks. Wage Bill, Finance Insurance & Real Estate

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9981

DURBIN-WATSON D 2.300

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
Ks Wage Bill, Durables	0.02073	1.72
Ks Wage Bill, Nondurables	0.09910	2.45
Ks Wage Bill, Fed. Gov.	0.07287	2.71
Ks Farm Income	.00140768	0.67
Exogenous Income	0.02902	5.22
1st Order Autocorrelation	1.02624	201.45

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 1(5). Parameter Estimates for Basic Industries Model One Lag Of Basic Industries

DEP VARIABLE: Ks. Wage Bill, Services

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9984

DURBIN-WATSON D 2.352

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
Ks Wage Bill, Mining	0.56018	3.61
Ks Wage Bill, Durables	0.07070	2.21
Ks Wage Bill, Nondurables	0.22782	2.06
Ks Wage Bill, Fed. Gov.	0.19926	2.79
Exogenous Income	0.05026	3.33
1st Order Autocorrelation	1.02113	277.39

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 1(6). Parameter Estimates for Basic Industries Model One Lag Of Basic Industries

DEP VARIABLE: Ks. Wage Bill, State and Local Government

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9834

DURBIN-WATSON D 2.069

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
Ks Wage Bill, Mining	0.09652	0.41
Ks Wage Bill, Nondurables	0.74203	5.92
Ks Wage Bill, Fed. Gov.	0.38247	4.55
Ks Farm Income	.00039573	0.05
Exogenous Income	0.06186	5.04
1st Order Autocorrelation	0.87137	13.95

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 1(7). Parameter Estimates for Basic Industries Model One Lag Of Basic Industries

DEP VARIABLE: Ks. Wage Bill, Agricultural Services

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9212

DURBIN-WATSON D 2.016

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
Ks Wage Bill, Durables	0.0033606	1.28
Ks Wage Bill, Fed. Gov.	.00149844	0.24
Exogenous Income	.00331833	4.03
1st Order Autocorrelation	0.95474	29.20

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 2(1). Parameter Estimates for Export Proxy Model
One Lag Of Export Proxies

DEP VARIABLE: Ks. Wage Bill, Wholesale and Retail Trade

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9978

DURBIN-WATSON D 1.823

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
US Wage Bill, Trade - Lag0	.00599615	4.79
US Wage Bill, Mining - Lag1	.00248003	1.52
US Wage Bill, Durables - Lag1	.00069341	1.42
US Wage Bill, Transp. - Lag1	.00076263	0.45
US Wage Bill, S&L Gov. - Lag1	.00092427	0.74
US Wage Bill, Ag. Serv. - Lag1	0.01022	0.81
US Farm Income - Lag1	0.14335	0.59
Ks Exogenous Income - Lag0	0.02762	1.58
Ks Exogenous Income - Lag1	.00672628	0.36
1st Order Autocorrelation	0.97847	42.78

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 2(2). Parameter Estimates for Export Proxy Model
One Lag Of Export Proxies

DEP VARIABLE: Ks. Wage Bill, Mining

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9851

DURBIN-WATSON D 1.571

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
US Wage Bill, Mining - Lag0	.00796393	9.54
US Wage Bill, Mining - Lag1	0.0032012	3.64
Ks Exogenous Income - Lag1	.00838562	3.16
1st Order Autocorrelation	1.01125	58.87

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 2(3). Parameter Estimates for Export Proxy Model
One Lag Of Export Proxies

DEP VARIABLE: Ks. Wage Bill, Construction

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9275

DURBIN-WATSON D 2.034

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
US Wage Bill, Const. - Lag0	.00703361	4.60
US Wage Bill, S&L Gov. - Lag1	.00054843	0.59
US Wage Bill, Ag. Serv. - Lag1	.00731476	0.45
1st Order Autocorrelation	0.93098	26.28

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 2(4). Parameter Estimates for Export Proxy Model
One Lag Of Export Proxies

DEP VARIABLE: Us. Wage Bill, Durable Goods Manufacturing

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9622

DURBIN-WATSON D 2.316

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
US Wage Bill, Durables - Lag0	.00689256	11.70
US Wage Bill, F.I.R.E. - Lag1	.00140864	0.45
US Wage Bill, Ag. Serv. - Lag1	0.02655	0.64
1st Order Autocorrelation	0.95233	26.86

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 2(5). Parameter Estimates for Export Proxy Model One Lag Of Export Proxies

DEP VARIABLE: Ks. Wage Bill, Nondurable Goods Manufacturing

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9868

DURBIN-WATSON D 2.189

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
US Wage Bill, Nondur. - Lag0	.00304132	5.20
US Wage Bill, Mining - Lag1	.00295128	2.17
US Wage Bill, Durables - Lag1	.00095975	2.98
US Wage Bill, F.I.R.E. - Lag1	0.0003893	0.62
Ks Exogenous Income - Lag0	.00619636	0.55
Ks Exogenous Income - Lag1	0.03254	2.75
1st Order Autocorrelation	0.71965	9.58

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 2(6). Parameter Estimates for Export Proxy Model One Lag Of Export Proxies

DEP VARIABLE: Ks. Wage Bill, Transportation and Utilities

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9924

DURBIN-WATSON D 2.241

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
US Wage Bill, Transp. - Lag0	0.01135	57.36
US Farm Income - Lag1	0.39764	1.86
1st Order Autocorrelation	0.95761	37.07

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 2(7). Parameter Estimates for Export Proxy Model
One Lag Of Export Proxies

DEP VARIABLE: Ks. Wage Bill, Finance, Insurance, and Real Estate

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9987

DURBIN-WATSON D 2.113

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
US Wage Bill, F.I.R.E. - Lag0	0.0032217	3.15
US Wage Bill, Mining - Lag1	.00083745	1.33
US Wage Bill, Durables - Lag1	7.26E-05	0.37
US Wage Bill, Transp. - Lag1	.00027542	0.40
US Wage Bill, Services - Lag1	.00011778	0.18
US Wage Bill, S&L Gov. - Lag1	.00071256	1.14
US Farm Income - Lag1	0.12129	1.25
Ks Exogenous Income - Lag0	.00549771	0.95
Ks Exogenous Income - Lag1	.00510718	0.82
1st Order Autocorrelation	1.01318	65.77

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 2(8). Parameter Estimates for Export Proxy Model
One Lag Of Export Proxies

DEP VARIABLE: Ks. Wage Bill, Services

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9989

DURBIN-WATSON D 2.244

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
US Wage Bill, Services - Lag0	.00446308	4.48
US Wage Bill, Mining - Lag1	.00383829	2.53
US Wage Bill, Transp. - Lag1	.00165942	1.24
US Wage Bill, Ag. Serv. - Lag1	0.01401	1.14
Ks Exogenous Income - Lag0	0.02074	1.41
1st Order Autocorrelation	1.00677	97.93

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 2(9). Parameter Estimates for Export Proxy Model One Lag Of Export Proxies

DEP VARIABLE: Ks. Wage Bill, State and Local Government

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9873

DURBIN-WATSON D 1.951

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
US Wage Bill, S&L Gov. - Lag0	.00290761	2.70
US Wage Bill, Mining - Lag1	.00131315	0.55
US Wage Bill, Nondur. - Lag1	.00383196	3.65
US Wage Bill, F.I.R.E. - Lag1	.00173129	1.35
US Wage Bill, Fed. Gov. - Lag1	.00278435	1.82
Ks Exogenous Income - Lag0	0.03620	1.99
1st Order Autocorrelation	0.78822	10.30

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 2(10). Parameter Estimates for Export Proxy Model One Lag Of Export Proxies

DEP VARIABLE: Ks. Wage Bill, Federal Government

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9418

DURBIN-WATSON D 1.683

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
US Wage Bill, Fed. Gov. - Lag0	.00891772	32.29
US Wage Bill, Mining - Lag1	.00114842	0.78
1st Order Autocorrelation	1.00268	75.79

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 2(11). Parameter Estimates for Export Proxy Model
One Lag Of Export Proxies

DEP VARIABLE: Ks. Wage Bill, Agricultural Services

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.9522

DURBIN-WATSON D 2.117

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
US Wage Bill, Ag. Serv. - Lag0	.00787727	8.02
US Wage Bill, Nondur. - Lag1	2.61E-05	0.31
US Wage Bill, Transp. - Lag1	5.91E-05	0.44
US Farm Income - Lag1	0.01224	0.59
1st Order Autocorrelation	1.00593	79.34

RANGE OF FIT: DATE = 67Q2 TO 87Q4

Table 2(12). Parameter Estimates for Export Proxy Model
One Lag Of Export Proxies

DEP VARIABLE: Ks. Farm income

SEEMINGLY UNRELATED REGRESSION - AR1 ERRORS

ADJ R-SQ 0.7899

DURBIN-WATSON D 2.189

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER = 0
US Farm Income - Lag0	30.40604	18.98
1st Order Autocorrelation	0.60869	7.72

RANGE OF FIT: DATE = 67Q2 TO 87Q4

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