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Proxy Data and Income Estimates: The Economic Lag of Central and Eastern Europe

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In his recent article in this JOURNAL David F. Good gave income estimates for 22 regions of the Habsburg Empire from 1870 to 1910 and for the successor-state territories.[1] The article is based on a proxy-data approach that was apparently invented by Wilfred Beckerman and Robert Bacon. It has been employed by several authors, including N. F. R. Crafts, who used it to estimate Austrian and Hungarian incomes as well as the incomes of other European states, and Good himself in an earlier article.[2] In his latest article Good used data from 11 European countries to estimate the usefulness of three proxy variables for predicting income.[3] These variables were the percentage of the labor force employed in the nonagricultural sectors, the crude death rate, and the number of letters posted per capita. The logarithms of these variables were used as the independent variables in a regression equation, with the logarithm of GDP per capita as the dependent variable. The regression coefficients were then used to estimate GDP per capita for the Habsburg monarchy on the regional level, whereby data for the independent variables from 22 regions of the Empire were employed.

This note will demonstrate that the measures used by Good produced statistical artifacts in both the absolute level of incomes and the economic growth rates; Good's estimates suffer from biases caused by inappropriate functional specification and by the inappropriate application to backward regions of coefficients that were estimated for relatively advanced countries. Second, I show that even within the set of European countries, individual country effects alter or offset the impact of variables generally associated with income and thus severely restrict the value of those proxy variables for predicting income even in advanced economies.

To begin with, I ascertain the robustness of Good's specification, changing his regression model superficially. Instead of employing the share of the nonagricultural sectors in the labor force in its logarithmic form as an independent variable, I use the logarithm of the share of agriculture in the labor force. The informational content thereby remains the same, since the percentages of the agricultural and the nonagricultural sectors add up by definition to 100 percent. The results are shown in Table 1. Equation 1 resummarizes Good's model; equation 2 gives the values of the alternative model.[4] Inserting the data for the independent variables from the 22 regions of the Habsburg Empire in either of the two equations should yield the same estimate of GDP per capita, given the fact that the information provided by the independent variables and the basic structure of the model remain virtually unchanged.

Actually, the results are significantly different, as is shown in Table 2. The regression coefficients estimated from equations 1 and 2 were used to calculate estimates for each of the 22 regions and for Imperial Austria, Imperial Hungary, and the Habsburg Empire. The

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[1] Good, "Economic Lag."

[2] Beckerman and Bacon, "International Comparisons"; Crafts, "Gross National Product"; and Good, "Austria-Hungary."

[3] Good's data set originally includes 12 countries, but Russia had to be excluded from the estimation due to missing data.

[4] The differences between Good's coefficients in equation 1 and mine are due to rounding in Good's published data; the differences are minimal and do not disturb the main argument.

TABLE 1
REGRESSION RESULTS: GDP PER CAPITA AS A FUNCTION OF PROXY VARIABLES IN 12 EUROPEAN STATES AND BELGIUM, 1850–1910

Equation	*CON*	*LCDR*	*LNAGR*	*LAGR*	*LMAIL*	*N*	R^2	*SEE*
(1)	5.177881	-0.268182	0.609190		0.142147	59	0.88675	0.11243
	(14.013)***	(-3.477)**	(7.480)***		(7.345)***			
(2)	8.457579	-0.209998		-0.296292	0.168591	59	0.89379	0.10888
	(28.987)***	(-2.819)**		(-7.956)***	(10.224)***			
(3)	5.495194	0.027929	0.257692		0.229258	7	0.99941	0.00680
	(15.008)***	(1.457)	(2.959)		(21.946)***			

* = Significant at the 5 percent level.
** = Significant at the 1 percent level.
*** = Significant at the 0.05 percent level.
Notes: The dependent variable is the natural logarithm of gross domestic product per capita; *CON* is the constant term; *LCDR* is the logarithm of the crude death rate; *LNAGR* is the logarithm of the share of the nonagricultural sectors in the total labor force; *LAGR* is the logarithm of the share of the agricultural sector in the total labor force; *LMAIL* is the logarithm of letters posted per capita; *FGIN* is a dummy variable denoting France, Germany, Italy and Norway. *N* is the number of cases; R^2 is the adjusted coefficient of determination. The figures in parentheses are *t*-statistics.
Source: Good, Estimating Pre-1914 Incomes, tables A-1 and A-2.

regional estimates were then compared; the mean difference between estimates 1 and 2 is significantly different from zero.[5] Among 125 pairs of estimates, 44 fall outside the 95 percent interval.[6] The differences are not randomly distributed; they are greater for the earlier years and for the more backward regions, whereas the 1910 results and the results for the more industrialized regions are less divergent. Most *t*-values have the same sign; the few exceptions are small and concern advanced regions.[7]

This means that equation 2 suggests a higher GDP per capita in the years around 1870 than equation 1 and, accordingly, lower economic growth between 1870 and 1910; due to the large standard errors of the estimates of the growth rates, the differences between the

[5]For the 22 regions of the Habsburg Empire the *t*-value is 15.41 and was calculated according to the formula $t = \bar{d} / (s_d^2 / n)^{0.5}$, where $\bar{d}$ is the mean difference (d) between the predicted values of the logarithm of GDP per capita (*LYP*), based on equations 1 and 2, respectively, and s_d is the standard deviation of d.

[6]The *t*-values for the differences in the estimates for the *k*th region in the *j*th year, based upon equations 1 and 2, were calculated according to the following formula:

$$t_{jk} = ({}_2\hat{Y}_{jk} - {}_1\hat{Y}_{jk}) \,/\, ({}_2S^2_{\hat{Y}jk} + {}_1S^2 + {}_2S^2_{\hat{Y}jk} + {}_2S^2)^{0.5}$$

where ${}_1\hat{Y}_{jk}$ and ${}_2\hat{Y}_{jk}$ are the predicted values of *LYP* of the *k*th region in the *j*th year, based on equations 1 and 2, respectively; ${}_1S$ and ${}_2S$ are the standard errors of equations 1 and 2, respectively, and ${}_1S_{\hat{Y}jk}$ and ${}_2S_{\hat{Y}jk}$ are the standard errors of ${}_1\hat{Y}_{jk}$ and ${}_2\hat{Y}_{jk}$, respectively. See Sen and Srivastava, *Regression Analysis*, pp. 71–72.

[7]These results remain virtually unchanged if we take into consideration that Good did not use the 1869 and 1880 census data for the shares of agriculture in the labor force in 1870 and 1880 but extrapolated these values back from the 1890, 1900, and 1910 values. Thus the estimates of the 1870 and 1880 values suffer from errors in measurement apart from the usual errors in census data. I recalculated the 1870 and 1880 GDP estimates using the lower bound as well as the upper bound values of the 95 percent confidence interval of Good's estimate of the 1870 and 1880 sectoral shares. Equations 1 and 2 yield significantly different results in either calculation.

TABLE 2
ARTIFICIAL LEVELS OF GDP PER CAPITA IN 22 REGIONS OF THE HABSBURG EMPIRE, 1870–1910
(1980 international dollars)

Region	1870 (1)	1870 (2)	1880 (1)	1880 (2)	1890 (1)	1890 (2)	1900 (1)	1900 (2)	1910 (1)	1910 (2)	Growth Rate (percentage) (1)	Growth Rate (percentage) (2)
Lower Austria	1,380	1,361	1,495	1,456	1,702	1,662	2,085	2,081	2,290	2,297	1.34	1.40
Upper Austria	716	923	851	1,031	1,003	1,151	1,156	1,298	1,242	1,356	1.41[a]	1.00
Salzburg	789	995	955	1,137	1,152	1,310	1,372	1,485	1,534	1,589	1.70[a]	1.21
Styria	633	941	738	1,025	857	1,107	1,033	1,263	1,199	1,394	1.62[a]	0.99
Carinthia	643	977	764	1,092	834	1,098	1,007	1,214	1,267	1,431	1.64[a]	0.87
Tyrol/Vorarlberg	669	948	764	1,006	917	1,143	1,161	1,353	1,434	1,570	1.95[a]	1.31
Carniola	487	824	571	919	657	985	728	1,056	961	1,226	1.61[a]	0.93
Littoral	747	994	861	1,070	966	1,119	1,133	1,272	1,476	1,532	1.64[a]	1.04
Dalmatia	354	796	392	859	443	957	492	1,028	623	1,180	1.41[c]	0.97
Bohemia	939	1,015	1,049	1,085	1,224	1,233	1,494	1,479	1,712	1,667	1.55	1.30
Moravia	787	949	927	1,065	1,079	1,176	1,261	1,337	1,429	1,447	1.50	1.07
Silesia	862	930	1,063	1,110	1,217	1,235	1,415	1,402	1,646	1,599	1.58	1.32
Galicia	397	734	441	774	534	880	619	1,061	706	1,107	1.51[b]	1.14
Bukowina	416	750	469	814	538	860	678	1,026	739	1,119	1.54[b]	1.03
Danube Right Bank	448	696	532	780	670	918	818	1,083	1,008	1,226	2.07[a]	1.46
Danube Tisza	641	818	820	997	948	1,074	1,248	1,297	1,506	1,509	2.13[a]	1.49
Danube Left Bank	507	748	576	802	722	932	847	1,069	1,036	1,211	1.83[a]	1.25
Tisza Right Bank	486	728	547	781	694	916	864	1,079	1,034	1,213	1.97[a]	1.34
Tisza Left Bank	418	712	467	760	581	877	721	1,032	870	1,146	1.92[a]	1.26
Tisza-Maros	406	677	486	771	577	848	706	990	863	1,117	1.90[a]	1.25
Transylvania	372	666	460	785	526	840	621	962	816	1,091	1.89[a]	1.19
Croatia-Slavonia	314	638	411	813	447	838	514	922	698	1,066	1.85[b]	1.15[a]
Imperial Austria	725	946	826	1,011	978	1,126	1,183	1,325	1,347	1,450	1.48[a]	1.10
Imperial Hungary	452	717	549	828	656	914	806	1,062	1,011	1,211	2.00[a]	1.30
Habsburg Empire	620	865	719	940	857	1,045	1,039	1,226	1,218	1,357	1.62[a]	1.15

TABLE 2—continued

* = Difference significant at the 5 percent level (t-value of the difference larger than 2.000).
[a] Standard errors larger than 0.5.
[b] Standard errors larger than 0.6.
[c] Standard errors larger than 0.7.
All Standard errors of the growth rates are larger than 0.4.
Notes: The figures were estimated by using the regression coefficients from both equations in Table 1 with the values of the independent variables for 22 regions. Columns 1 were calculated using equation 1; columns 2 were calculated using equation 2. For the calculation of the t-values of the differences and the standard errors of the growth rates, see the text.
Source: Good, "Estimating Pre-1914 Incomes," table A-3.

regional growth rates are not significant.[8] However, this does not confirm Good's conclusion that regional disparities within the Habsburg Empire began to close in the pre-World War I decades, which is a substantial revision of his prior results that are based on the proxy-data approach as well.[9] Since the standard errors yield confidence intervals of about ± 1.5 percent, any difference between growth rates mentioned in Table 2, either between estimates for a single region or between estimates for different regions, is insignificant.

These inconsistencies were generated using logarithms of percentage shares as independent variables in a regression. Which is a better indicator for the sectoral change in an economy: the share of agriculture in the labor force or the share of the other sectors? The question sounds absurd, but the answer determines the result of the income estimation. The reason lies in the different sectoral structures of western Europe and the Habsburg Empire. The European countries whose data were used for the estimation of equations 1 and 2 show mostly the sectoral structure of comparably advanced economies. In these countries the shares of agriculture in the labor force are below 53 percent in eight of ten cases, and the unweighted mean share of agriculture is about 42 percent. In this range equations 1 and 2 fit equally well and yield similar GDP estimates and similar relations between income estimates for different countries: comparing GDP per capita in two countries with shares of agriculture in the labor force of 10 percent and 50 percent, respectively, we find that the GDP in the more advanced country is, *ceteris paribus*, 1.4 times as large as in the backward country according to equation 1 and 1.6 times as large according to equation 2.

[8]The regional growth rates are identical with the beta-coefficients in two bivariate regression equations that were calculated for every region:

$$_1\hat{Y}_{jk} = {_1c_k} + {_1b_k}\ YEAR_j \qquad (5)$$

$$_2\hat{Y}_{jk} = {_2c_k} + {_2b_k}\ YEAR_j \qquad (6)$$

where $YEAR_j$ is the jth year. $_1b_k$ and $_2b_k$ are the growth rates for the kth region, according to equations 1 and 2, respectively, and $_1c_k$ and $_2c_k$ are constant terms. The calculation of the standard errors of $_1b_k$ and $_2b_k$ has to take into consideration that $_1\hat{Y}_{jk}$ and $_2\hat{Y}_{jk}$ are estimates with considerable standard errors themselves. Thus the standard errors of the growth rates for the kth region, $_1s_{bk}$ and $_2s_{bk}$, respectively, were calculated according to the following formulae:

$$_1s_{bk} = ((\sum_{j=1870}^{1910} ((_1\hat{Y}_{jk} - {_5\hat{Y}_{jk}})^2 + {_1S^2_{\hat{Y}jk}} + {_2S^2}))/(n-2))^{0.5} / (\sum_{j=1870}^{1910} (YEAR_j - 1880)^2)^{0.5} \quad \text{and}$$

$$_2s_{bk} = ((\sum_{j=1870}^{1910} ((_2\hat{Y}_{jk} - {_6\hat{Y}_{jk}})^2 + {_2S^2_{\hat{Y}jk}} + {_2S^2}))/(n-2))^{0.5} / (\sum_{j=1870}^{1910} (YEAR_j - 1880)^2)^{0.5}$$

where $_5\hat{Y}_{jk}$ and $_6\hat{Y}_{jk}$ are the predicted values of *LYP* of the kth region in the jth year, based on equations 5 and 6, respectively.

[9]Good, "Austria-Hungary."

The sectoral structure is significantly different in the comparably backward Habsburg regions where the shares of agriculture in the labor force are above 59 percent in eight of ten cases, and the unweighted mean of the share of agriculture is about 70 percent. In the major part of the Habsburg regions the shares of agriculture are higher than in any western European country. Due to the logarithmic form of equations 1 and 2, their application to those outlying cases is likely to produce severely biased results for GDP estimates and income relations between different regions: comparing GDP per capita in two regions with shares of agriculture in the labor force of 50 percent and 90 percent, respectively, we find that the GDP in the more advanced region is now, *ceteris paribus*, 2.7 times as large as in the more backward region according to equation 1 and just 1.2 times as large according to equation 2.

The share of agriculture in the labor force and the share of the other sectors yield identical estimates of GDP only if they are used in their natural instead of their logarithmic form.[10] However, even these results are misleading and inappropriate both because of the composition of the data set and for formal reasons. As the European countries involved in the estimation were advanced economies, the coefficients tend to underestimate GDP and overestimate the growth rates of backward regions like the major part of the Habsburg Empire.[11] In any other case the linear approach would not be feasible either, since the share of the nonagricultural sectors is limited by 100 percent; thus the relation between the sectoral shares and GDP must be nonlinear, and the problem of robustness is unavoidable in any case.

According to these results, findings for advanced European countries should not be extrapolated to the backward regions of the Habsburg Empire. The question still remains of whether coefficients estimated for a set of European countries offer much of a clue to the developments in the individual countries involved in the estimation. Unfortunately, most equations calculated on the national level do not yield significant results at all due to the small number of observations for each country.[12] This is true as well if the estimates on the national level are corrected for autocorrelation by estimating a regression with first-order autocorrelated errors. Results for the pooled data set, however, suggest the existence of autocorrelation effects, since the error terms correlate positively with the error terms of the previous time period. Correction for autocorrelation yields somewhat lower impacts of the independent variables on *LYP*, but the results are not very robust.[13]

Among the equations calculated on the national level, Belgium may be used as an example of individual country effects. According to equation 3, the beta-coefficient for *LMAIL* in Belgium is between 0.196 and 0.263 at the 5 percent level of significance and is thus significantly different from the coefficient for *LMAIL* in all 11 European countries (between 0.103 and 0.181 at the 5 percent level of significance); the same is true for *LCDR*,

[10]In the two regression equations this would have yielded identical coefficients for the death rate and the mailed items, different constant terms, and different signs for otherwise identical coefficients for the sectoral variables.

[11]Employing just the sectoral variable as a variable in the regression equation and leaving aside the other two proxies would, for example, yield an annual growth rate of 0.78 percent for advanced Lower Austria and 3.36 percent for backward Croatia-Slavonia. The equation is $YP = -241 + 3022\ NAGR$, where *YP* is GDP per capita (adjusted R^2 is 0.73341; the standard error of the estimate is 262).

[12]The same is true for separate calculations by year. In the pooled sample, however, the mean residuals, broken down by years, are not significantly different from zero and, accordingly, dummy variables for single years have no significant impact on *LYP*.

[13]The coefficient of correlation between the error terms $e_{k,j-10}$ and $e_{k,j}$ can be used as an estimator of the coefficient of autocorrelation (*RHO*) in a combined time series and cross-section data set, especially if the time series are short. The estimated *RHO*, based on equation 1 would then be 0.76. For the estimation and transformation procedure; see Greene, *Econometric Analysis*, pp. 456–57.

where the coefficient is −0.033 to 0.089 for Belgium (and thus not significantly different from zero), and −0.423 to −0.114 for the eleven countries. The Belgian coefficient for *LNAGR* is not significantly different from zero or from the coefficient for the 11 countries.

Individual country effects are observable in the residuals of equations 1 and 2 as well, since a number of countries show mean residuals significantly different from zero. If we include dummy variables for the United Kingdom, the Netherlands, Belgium, Denmark, and Sweden in the model, in addition to the three proxy variables employed by Good, both *LNAGR* and *LCDR* have no significant impact on *LYP* any more.[14] Including dummy variables for single years does not alter this result since the time variables have no significant impact on *LYP*. Thus, among the variables represented in Good's data set, the best predictor for GDP is the number of letters posted per capita in connection with individual country effects. With given mailing rates, GDP per capita is higher in the five countries mentioned, compared to the other six European countries represented in the sample. In Sweden this effect is significantly weaker than in the United Kingdom and the Netherlands whereas the differences between Denmark and Belgium on the one hand and Sweden, the Netherlands, and the United Kingdom on the other, are not significant. Clearly, models including individual country effects cannot be used for predicting GDP in the Habsburg Empire.[15]

Although the three indicators used in Good's estimations may be associated with GDP and economic growth on a general level, their relation to income may vary in different countries due to interacting variables. A change in the share of various sectors in the labor force may reflect a change in the pattern of sectoral labor productivities, but its relation to overall productivity cannot be determined unambiguously. Large differences in the growth rates of sectoral labor productivities may cause considerable changes in the sectoral structure even in a slowly growing economy whereas an economy with fast rising productivity in all sectors and, consequently, high growth rates may show little sectoral change. Even if we acknowledge that in a growing economy demand for agricultural products usually rises more slowly than demand for nonagricultural products, rapid growth may be balanced, since demand for agricultural products is not necessarily restricted to the area of production. European countries showed quite different patterns of sectoral change and economic growth. In 1850 Denmark, Belgium, and France, for example, started at a similar level of GDP per capita and a similar share of agriculture in the labor force. In 1910 Denmark and Belgium had more than doubled their GDP per capita; the share of agriculture in the labor force had shrunk from almost 50 percent to 23 percent in Belgium whereas Denmark, being a strong exporter of agricultural products, still had a share of agriculture in the labor force of 42 percent. France's share of agriculture in the labor force was the same as Denmark's in 1910, but France's GDP per capita had grown by just two-thirds. Similarly, the data on sectoral structure and agricultural productivity in the Habsburg Empire in the nineteenth century suggest that each region experienced its specific development in terms of sectoral change and rise of productivity. In Moravia, for example, the share of the nonagricultural sectors grew only moderately, but labor productivity in agriculture was rising particularly

[14]The equation is (the values in parentheses are *t*-statistics):

$$\underset{(16.619)}{LYP = 6.343} \; \underset{(-1.805)}{-\,0.105LCDR} + \underset{(1.276)}{0.115LNAGR} + \underset{(14.544)}{0.212LLET} +$$

$$\underset{(6.756)}{0.338U} + \underset{(7.246)}{0.294N} + \underset{(5.957)}{0.200B} + \underset{(5.767)}{0.200D} + \underset{(3.130)}{0.122S}$$

where the dummy variables denoting countries are *U* for the United Kingdom, *N* for the Netherlands, *B* for Belgium, *D* for Denmark, and *S* for Sweden. R^2 in this model is 0.955, the standard error is 0.071.

[15]For a more sophisticated comparative model including country specific factors, see Foreman-Peck, "Model."

fast there; in Tyrol-Vorarlberg the nonagricultural sectors grew faster whereas agricultural productivity was rising more slowly than in Moravia.[16] Although we still lack exhaustive data on internal trade in the Habsburg Empire, we know that there was considerable trade in agricultural as well as nonagricultural goods between the regions. The large market of the Habsburg Empire (which was a customs union from 1850 on) thus allowed for specific regional patterns of sectoral change and change in productivity. Relying on sectoral data as a proxy for income and neglecting the productivity issue would be misleading in such a setting.

The other two independent variables do not seem to be dependable proxies for GDP on the regional level either. The postal service contributed only a small percentage of the GDP, but it plays an important role in Good's estimates. As mentioned above, mailings are still a valid proxy for income even when individual country effects are taken into consideration, but these individual country effects may change the result by a large degree. It is not likely that the regional differences within the heterogeneous Habsburg Empire were smaller than the differences between large countries like Great Britain and France; with mailing rates held constant, the GDP was about 1.5 times greater in Great Britain than in France. The employment of mailings per capita as a proxy for GDP on the regional level will thus be misleading when an industry that requires comparably large numbers of mailings shows relatively high growth rates in a certain region, as may be the case with tourism in Tyrol and Salzburg. The crude death rate is of minor importance in terms of its contribution to the estimate. However, as far as regional developments are concerned, urbanization and industrialization may, *ceteris paribus*, have raised the incomes in the respective regions, but they may have raised rather than lowered the death rates in those same areas, too. The successes in lowering the death rates were connected directly with national health policy and indirectly with the growth rates in the national economy as a whole but not with the situation of the respective regional economy.

All this suggests that a pattern that seems clear on the European level may change or disappear on the national or regional level. What may be true for the average need not be true for any one selected case. Functions that have been estimated for a set of European countries should not be used for the prediction of developments on a disaggregated level since we cannot presume that individual country or regional effects will be absent. If we have already observed individual country effects, as was the case in Good's European sample, we even can safely assume that individual regional effects will be present in other cases as well.

The proxy-data approach does not seem to offer a reliable technique for income estimation and international or interregional comparison, even if all countries or regions involved are on a similar level of development. This approach becomes even less reliable when the estimation is conducted for advanced countries and the results are extrapolated to backward countries, be it western Europe and the backward regions of the Habsburg Empire in the nineteenth century or developed and underdeveloped countries in the twentieth century.

Indirect measures of GDP may be a valid, and sometimes the only, way of income estimation, provided that their relation to GDP is theoretically reflected and appropriately specified. However, the application of a methodology that, in Crafts's words, "is not, of course, one in which an equation can be based on a well-articulated theory," and the retreat to "a structural equation that predicts income per capita, not one that tests a well-specified theory about its determinants," as Good put it, will yield predictions that can hardly be evaluated.[17] This enhances the danger of being deceived by mere correlations that are

[16]Sandgruber, *Österreichische Agrarstatistik*, pp. 111–15; and Pammer, "Regional Agricultural Productivity."

[17]Crafts, "Gross National Product," p. 391; and Good, "Economic Lag," p. 880.

without any functional significance. Thus I would suggest that one should abstain from such exercises. The tedious work of gathering basic data from the microeconomic level and of detailed regional studies, which is perhaps the traditional method, still remains to be done in the case of the Habsburg Empire. Resorting to macroeconomic proxy data does not constitute an acceptable alternative.

REFERENCES

Beckerman, Wilfred, and Robert Bacon. "International Comparisons of Income Levels: A Suggested New Measure." *Economic Journal* 76, no. 3 (1966): 519–36.

Crafts, N. F. R. "Gross National Product in Europe 1970–1910: Some New Estimates." *Explorations in Economic History* 20, no. 4 (1983): 387–401.

Foreman-Peck, James. "A Model of Later Nineteenth Century European Economic Development." *Revista de Historia Económica* 13, no. 3 (1995): 441–71.

Good, David F. "Austria-Hungary." In *Patterns of European Industrialization. The Nineteenth Century*, edited by Richard Sylla and Gianni Toniolo, 218-47. London: Routledge, 1991.

______. "Estimating Pre-1914 Incomes in the Post-1919 Successor States of the Habsburg Empire: Supplementary Notes." Unpublished Manuscript. University of Minnesota, 1993.

______. "The Economic Lag of Central and Eastern Europe: Income Estimates for the Habsburg Successor States, 1870–1910." this JOURNAL 54, no. 4 (1994): 869–91.

Greene, William H. *Econometric Analysis*. 2nd ed. New York: Macmillan, 1993.

Pammer, Michael. "Regional Agricultural Productivity in Cisleithania, 1870–1910." Unpublished Manuscript and Machine-readable Data. Johannes Kepler University, Linz, 1996.

Sandgruber, Roman. *Österreichische Agrarstatistik 1750–1918*. Wien: Verlag für Geschichte und Politik, 1978.

Sen, Ashish, and Muni Srivastava. *Regression Analysis. Theory, Methods, and Applications*. New York: Springer, 1990.