

T-3532

COMPARISONS OF METAL DEMAND DURING
THE TWENTIETH CENTURY

by

Robert J. Laurie

ProQuest Number: 10796366

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



ProQuest 10796366

Published by ProQuest LLC (2019). Copyright of the Dissertation is held by the Author.

All rights reserved.

This work is protected against unauthorized copying under Title 17, United States Code
Microform Edition © ProQuest LLC.

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 – 1346

T-3532

A thesis submitted to the Faculty and the Board of Trustees of the Colorado School of Mines in partial fulfillment of the requirements for the degree of Doctor of Philosophy (Mineral Economics).


Golden, Colorado

Date 10/24/88

Signed: _____

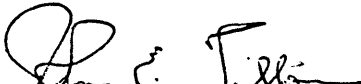

Robert J. Laurie

Approved: _____


Dr. John E. Tilton
Thesis Advisor

Golden, Colorado

Date 10/24/88


Dr. John E. Tilton
Professor and Head,
Mineral Economics Department

ABSTRACT

Recent studies of metal demand have encompassed short periods of time, generally since World War II. Data from the entire twentieth century, 1900 to 1986, is presented for the world, the United States, the United Kingdom, Japan, and Australia for the industrial metals of steel, aluminum, copper, lead, and zinc.

This dissertation tests Malenbaum's Intensity of Use (IOU) hypothesis--that metal IOU when plotted against per capita Gross Domestic Product (GDP) displays an inverted U pattern over time--using 87 years of data, a substantially longer period than the 25 years used by Malenbaum (1978). Metal IOU is defined as the amount of metal used per unit of GDP. Malenbaum's hypothesis is supported and enhanced in a majority of the 25 cases studied. For some of the metals and countries studied, additional data from the nineteenth century would be useful.

In addition, a two-part hypothesis is proposed and tested based on the relationship for metal demand expressed by the IOU technique (as distinct from the IOU hypothesis):

$$D_t = IOU_t * GDP_t$$

The first part states that the period 1946 to 1973 represents a period of growth in metal consumption above the

long-term average growth for the century caused primarily by growth in GNP that was higher than the average for the century. The second part states that the period 1973 to 1986 is a period with growth in metal consumption below the long-term average, caused primarily by lower growth in GNP than the average for the century.

The first part of the hypothesis is partially supported because higher than average growth in metal consumption during the 1946 to 1973 period is determined to be equally the result of higher than average growth in GNP and higher than average growth in metal IOU. The lower than average growth in metal consumption during the 1973 to 1986 period is shown to be almost solely the consequence of substantially lower than average growth in metal IOU, and consequently the second part of the hypothesis is not supported.

TABLE OF CONTENTS

	<u>Page</u>
ABSTRACT	iii
LIST OF FIGURES	vii
LIST OF TABLES	ix
ACKNOWLEDGMENTS	xii
Chapter 1. INTRODUCTION	1
1.1 Objective	1
1.2 Summary of Conclusions	4
1.3 Organization	5
Chapter 2. LITERATURE REVIEW	6
2.1 Introduction	6
2.2 Malenbaum's Hypothesis	6
2.3 Criticisms of Malenbaum's Hypothesis and the IOU Method	9
2.4 The Dissertation Hypothesis	15
2.5 Conclusions	20
Chapter 3. DATA COLLECTION	21
3.1 Introduction	21
3.2 The World	22
3.3 The United States	25
3.4 The United Kingdom	26
3.5 Japan	27
3.6 Australia	28
3.7 Summary	30
Chapter 4. TESTING MALENBAUM'S HYPOTHESIS	31
4.1 Introduction	31
4.2 Methodology	31
4.3 Steel	34
4.4 Aluminum	41
4.5 Copper	47
4.6 Lead	54
4.7 Zinc	61
4.8 Conclusions	67

	<u>Page</u>
Chapter 5. TESTING THE DISSERTATION HYPOTHESIS	74
5.1 Introduction	74
5.2 Methodology	74
5.3 Steel	79
5.4 Aluminum	84
5.5 Copper	88
5.6 Lead	92
5.7 Zinc	95
5.8 Metal Consumption Growth After 1973 ..	98
5.9 Conclusions	102
Chapter 6. CONCLUSIONS	104
6.1 Introduction	104
6.2 Malenbaum's Hypothesis	104
6.3 The Dissertation Hypothesis	107
6.4 Implications Of The Findings	109
6.5 Suggestions For Further Research	110
REFERENCES CITED	113
SELECTED BIBLIOGRAPHY	116
Appendix A: BASIC DATA FOR ALL COUNTRIES	121
Appendix B: WORLD DATA	163
Appendix C: UNITED STATES DATA	167
Appendix D: UNITED KINGDOM DATA	174
Appendix E: JAPANESE DATA	178
Appendix F: AUSTRALIAN DATA	182

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
4-1 World: Steel IOU versus Per Capita GNP	36
4-2 United States: Steel IOU versus Per Capita GNP ..	37
4-3 United Kingdom: Steel IOU versus Per Capita GNP ..	38
4-4 Japan: Steel IOU versus Per Capita GNP	39
4-5 Australia: Steel IOU versus Per Capita GNP	40
4-6 World: Aluminum IOU versus Per Capita GNP	42
4-7 United States: Aluminum IOU versus Per Capita GNP.	43
4-8 United Kingdom: Aluminum IOU versus Per Capita GNP	44
4-9 Japan: Aluminum IOU versus Per Capita GNP	45
4-10 Australia: Aluminum IOU versus Per Capita GNP ...	46
4-11 World: Copper IOU versus Per Capita GNP	49
4-12 United States: Copper IOU versus Per Capita GNP ..	50
4-13 United Kingdom: Copper IOU versus Per Capita GNP..	51
4-14 Japan: Copper IOU versus Per Capita GNP	52
4-15 Australia: Copper IOU versus Per Capita GNP	53
4-16 World: Lead IOU versus Per Capita GNP	55
4-17 United States: Lead IOU versus Per Capita GNP ...	56
4-18 United Kingdom: Lead IOU versus Per Capita GNP ..	57
4-19 Japan: Lead IOU versus Per Capita GNP	58
4-20 Australia: Lead IOU versus Per Capita GNP	59
4-21 World: Zinc IOU versus Per Capita GNP	62
4-22 United States: Zinc IOU versus Per Capita GNP ...	63

<u>Figure</u>	<u>Page</u>
4-23 United Kingdom: Zinc IOU versus Per Capita GNP ..	64
4-24 Japan: Zinc IOU versus Per Capita GNP	65
4-25 Australia: Zinc IOU versus Per Capita GNP	66
4-26 World: Steel Weighted IOU Versus Per Capita GNP .	71
4-27 World: Steel IOU Versus Per Capita GNP 1947-1986	72
5-1 Cumulative Total of U.S. Registrations for Automobiles and Trucks/Buses	100

LIST OF TABLES

<u>Table</u>		<u>Page</u>
2-1	Metal Consumption for 1975	18
4-1	Summary: R ² Values Greater Than 0.50	68
4-2	Summary: Negative a ₂ Regression Coefficients with Corresponding Statistically Significant Independent Variables	69
5-1	Average Annual Percentage Growth in Steel Consumption, GNP, and IOU for the World and Selected Countries Showing Percentage Change in Steel Consumption Due to GNP and IOU for the Periods 1946-1973 & 1973-1986	77
5-2	Average Annual Percentage Growth in Aluminum Consumption, GNP, and IOU for the World and Selected Countries Showing Percentage Change in Aluminum Consumption Due to GNP and IOU for the Periods 1946-1973 & 1973-1986	85
5-3	Average Annual Percentage Growth in Copper Consumption, GNP, and IOU for the World and Selected Countries Showing Percentage Change in Copper Consumption Due to GNP and IOU for the Periods 1946-1973 & 1973-1986	89
5-4	Average Annual Percentage Growth in Lead Consumption, GNP, and IOU for the World and Selected Countries Showing Percentage Change in Lead Consumption Due to GNP and IOU for the Periods 1946-1973 & 1973-1986	93
5-5	Average Annual Percentage Growth in Zinc Consumption, GNP, and IOU for the World and Selected Countries Showing Percentage Change in Zinc Consumption Due to GNP and IOU for the Periods 1946-1973 & 1973-1986	96
5-6	Average Annual Percentage Growth in Per Capita U.S. Registrations of Automobiles and Trucks/ Buses	99

<u>Table</u>	<u>Page</u>
5-7 Summary: Countries that exhibit Metal Consumption Growth during the 1946 to 1973 Period above the Long Term Average (1900 to 1986) due Primarily to Higher Than Average Growth in GNP	103
A-1 Population for World and Selected Countries	122
A-2 GNP for World and Selected Countries	125
A-3 Steel Production	129
A-4 Steel Consumption	132
A-5 Aluminum Production	135
A-6 Aluminum Consumption	138
A-7 Copper Production	141
A-8 Copper Consumption	144
A-9 Lead Production	147
A-10 Lead Consumption	150
A-11 Zinc Production	153
A-12 Zinc Consumption	156
A-13 Percentage Change in Metal Consumption-GNP/IOU .	159
B-1 World Intensity of Use & Per Capita Consumption.	164
C-1 U.S. Intensity of Use and Per Capita Consumption.	168
C-2 United States: Automobile and Trucks/Buses Total Registrations and Per Capita Registrations	171
D-1 United Kingdom: Intensity of Use and Per Capita Consumption	175
E-1 Japan: Intensity of Use & Per Capita Consumption.	179

T-3532

<u>Table</u>	<u>Page</u>
F-1 Australia: Intensity of Use and Per Capita Consumption	183

ACKNOWLEDGMENTS

The author wishes to acknowledge Dr. John E. Tilton who, as thesis advisor, provided extensive guidance and assistance during the preparation of this dissertation. The author would also like to acknowledge all other members of the thesis committee, namely Drs. Robert C. Drury, Richard W. Hutchinson, Thomas D. Kaufmann, and Michael S. Nyikos, for their suggestions and support.

Special thanks are extended to Mr. B. Forro for assistance in the collection of data in the United Kingdom, to Mr. P. Stuntz for providing information from Australia, and to Ms. D. Sherring from the United Kingdom Iron and Steel Statistics Bureau who provided extensive steel statistics. Acknowledgments are also extended to Lita Dunham for extensive editorial assistance and to Dr. Ross Bhappu for comments and suggestions.

Thanks are also extended to the various government agencies, industry representatives and libraries that provided considerable assistance to the author in the collection of data.

Finally, the author would like to acknowledge his parents who gave considerable support during the writing of this dissertation.

The original material for this dissertation includes a significant number of oversized pages. The full text can be viewed by accessing the supplement file.

