Pennsylvania Economic Association

Annual Conference
June 1 – June 3, 2017

Alvernia University
Reading, Pennsylvania
Pennsylvania Economic Association

Annual Conference

June 1 – June 3, 2017

Alvernia University

Reading, Pennsylvania

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Pennsylvania Economic Association
2016 – 2017

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For submission information, see the style sheet posted at the association website – http://www.econpea.org/pub/proceedings.html.

The deadline for proceeding submissions is **July 31, 2017**.
Acknowledgement

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Dr. Patrick T. Harker, the Keynote Speaker, President and Chief Executive Officer of the Federal Reserve Bank of Philadelphia
Dr. Theresa Y. Singleton, the Fed Panel Speaker, Senior Vice President and Community Affairs Officer of the Federal Reserve Bank of Philadelphia
Mr. Ryotaro Tashiro, the Fed Panel Speaker, Economic and Public Outreach Associate of the Federal Reserve Bank of Philadelphia

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2017 Conference Proceedings

Pennsylvania Economic Association
2017 CONFERENCE AGENDA

THURSDAY, June 1
04:00 pm – 09:00 pm Registration (Bernardine Hall Lobby)
05:00 pm – 06:00 pm Board of Directors’ Dinner (Student Center – Private Dining Room)
06:00 pm – 08:00 pm Board of Directors’ Meeting (Student Center – Private Dining Room)
06:00 pm – 09:00 pm Reception (Bernardine Hall Lobby)
Sponsored by O’Pake Institute – Alvernia University

FRIDAY, June 2
08:00 am – 12:00 pm & 2:00 pm – 4:00 pm Registration (Bernardine Hall Lobby)
07:30 am – 10:30 am Cengage Breakfast (Bernardine Hall Lobby) – Continental Breakfast
Sponsored by Cengage Learning
08:00 am – 08:50 am Cengage Demo (Bernardine Hall Lecture Hall)
Dr. Stephanie Thomas, Cornell University, “Using technology more effectively in the classroom with Cengage’s MindTap for Economics”
09:00 am – 10:15 am Concurrent Sessions (Bernardine Hall)
10:15 am – 10:30 am Cengage Coffee Break (Bernardine Hall Lobby) – Coffee/Refreshment
10:30 am – 11:45 am Concurrent Sessions (Bernardine Hall)
12:00 pm – 12:45 pm Luncheon (McGlinn Conference Center)
12:45 pm – 01:45 pm Key Note Speaker (McGlinn Conference Center)
Dr. Patrick T. Harker, President and Chief Executive Officer of the Federal Reserve Bank of Philadelphia
02:15 pm – 03:30 pm Concurrent Sessions (Bernardine Hall)
03:30 pm – 04:15 pm Coffee Break (Bernardine Hall Lobby) – Coffee/Refreshment
03:45 pm – 04:45 pm Fed Lecture - (Francis Hall Theater)
Dr. Theresa Y. Singleton, Senior Vice President and Community Affairs Officer, the Federal Reserve Bank of Philadelphia
“Fostering Economic Growth and Opportunity”
Mr. Ryotaro Tashiro, Economic and Public Outreach Associate, the Federal Reserve Bank of Philadelphia
“National and Regional Outlook”
05:00 pm – 08:00 pm Fed Reception - (Francis Hall Atrium) - Sponsored by the Greater Reading Chamber and Economic Development Corporation

SATURDAY, June 3
07:30 am – 10:30 am Registration (Bernardine Hall Lobby)
07:30 am – 09:00 am Macmillan Learning Breakfast (Bernardine Hall Lobby)
Sponsored by Macmillan Learning
08:00 am – 08:50 am Macmillan Learning Demo (Bernardine Hall Lecture Hall)
09:00 am – 10:15 am Concurrent Sessions (Bernardine Hall)
10:30 am – 11:45 am General Membership Meeting (Bernardine Hall Lecture Hall)
11:45 am Closing
**FRIDAY, June 2, 2017**

**Conference Registration** – Bernardine Hall Lobby  
08:00 AM – 12:00 PM  
02:00 PM – 04:00 PM

*Cengage Continental Breakfast* – Bernardine Hall Lobby  
07:30 AM – 10:30 AM

**Cengage Demo** -Bernardine Hall Lecture Hall  
08:00 am – 08:50 am

Dr. Stephanie Thomas, Cornell University  
“Using technology more effectively in the classroom with Cengage’s MindTap for Economics”

**Session F1: Friday, June 2, 2017**  
09:00 AM – 10:15 AM

F (Friday); F1 (Friday Concurrent 1); F1A (Friday Concurrent 1 Session A)

**Session F1A: Microeconomics, General Economics & Teaching**  
Bernardine Hall 201 (09:00 – 10:15 am)

Chair: **Mark Eschenfelder**, Robert Morris University

[1] An Experiment in Multitasking  
**Ron Baker**, Millersville University of PA

**Ralph Ancil**, Geneva College

[3] Part-time Economics Faculty in Higher Education and Assurance of Learning  
**Mark Eschenfelder**, Robert Morris University  
**Lois Bryan**, Robert Morris University  
**Tanya Lee**, Valdosta State University
[4] Post Bankruptcy Credit Experience of Student Loans Borrowers
Onesime Epouhe, Federal Reserve Bank of Philadelphia

Discussants:
[3] Imad EL Hamma, GREDEG, CNRS, Cote d'Azur UNIVERSITY

Session F1B: International Economics
Bernardine Hall 203 (09:00 – 10:15 am)

Chair: Frew Hailou, West Virginia State University

[1] Does rising private external debt contribute to growth? – Evidence from India
Prasanna Venkatesan Narayanasamy, Gokhale Institute of Politics and Economics, Pune, India

Crisis on Mexico
Kayhan Koleyni, Clarion University of Pennsylvania

African Countries
Kafilah Gold, University of Malaya
Rasiah Rajah, University of Malaya
Kwek Kian Teng, University of Malaya
Murtala Mohammed, University of Malaya

[4] Heterogeneity Effects and International Trade
Frew Hailou, West Virginia State University

Discussants:
[2] Lawrence Maishu NGALIM, Istanbul University

Session F1C: Student Paper Session 1
Bernardine Hall 205 (09:00 – 10:15 am)

Chair: Stephanie Brewer, Indiana University of Pennsylvania

Samantha Anderson, Youngstown State University

Valeriya Marchenko, LIU Post
Veronika Dollar, LIU Post

Jordan Gwinn, Indiana University of Pennsylvania
Robert Schwartz, Indiana University of Pennsylvania

Discussants:
[1] Farhad Saboori, Albright College
[2] Stephanie Brewer, Indiana University of Pennsylvania

Session F1D: Urban, Rural, Regional, Real Estate, and Transportation Economics

Bernardine Hall 209 (09:00 – 10:15 am)

Chair: Brian Sloboda, University of Phoenix

Soumendra Banerjee, Misericordia University
Boishampayan Chatterjee, Narsee Monjee Institute of Management Studies

Brian Sloboda, University of Phoenix
Yaya Sissoko, Indiana University of Pennsylvania

Timothy Wilson, Umeå School of Business and Economics
Lars Lindbergh, Umeå School of Business and Economics

[4] The Economic Significance of the VITA Program in Butler County, Pennsylvania
John Golden, Slippery Rock University of Pennsylvania
David Culp, Slippery Rock University of Pennsylvania
Rhonda Clark, Slippery Rock University of Pennsylvania
Jeffrey Forrest, Slippery Rock University of Pennsylvania

Discussants:
[1] David Doorn, West Chester University of Pennsylvania
Session F1E: Microeconomics, General Economics & Teaching
Bernardine Hall 210 (09:00 – 10:15 am)

Chair: Elsy Thomas K, Bowling Green State University Firelands

[1] Course Design Considerations for New Majority Learners
Paul Cowley, Cabrini University
Eric Malm, Cabrini University

[2] Unequal Opportunity in Early Childhood Education in India
Saikat Ghosh, University of Bamberg

[3] The Impact of Lean Implementation and Board Composition on Healthcare Outcomes
Huilan Zhang, Shippensburg University of Pennsylvania
Hassan HassabElnaby, University of Toledo
Amal Said, University of Toledo

[4] An Empirical Investigation on Factors that impact the IMR
Elsy Thomas K, Bowling Green State University Firelands

Discussants:
[1] Elsy Thomas K, Bowling Green State University Firelands
[2] Paul Cowley, Cabrini University
[3] Saikat Ghosh, University of Bamberg

Session F2: Friday, June 2, 2017
10:30 AM – 11:45 AM

F (Friday); F2 (Friday Concurrent 2); F2A (Friday Concurrent 2 Session A)

Session F2A: Macroeconomics and Monetary Economics
Bernardine Hall 201 (10:30-11:45 am)

Chair: Michael Trebing, Federal Reserve Bank of Philadelphia
[1] Quantitative Easing, Household Deposits and Mutual Funds and Growth: A Luxembourgish Case Study
Gueddoudj Sabbah, Central Bank of Luxembourg

Riyadh Arooq, Western Michigan University
Matthew Higgins, Western Michigan University

Habeeb Butu-Onakoya Olabisi Onabanjo, University Ago-Iwoye Nigeria

Michael Trebing, Federal Reserve Bank of Philadelphia

Discussants:
[1] Kafilah Gold, University of Malaya
[2] Adora Holstein, Robert Morris University
[4] Riyadh Arooq, Western Michigan University

Session F2B: Student Session 2
Bernardine Hall 203 (10:30 – 11:45 am)

Chair: James Jozefowicz, Indiana University of Pennsylvania

[1] Exploring the Appalachian Gender Wage Gap
Lucas Mafrica, Indiana University of Pennsylvania
Brandon Vick, Indiana University of Pennsylvania

Savannah Morrissey Martin, Gettysburg College

[3] The Effects of Airline Behavior on Aircraft Accidents
Anneliese Brown, Gettysburg College

Discussants:
[1] Aboozar Hadavand, City University of New York
[3] Lucas Mafrica, Indiana University of Pennsylvania
Session F2C: Urban, Rural, Agricultural and Business Economics  
Bernardine Hall 205 (10:30 – 11:45 am)

Chair: Jeffrey Forrest, Slippery Rock University of Pennsylvania

[1] A Dynamic Shift-Share Analysis of Employment Change in Virginia Workforce Investment Regions  
David Doorn, West Chester University of Pennsylvania  
Kyle Kelly, West Chester University of Pennsylvania

Susan G. Zumas, Clarion University of Pennsylvania

Jeffrey Forrest, Slippery Rock University of Pennsylvania  
Larry McCarthy, Slippery Rock University of Pennsylvania

Discussants:  
[1] Susan G. Zumas, Clarion University of Pennsylvania  
[3] Jeff Salavitabar, Delaware County Community College

Session F2D: Labor and Demographic Economics  
Bernardine Hall 209 (10:30 – 11:45 am)

Chair: Ron Baker, Millersville University of PA

[1] Board Gender Diversity and Bank Performance  
Victoria Geyfman, Bloomsburg University  
Wade Cooper, Bloomsburg University  
Laura Davis, Bloomsburg University

[2] Are Risk Attitudes Fixed Factors or Fleeting Feelings?  
Insoo Cho, York College of Pennsylvania  
Peter Orazem, Iowa State University

Sandra Trejos, Clarion University of Pennsylvania

Discussants:  
[1] Ron Baker, Millersville University of PA  
[2] Victoria Geyfman, Bloomsburg University  
[3] Paul Orzechowski, College of Staten Island – CUNY
Session F2E: Health, Education and Welfare  
Bernardine Hall 210 (10:30 – 11:45 am)

Chair: Divya Balasubramaniam, Saint Joseph's University

[1] The Impact of Public Insurance on Medical Care Utilization  
Bondi Arifin, Georgia State University

Shree Priya Singh, Banaras Hindu University

[3] Public versus Private Investment in Determining Child Health Outcomes: Evidence from India  
Divya Balasubramaniam, Saint Joseph's University

Farhad Saboori, Albright College  
Gertrude Eguae-Obaze, Albright College

Discussants:  
[1] Shree Priya Singh, Banaras Hindu University  
[2] Ralph Ancil, Geneva College  
[3] Bondi Arifin, Georgia State University  

Session F2F: Financial Economics  
Bernardine Hall 212 (10:30 – 11:45 am)

Chair: Scott Deacle, Ursinus College

[1] Do Political Institutions Improve the Effect of Remittances? Evidence from South-Mediterranean Countries  
Imad EL Hamma, GREDEG, CNRS, Cote d'Azur UNIVERSITY

Xiaohui Yang, Fairleigh Dickinson University  
Karen Denning, Fairleigh Dickinson University  
James Cowan, Fairleigh Dickinson University

Scott Deacle, Ursinus College

Brian Sloboda, University of Phoenix

Discussants:
[1] Paul Cowley, Cabrini University
[2] Brian Sloboda, University of Phoenix
[3] Xiaohui Yang, Fairleigh Dickinson University
[4] Scott Deacle, Ursinus College
Keynote Speaker Luncheon
Friday, June 2, 2017
12:00 PM – 01:45 PM
McGlinn Conference Center
Keynote Speaker

Friday, June 2, 2017
12:00 PM – 01:45 PM
McGlinn Conference Center

Patrick T. Harker

President and Chief Executive Officer, Federal Reserve Bank of Philadelphia

Patrick T. Harker took office on July 1, 2015, as the 11th president and chief executive officer of the Federal Reserve Bank of Philadelphia. In this role, Harker participates on the Federal Open Market Committee, which formulates the nation's monetary policy.
Before taking office at the Philadelphia Fed, Harker served as the 26th president of the University of Delaware. He was also a professor of business administration at the university's Alfred Lerner College of Business and Economics and a professor of civil and environmental engineering at the College of Engineering.

Before joining the University of Delaware in 2007, Harker was dean and Reliance Professor of Management and Private Enterprise at the Wharton School of the University of Pennsylvania. Prior to being appointed dean in 2000, Harker served as the Wharton School's interim dean and deputy dean as well as the chair of its operations and information management department. In 1991, he was the youngest faculty member in Wharton's history to be awarded an endowed professorship as UPS Transportation Professor of the Private Sector. He has published/edited nine books and more than 100 professional articles. From 1996 to 1999, he served as editor-in-chief of the journal Operations Research.

In 2012, Harker was named a fellow of the Institute for Operations Research and the Management Sciences (INFORMS) and a charter fellow of the National Academy of Inventors. He was also named a White House fellow by President George H. W. Bush in 1991 and served as a special assistant to FBI Director William S. Sessions from 1991 to 1992.

Harker serves as a member of the Select Operating Committee of Select Greater Philadelphia. He previously served on the boards of Catholic Relief Services, Pepco Holdings, Inc., and Huntsman Corporation and was a founding member of the board of advisors for Decision Lens, Inc. Harker was also a nonbanking Class B director of the Philadelphia Fed from 2012 to 2015.

Harker has a Ph.D. in civil and urban engineering, an M.A. in economics, and an M.S.E. and B.S.E. in civil engineering, all from the University of Pennsylvania.
Session F3: Friday, June 2, 2017
02:15 PM – 03:30 PM

F (Friday); F3 (Friday Concurrent 3); F3A (Friday Concurrent 3 Session A)

Session F3A: Business Administration and Business Economics
Bernardine Hall 201 (2:15-3:30 pm)

Chair: Kosin Isariyawongse, Edinboro University of Pennsylvania

[1] Are U.S. Small Business Administration loans significant?
Paul Orzechowski, College of Staten Island – CUNY

Jeffrey Forrest, Slippery Rock University of Pennsylvania
Melanie Anderson, Slippery Rock University of Pennsylvania

Kosin Isariyawongse, Edinboro University of Pennsylvania

Judex Hyppolite, Monmouth University

Discussants:

Session F3B: Economic Development, Innovation, Technological Change, and Growth
Bernardine Hall 203 (2:15-3:30 pm)

Chair: Orhan Kara, West Chester University

[1] Lineage, Cereals, and Gender Roles: Evidence from Africa
Muse Gadisa Demie, University of New South Wales

[2] A Comparative Study of Multi-Dimensional Analysis of Social Exclusion and Poverty in India
Pardeep Singh Chauhan, Kurukshetra University
**Thomas Armstrong**, Wilson College

**Orhan Kara**, West Chester University

**Discussants:**  
[1] **Pardeep Singh Chauhan**, Kurukshetra University  
[2] **Muse Gadisa Demie**, University of New South Wales  
[3] **Orhan Kara**, West Chester University  

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**Session F3C: Student Paper Session 3**  
**Bernardine Hall 205 (2:15 – 3:30 pm)**

Chair: **Sandra Trejos**, Clarion University of Pennsylvania

[1] Life Satisfaction, School Performance and Income in Ghana  
**Melody Amanor**, Clarion University of Pennsylvania  
**Sandra Trejos**, Clarion University of Pennsylvania

**Mehdi Hojjat**, Neumann University

[3] Pioneer Connect  
**Fiorella Riccobono**, Net Impact

**Zoleka Mekile**, Shippensburg University  
**Freddy Siahaan**, Shippensburg University

**Discussants:**  
[1] **Fiorella Riccobono**, Net Impact  
[2] **Sandra Trejos**, Clarion University of Pennsylvania  

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**Session F3D: Labor and Demographic Economics**  
**Bernardine Hall 209 (2:15 – 3:30 pm)**
Chair: David Nugent, Robert Morris University

[1] To Each According to their Ability? Academic Ranking and Salary Inequality across Public Colleges and Universities
   M. Garrett Roth, Gannon University
   William McAndrew, Gannon University

   Aboozar Hadavand, City University of New York

[3] Assessing the impact of vocational training on productivity: An analysis of NSSO data and a case study of a manufacturing firm in India
   Srishti Mittal, Entrepreneur

[4] Economic Factors That Affect Adjunct Faculty Salaries
   David Nugent, Robert Morris University

Discussants:
[1] Aboozar Hadavand, City University of New York
[2] Insoo Cho, York College of Pennsylvania
[3] David Nugent, Robert Morris University

Session F3E: Health, Education and Welfare
Bernardine Hall 210 (2:15–3:30 pm)

Chair: Michael Malcolm, West Chester University

[1] Obesity, Poverty and Income Inequality in USA: Evidence from Panel Cointegration
   Tahereh Alavi Hojjat, DeSales University

[2] The Impact of Public Hospital Availability in Underdeveloped Areas on Medical Care Utilization and Household Health Expenditures
   Bondi Arifin, Georgia State University

   Michael Malcolm, West Chester University

Discussants:
[1] Ron Baker, Millersville University of PA
[3] Tahereh Alavi Hojjat, DeSales University
Session F3F: Financial Economics
Bernardine Hall 212 (2:15 – 3:30 pm)

Chair: John Walker, Kutztown University of Pennsylvania

[1] Financial and Monetary Variables as Predictive Indicators of the Luxembourgish GDP Growth
Gueddoudj Sabbah, Central Bank of Luxembourg

Mike Witowski, Federal Reserve Bank of Philadelphia
Michael Boldin, Federal Reserve Bank of Philadelphia
William Hewitt, Federal Reserve Bank of Philadelphia

John Walker, Kutztown University of Pennsylvania
Jonathan Kramer, Kutztown University of Pennsylvania

Adora Holstein, Robert Morris University

Discussants:
Federal Reserve Lecture
Friday, June 2, 2017
03:45 PM – 04:45 PM
Francis Hall Theater

“Fostering Economic Growth and Opportunity”

Theresa Y. Singleton
Federal Reserve Bank of Philadelphia

Theresa Y. Singleton

Theresa Y. Singleton is senior vice president of the Community Development Studies & Education Department at the Federal Reserve Bank of Philadelphia and the Bank’s community affairs officer. Singleton is responsible for overseeing research and outreach initiatives that promote community development and fair and impartial access to credit. She has guided the creation and implementation of the Economic Growth & Mobility
Project. She also oversees economic education and personal financial efforts for the Bank. Before joining the Bank, Singleton served as the director of research and information at the Housing Assistance Council in Washington, D.C. In that role, she was responsible for the organization’s research and information activities, including oversight of the communications and public relations functions. She also developed and managed the council’s research agenda. In addition, she directed and contributed to research and information products that examined demographic trends, assessed policy impacts, and developed recommendations for rural communities. Prior to her work on rural housing issues, Singleton taught undergraduate courses on the American political system at Temple University and Widener University. She has a Ph.D., an M.A., and a B.A. in political science from Temple University.

“National and Regional Outlook”

Ryotaro Tashiro
Federal Reserve Bank of Philadelphia
Ryotaro Tashiro is an economic and public outreach associate in the Research Department of the Federal Reserve Bank of Philadelphia. He is responsible for conducting research on current regional economic issues in the Federal Reserve’s Third District and informing external audiences on national and regional economic conditions, monetary policy, and the role of the Federal Reserve in the economy. Prior to joining the Bank in June 2016, Tashiro was a business analyst for Bloomberg, where he was responsible for conducting research on issues related to equity data quality. He also has substantial teaching experience, ranging from high school advanced placement economics to undergraduate intermediate Japanese and intermediate Spanish. Tashiro has a master’s degree in economics from the University of Michigan–Ann Arbor and a bachelor’s degree in economics from Kenyon College.
Federal Reserve Reception
Sponsored by
The Greater Reading Chamber and Economic Development Corporation
Friday, June 2, 2017
05:00 PM – 08:00 PM
Francis Hall Atrium
SATURDAY, June 3, 2017

Conference Registration – Bernardine Hall Lobby
07:30 AM – 10:30 AM

Macmillan Learning Continental Breakfast – Bernardine Hall Lobby
07:30 AM – 9:00 AM

Session S1: Saturday, June 3, 2017
09:00 AM – 10:15 AM

S (Saturday); S1 (Saturday Concurrent 1); S1A (Saturday Concurrent 1 Session A)

Session S1A: International Economics
Bernardine Hall 201 (09:00 – 10:15 am)

Chair: Yizhi Wang, George Washington University

[1] China’s one-child policy has created irreversible damage: A Comprehensive Look at a Life Changing Issue
Jullien Searfoss, Alvernia University

Lawrence Maishu NGALIM, Istanbul University

Yizhi Wang, George Washington University

[4] Lowering the cost for faculty who use frequent testing
Robert Liebler, King’s College

Discussants:
[1] Robert Liebler, King’s College
[4] Jeff Salavitabar, Delaware County Community College
Session S1B: Financial, Health, Education and Welfare Economics
Bernardine Hall 203 (09:00 – 10:15 am)

Chair: Xuebing Yang, Penn State Altoona

[1] Determinants of Islamic Banking Growth: An Empirical Analysis
Tamsir Cham, Islamic Development Bank

[2] Unemployment Insurance and Cigarette Smoking -- Evidence from the U.S.
Wei Fu, Lehigh University
Feng Liu, Chinese university of Hong Kong

Xuebing Yang, Penn State Altoona

[4] Be Bold Take Charge: A Social Entrepreneurship Approach to Reduce Health Disparities in the City of Reading, PA
Ada Leung, Penn State Berks
James Shankweiler, Penn State Berks
Lisa Weaver, Penn State Berks

Discussants:
[1] Xuebing Yang, Penn State Altoona

Session S1C: Agricultural and Natural Resource Economics and Economic Development
Bernardine Hall 205 (09:00 – 10:15 am)

Chair: Babita Srivastava, William Paterson University

[1] Opportunities for Andhra Pradesh (India) doing Business in Nebraska (USA)
Gandhi Babu Veluri, Andhra University
Michael Lundeen, Nebraska Department of Economic Development
Vani Kotcherlakota, Nebraska Department of Economic Development

[2] Potential of Renewable Energy in India
Babita Srivastava, William Paterson University

[3] Transitioning into a ‘Throwaway Planet’
John McCollough, Lamar University
Mehmet Fatih Bayramoglu, Bulent Ecevit University
Miao He, Henan Polytechnic University

Discussants:
[1] Muse Gadisa Demie, University of New South Wales

Session S1D: Student Session 4
Bernardine Hall 209 (9:00-10:15 am)

Chair: Sunita Mondal, Slippery Rock University of Pennsylvania

Shannon Andres, Alvernia University

[2] Childhood Poverty
James Morris, Millersville University of Pennsylvania

Kyle Lindberg, Alvernia University

Discussants:
[1] James Morris, Millersville University of Pennsylvania
[3] Shannon Andres, Alvernia University
General Membership Meeting

Saturday, June 3, 2017
10:30 AM – 11:45 AM
Bernardine Hall Lecture Hall

Our Annual Business Meeting of the General Membership of the Pennsylvania Economic Association is open to the entire membership of the PEA, including all registrants of the conference.

“Door Prizes” will be awarded!

Closing
11:45 AM
Faculty Partner:

**STEPHANIE THOMAS**
Cornell University

**BIography**

Stephanie Thomas is a lecturer in the Economics Department at Cornell University. She currently teaches courses in microeconomics, labor economics, and personnel economics. Her past experience includes teaching microeconomic theory, macroeconomic theory, and econometrics at New York University. In 1998, Stephanie Thomas was awarded the NYU College of Arts and Sciences Outstanding Teaching Award, and in 1999 she was awarded the NYU Economics Society Students' Appreciation Award.

In addition to her undergraduate courses, she regularly teaches executive education programs on topics such as compensation, performance pay, decision making, and risk management. Her experiences in executive education range from short 3-hour courses to multi-day training programs in the United States and abroad.

Stephanie Thomas's teaching philosophy centers on presenting complex concepts in an intuitive manner and demonstrating the relevance of those concepts to real-world issues. In all of her classes, she incorporates active learning techniques encompassing a variety of learning styles, relying on her LMS and supplemental technologies to engage students and bring the course materials to life. MindTap has allowed her to create an array of materials that match any learning style, helping her students succeed.

Stephanie earned her B.A. in Economics from Elmira College and her Ph.D. in Economics from The New School for Social Research.

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To help fulfill the University’s mission to form “engaged citizens and ethical leaders with moral courage”, the Institute coordinates all academic and co-curricular leadership education programs. It also supports community based research efforts at the University, sponsors two annual lectures on ethics and leadership, and provides assistance to several community and economic revitalization efforts in the region.

Over the past two years, the Institute has hosted a series of community forums bringing experts in community revitalization, economic development and anchor institution strategies to the Reading area. The Institute has also produced a series of reports for the Berks County Community Foundation on key aspects of life in Berks County.

The Institute is supported by an endowment created through the bequest of former state senator Michael O’Pake.

Director: Dave Myers has served as the Director of the Institute since its inception in 2012. He previously served as Chief of Staff for the President of Bucknell University and as a senior adviser to two Pennsylvania Governors. He also served as a Deputy Secretary in two state agencies and as a Vice President at the Hospital and Healthsystem Association of Pennsylvania. He is a graduate of Cornell University and the University of Massachusetts and is ABD at Rutgers University.
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Figure 7 shows the shifts in Supply Curve in the chapter about Supply and Demand.

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THE RELATIVE CONTRIBUTION OF CYCLICAL AND STRUCTURAL FACTORS IN THE U.S.
UNEMPLOYMENT: EVIDENCE FROM A (FAVAR)

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ABSTRACT

The problem of slow decline in the rate of U.S. unemployment after the last recessions has been the concern of policy makers. In this paper, I contribute to the literature by using FAVAR approach to investigate the relative contribution of cyclical and structural factors in the U.S. unemployment. The results showed that the cyclical factors can explain about 60% of the forecast error variance of unemployment. The structural factors can explain about 16%. These results, in general, indicated that cyclical factors have more contribution than structural factors in the U.S. unemployment which is in line with the literature. However, the results indicated that FAVAR approach can provide better results by reducing the bias in the results of past studies.

Key words: The US unemployment; Structural factors; Cyclical Factors.

INTRODUCTION

The slow decline in the U.S. unemployment rate after the 2007-2009 recession has been the concern of researchers and policy makers. Sala et al (2012), Chen (2011), and others indicated that the rate of unemployment was still high in the U.S. even after the recovery period of the last recessions. Researchers have been trying to identify whether the factors that led to the slow decline in the U.S. unemployment rate are structural or cyclical. In this paper, I investigate the relative contribution of two main sources (cyclical and structural) in the U.S. unemployment.

The first source is related to the cyclical factors and lead to what is called (cyclical unemployment). The second source is related to the structural factors and lead to what is called (structural unemployment). Some studies consider frictional unemployment as another source, but it can be part of structural unemployment, Lindbeck (1999).

Structural unemployment is the part of unemployment that caused by structural changes including the changes in institutional framework, technological changes, changes in legislations and political changes. Cyclical unemployment is the part of unemployment that is caused by losing jobs due to economic downturns, Aysun (2014). The cyclical unemployment is connected to the changes in economic stimulative policies, Diamond (2013).

All te studies in the literature agreed that unemployment in the U.S is due to both cyclical factors and structural factors. However, many researches have been working on measuring the relative contribution of each type of factor in explaining the movement in unemployment. In this paper, I differ from the literature by using a factor augmented vector auto regression model (FAVAR) introduced by Bernanke et al (2005). I use a FAVAR to identify the relative contribution of each type of factor in explaining the movement in unemployment in the U.S.

What motivates me to use FAVAR is that past studies in this area may suffer from potential identification problems. The existence of identification problems in such studies can lead to biased results as showed by Bernanke et al (2005). Bernanke et al (2005) indicated three potential problems when using the standard VAR approach. First, some information may not be reflected in the model (measurement error in the model variables). Second, the choice of the data series to represent an economic concept is often arbitrary to some degree. Third, results can be observed only for the small subset of the variables which the researcher included in the model.

By examining some of studies in this area we can see that all the three potential problems may exist especially when identifying the structural factors. For example, Chen et al (2001) used only dispersion of industry-level stock returns as a structural factor. Sala et al (2012) used wage rigidity and a construct measure for matching efficiency as structural factors. Maidorn (2003) tested the effects of shocks to productivity, demand, wages and labor supply as structural shocks on unemployment. From these examples, I can see that researchers only consider a few structural variables and miss the others. Researchers sometimes construct proxies using different methods which can lead to measurement error. Furthermore, researchers choose structural variables that represent few structural changes in the economy. As a result, past studies may suffer from an identification problem and have biased results.

To solve the identification problem when it exists, Bernanke et al (2005) suggested using a factor augmented autoregressive (FAVAR) model as one of the solutions to this problem. Bernanke et al (2005) defined FAVAR as a combination of standard VAR and factor analysis for large data sets. Bernanke et al (2005) indicated three advantages of using FAVAR. First, FAVAR allows us to use multiple indicators of economic concepts, so we do not need to assume that the concepts are observed. Second, we can determine whether or not the additional information
connected to the unobserved factors is relevant. Third, FAVAR can be used to measure the dynamic responses of not only the main variables but many related variables.

In this paper I use FAVAR to investigate the relative contribution of each type of factor in explaining the movement in unemployment in the U.S. I will use many cyclical and structural variables that have been indicated in the literature to have an important relationship with unemployment. My methodology should reduce the bias in accessing to relative importance of cyclical versus structural factors in explaining U.S. unemployment.

The rest of this paper will have several sections. Section II will be the literature review. Section III will discuss the empirical work including data, variables, the model, and the results. The last section will be the conclusion.

LITERATURE REVIEW

The main purpose of this section is to identify the available cyclical and structural variables that have been indicated in the literature to have an important relationship with unemployment. More specifically, I review what previous researchers have done in this area and select the variables that have an impact on unemployment. More focus will be on selecting the structural variables because the cyclical variables like GDP and vacancy are commonly used in almost all of the past studies.

The common way to analyze and identify the cyclical portion of unemployment is with both Okun’s law and the Beveridge Curve.

Okun’s law is an empirical negative relationship between the changes in unemployment rate and the changes in real output. The idea of Okun’s law is that more workers are required to produce more goods and services within an economy. Therefore, higher real output means higher employment and lower unemployment, Edward (2007). Based on Okun’s law, Sala (2012), Chen (2011) and others identify the real output (GDP) as the key cyclical factor that affects unemployment. They found that real GDP has high power to explain the movement in unemployment.

The Beveridge curve is the other common way to identify the cyclical variables that affect unemployment. Diamond and Sahin (2015) defined the Beveridge curve as “the negative relationship between the unemployment rate and the vacancy rate over the course of a business cycle”. Vacancy rate is the number of unfilled jobs expressed as a proportion of the labor force. Diamond and Sahin (2015) stated that The Beveridge curve is one of the most established stylized facts of macroeconomics.

Based on the idea of the Beveridge curve, Sala (2012), Diamond (2013), Supan (1991) and others identify vacancy rate as the other key cyclical variable when analyze the sources of unemployment. In this paper, I will use both real GDP and vacancy rate as the cyclical variables that affect unemployment in the U.S.

The structural unemployment is the part of unemployment that is caused by structural changes including the changes in institutional framework, technological changes, changes in legislations and political changes. To identify the structural variables, I have to look for the variables that measure these changes within an economy.

The wage rate is a common structural variable in the literature. Wage rate is strongly related to labor supply and labor demand. It is also related to the bargaining power of workers and employers and the power of unions in the economy. many studies used wage rate as a structural variable. For example, Anosova (2013), Maidorn (2003), Lindbeck (1999) and others used wage rate as one of the structural variables. They found that wage rate has a significant impact on unemployment.

The minimum wage rate is one of the structural variables that is related to the changes in laws and regulations within an economy. Magruder (2013) tested the effect of the minimum wage rate in Indonesia on employment. Magruder (2013) found that formal minimum wage rate can increase formal employment and decreases informal employment.

Magruder (2013) tested the effect of the shock to the productivity as one of the structural shocks on unemployment in Austria. The results indicated that productivity shocks can explain part of the structural unemployment in Austria. Chen (2008) tested the effect of productivity on unemployment in the U.S. The results showed that productivity has positive effect on unemployment in the short-run and a negative effect on unemployment in the long run.

Unemployment insurance or benefits is one of the structural variables that are related to legislation within an economy. Arrans et al (2009) tested the relationship between the changes in unemployment insurance and unemployment rate in Spain. The results suggested that the decrease in unemployment insurance benefit levels decreased unemployment.

Technological progress within an economy is believed to have an impact on labor market outcomes since it could reduce the number of worker needed for a specific operation. Based on Solow theory, total factor productivity (TFP) is one measure of technological change. Moreno (2012) tested the effect of TFP on unemployment using OECD data. The results showed that the technological progress reduces unemployment for individuals receiving training. In addition, it increases the unemployment of
unskilled workers without training.

Investment is one of the variables that has a strong relation with unemployment based on Keynes’ general theory. Keynes’ general theory stated that Investments determines effective demand, and then affect unemployment. Investment is a structural variable since it is related to the institution framework, financial structure, and saving behavior within an economy. Smith and Zoega (2009) provided evidence that investment is important for analyzing unemployment in OECD countries.

Foreign direct investment (FDI) is another structural variable that is related to the openness of an economy. Mucuk and Demirsel (2013) tested the relation between FDI and unemployment for seven developing countries. The results showed that FDI has a significant impact on unemployment.

Based on the above discussion, I will use eight structural variables in my empirical work. These variables are: wage rate, minimum wage rate, labor productivity, TFP, private sector investments, government investments, and FDI.

**THE EMPIRICAL WORK**

The goal of this section is to discuss the data and variables used in this paper, the methodology, the model, and the results. Table (1) shows the cyclical and structural variables that used in this paper. As mentioned before, I select the cyclical and structural variables based on the economic theory and the past literature.

Real GDP Growth represents the output growth of the U.S economy which has a negative relationship with unemployment based on Okun’s Law. Vacancy represent the total unfilled jobs which has a negative relationship with unemployment based on the Beverage Curve. Both Real GDP Growth and Vacancy Rate are used to represent the cyclical factors that affect unemployment rate.

The other eight variables shown in table (1) represent the structural factors that affect unemployment. Wage rate represents structural framework of setting wages in the U.S. labor market. Federal Minimum Wage represents the changing in the legislation regards minimum wage rate. Productivity (real output per hour) represents the changing in the productivity or skills in the U.S. economy. Unemployment Benefits represents the changing in the legislation regards unemployment insurance and other benefits. Private sector Investments, Government Investment, and Forging Direct Investment (FDI) represent legislation, the saving rate, and the financial institution structure. Total Factor Productivity (output growth less than the contribution of capital and labor) represents changes in technological progress.

The data used in this paper are quarterly data with a sample period from 1971: Q1 – 2014: Q4. Most of the data are taken from the federal reserve bank of St. Louis (FRED). For data on the vacancy variable, I used the composite Help-Wanted Index constructed by Barnichon (2010). That is because vacancy data constructed based on Job Opening and Labor Turnover Survey (JOLTS) started in 2001. Diamond and Sahin (2015) used the composite Help-Wanted Index to represent vacancy rate. For total factor productivity, I used data constructed by Fernald (2014).

**The Methodology**

In this paper I use a factor augmented vector autoregression (FAVAR) model introduced by Bernanke et al (2005). I use FAVAR to identify the relative contribution of cyclical and structural factors in explaining the movement in U.S. unemployment. Following Bernanke et al (2005) I do two steps to run the FAVAR. First, I construct the factors using the principal components analysis introduced by Stock and Watson (2002). Second, I run a standard VAR model including real GDP growth, Vacancy Rate, Unemployment, and the constructed factors from the eight structural variable. I use impulse responses and variance decomposition to provide the results.

In the first step, I follow the principal components analysis introduced by Stock and Watson (2002) to construct the factors from the eight structural variables. Stock and Watson (2002) idea is that when we have large number of indicator, we can forecast relatively one or two of unobserved latent factors. They use principal components analysis to estimate the factors. Their results showed that the constructed factors were efficient and consistent indicators.

The results of using p principal component analysis to construct the factors from the eight structural variables is shown in fig (1). Fig (1) shows that one factor (F) can be used to characterizes the eight structural factors.

In the second step, I run a four variable VAR model. The model has three variables (Real GDP Growth, Vacancy Rate, Unemployment) and one factor (F). The Model is:

\[ Z_t = C + A_1 Z_{t-1} + A_2 Z_{t-2} + A_3 Z_{t-3} + \ldots + A_p Z_{t-p} + \epsilon_t \]

Where:

\[ Z = \begin{pmatrix} Y_t \\ F_t \end{pmatrix}, \quad Y_t = \begin{pmatrix} GDP_t \\ Vacancy_t \\ Unemployment_t \end{pmatrix} \]

Where \( t = 1, 2, 3, \ldots, 176 \)
Augmented Dickey–Fuller test was used to test the data series for stationary and AIC criteria for determining the lag length. The unit root test showed that GDP and F are differenced stationary while unemployment rate and vacancy rate are level stationary. AIC criteria indicated three lags to be used as the lag length. I estimate the VAR with all stationary data series, three lags, and Cholesky decomposition with order (F Vacancy GDP Unemployment). The Cholesky ordering indicates that the structural changes happen first which affect the vacancy rate and GDP growth. That is because the structural changes can affect the matching process and the skills requirements. Then, the changes in vacancy rate contempently effects the GDP and unemployment rate.

The Results

Fig (2) shows that the unemployment rate decreases significantly as a response to the increase in real GDP growth. This result confirms Okun’s law (the negative relationship between unemployment rate and GDP growth). Fig (2) shows that the unemployment rate decreases significantly as a response to the increase in vacancy rate. This result confirms the Beverage Curve (the negative relationship between unemployment rate and vacancy rate). Therefore, the results show that GDP and Vacancy rate as cyclical factors have significant impact on unemployment rate in the U.S. economy. Fig (2) shows that the unemployment rate increases significantly as a response to the shocks to the structural variables. This result confirms that the structural factors play a role in the slow decline in unemployment rate.

The results confirm that the movement in the U.S. unemployment can be explained by both cyclical and structural factors. These results are in line with the past literature which agreed that unemployment can be explained by both cyclical and structural factors. The important issue here is to identify the relative contribution of cyclical and structural variables in the U.S. unemployment.

Table (2) provides the forecast error variance decomposition for Unemployment rate. Table (2) indicate that the shocks to structural variables but not to cyclical variables has a big impact on unemployment in the short run. Table (2) shows that in the long run, the contribution of cyclical factors (GDP growth and vacancy) in the forecast error variance of unemployment is about 60%. The contribution of structural factors in the forecast error variance of unemployment is about 16%. These results, in general, indicate that cyclical factors contribute more than structural factors in the forecast error variance of unemployment which is in line with the literature.

However, the results in table (2) indicate that The contribution of cyclical and structural factors in the movement of the U.S. unemployment were overestimated in the past literature. For example, Chen et al (2001) found that in the U.S economy about 75% of the forecast error variance of unemployment is due to cyclical factors and 25% is due to Structural factors. Farooq et al (2015) Found that only real GDP as a cyclical factor can explain 63% of the movement in U.S. unemployment and the rest is due to the Beverage curve and other factors.

The above analysis provides evidence that the FAVAR method used in this paper can help reducing the potential biased results in such studies. However, the results of this paper showed that there still a big part (about 20%) of unemployment is not explained. One possible explanation is that the unexplained part of unemployment is due to the increase in the frictional unemployment as indicated by Daly et al (2011).

CONCLUSION

Many studies indicated that the rate of unemployment in the U.S. is still high in the U.S. or declines slowly after the last recessions. Since stimulative polices were not fully successful in decreasing unemployment rate, researcher think that structural factors could play a role in the slow movement of the U.S. unemployment. Therefore, researchers have been trying to measure the relative contribution of cyclical and structural factors in the U.S. unemployment. In this paper, I used FAVAR approach to investigate the relative contribution of cyclical and structural factors in the U.S. unemployment.

The results showed that the cyclical factors (GDP and Vacancy) reduced the U.S. unemployment which is consistent with the idea of Okun’s low and Beverage curve. The results showed that structural factors increase the rate of unemployment which affect the unemployment decline.

The results showed that the cyclical factors (GDP growth and vacancy) can explain about 60% of the forecast error variance of unemployment while the structural factors can explain about 16%. However, about 20% of unemployment was not explained. One possible explanation is that it is due to the increase in the frictional unemployment.

These results, in general, indicated that cyclical factors have more contribution than structural factors in the movement of the U.S. unemployment. However, the results indicated that the contribution of cyclical and structural factors in U.S. unemployment were overestimated in the past literature.
Table (1) Cyclical and structural variables used to explain unemployment

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type</th>
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<tr>
<td>Real GDP Growth</td>
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<tr>
<td>Vacancy Rate</td>
<td>cyclical</td>
</tr>
<tr>
<td>Wage Rate</td>
<td>structural</td>
</tr>
<tr>
<td>Federal Minimum Wage Rate</td>
<td>structural</td>
</tr>
<tr>
<td>Productivity</td>
<td>structural</td>
</tr>
<tr>
<td>Unemployment benefits</td>
<td>structural</td>
</tr>
<tr>
<td>Private sector investments</td>
<td>structural</td>
</tr>
<tr>
<td>Government investments</td>
<td>structural</td>
</tr>
<tr>
<td>FDI</td>
<td>structural</td>
</tr>
<tr>
<td>TFP</td>
<td>structural</td>
</tr>
</tbody>
</table>

Fig (1) Scree plot for selecting the number of factors

Fig (2) the impulse responses from FAVAR
Table (2) Forecast Error Variance Decomposition of Unemployment

<table>
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<tr>
<th>Period</th>
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<th>Vacancy</th>
<th>GDP</th>
<th>Unemployment</th>
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<td>32.33</td>
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<td>23.74</td>
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REFERENCES


SALES ASSOCIATES’ COMPENSATION: A GAME THEORETIC APPROACH

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ABSTRACT

This paper investigates the dynamics between firms and their sales associates. All results are established on the thinking logic of systems science in general and the systemic yoyo model in particular. Then, rigorous deductions of the results are provided in the language of game theory. Among other results, this paper shows why firms should somehow make private cost information of their sales associates known to their respective members, and what incentive weights a firm should give to its individual sales associates in order to optimize its profits.

1. INTRODUCTION

Sales associates’ compensation (or sales force compensation) represents an area of research with a great potential of direct applications in real life. And a good number of scholars have contributed to this important research. For example, Basu, et al. (1985) develop a theory of salesforce compensation plans, where the sales of a product depend not only on the salesperson's effort but also on the uncertainty in the selling environment. Joseph and Thevaranjan (1998) analyze a framework that simultaneously examines the role of both monitoring and incentives in the design of sales force control systems. Lal and Srinivasan (1993) modify the agency theory approach for understanding salesforce compensation plans by incorporating the intratemporal nature of the salesperson's effort-rate decision. Inderst and Ottaviani (2009) analyze the implications of the inherent conflict between two tasks performed by direct marketing agents: prospecting for customers and advising on the product's "suitability" for the specific needs of customers. Sheth and Sharma (2008) examine the evolution of sales organizations as a result of the shift from product- to service-focused commerce that took place in the past three decades.

Misra and Nair (2011) present an empirical framework to analyze real-world sales-force compensation schemes, and report on a multi-million dollar, multi-year project involving a large contact lens manufacturer in the U.S. Frenzen, et al. (2010) develop and empirically test a framework of important drivers of price delegation to salespeople based on agency-theoretic research and investigate the impact of price delegation on firm performance. Chan, et al. (2014) examine how compensation systems impact peer effects and competition in collocated sales teams by using department store sales data and show that compensation systems influence worker incentives to help and compete with peers within the same firm, which in turn changes the capability of the firm to compete with rivals.

Lo, et al. (2011) use data on individual salesperson compensation contracts to show that firms design their pay plans to both discriminatingly select (i.e., attract and retain) salespeople and provide them with the right level of incentives. Daljord, et al. (2016) focus on the constraints faced by firms in fine-tuning contracts to the full heterogeneity distribution of their employees and explore the implication of these constraints for the provision of incentives within the firm. Chung, et al. (2013) estimate a dynamic structural model of sales force response to a bonus-based compensation plan. Kräkel and Schöttner (2016) explain when the compensation plans that are most common in practice, such as fixed salaries, quota-based bonuses, commissions, or a combination thereof, are optimal.

In comparison, conclusions in this paper add additional results of very different kinds to the existing literature on salesforce compensation. In particular, we will show the following main results: 1) How sales associates’ compensation should be aligned with the profit maximization of the firm; 2) How by revealing private cost information of individual sales associates within the firm increases the expected incomes of the associates; 3) Specifically how the firm should assign incentive weights to each sales associates in order to maximize its profits.

Other than contributing to the literature with brand new results, another main contribution of this work is that it shows vividly how the relevant reasoning and intuitive thinking in the research of sales associates’ compensation can be based on systems science in general and systemic yoyo model in particular.

The rest of this paper is organized as follows: Section 2 introduces the needed concepts of systems research and the systemic yoyo model, which will play the role of intuition for the rest of the paper. Section 3 establishes an abstract maximization problem for the sales associates’ compensation of concern. Section 4 studies the amounts of sales of individual associates at Cournot equilibrium. Section 5 looks at the associates’ payoffs at Cournot equilibrium. Section 6 investigates the relationship between the associates’ private cost information and expected
incomes. Section 7 specifically formulates how associates’ incentive weights should be determined at the firm level. And then this paper is concluded in Section 8.

2. SYSTEMS RESEARCH AND THE SYSTEMIC YOYO MODEL

Von Bertalanffy (1924) pointed out that the fundamental character of living things is their organization, the customary investigation of individual parts and processes cannot provide a complete explanation of the phenomenon of life. Since then, this holistic view of nature, social organizations, and social events has permeated the entire spectrum of science and technology (Lin, 2009). And in the past 90 some years, studies in systems science and systems thinking have brought forward brand new understandings and discoveries to some of the major unsettled problems in the conventional science (Klir, 1985; Lin, 1999). Because of these studies of wholes, parts, and their relationships, a forest of interdisciplinary studies has appeared, revealing the development trend in modern science and technology of synthesizing all areas of knowledge into a few major blocks, and the boundaries of conventional disciplines have become blurred (“Mathematical Sciences,” 1985). Underlying this trend, one can see the united effort of studying similar problems in different scientific fields on the basis of wholeness and parts, and of understanding the world in which we live by employing the point of view of interconnectedness. As tested in the past 90 plus years, the concept of systems and results of systems research have been widely accepted by the world of learning (Blauberg, et al., 1977; Klir, 2001).

Similar to how numbers and algebraic variables are theoretically abstracted, systems can also be proposed out of any and every object, event, and process. For instance, behind collections of objects, say, apples, there is a set of numbers such as 0 (apples), 1 (apple), 2 (apples), 3 (apples), …; and behind each organization, such as a business firm, a regional economy, etc., there is an abstract, theoretical system within which the relevant whole, component parts, and their interconnectedness are emphasized. As a matter of fact, it is because of these interconnected whole and parts, the totality is known as a firm, an economy, etc. In other words, when internal structures can be ignored, numbers and algebraic variables can be very useful; otherwise the world consists of dominantly systems (or structures or organizations).

When the traditional science is joined with systems science that investigates systemhood, that collectively gives rise of a 2-dimensional spectrum of knowledge, where the traditional science, which is classified by the thinghood it studies, constitutes the first dimension, and the systems science, which investigates structures and organizations, forms the genuine second dimension (Klir, 2001). In other words, systems research focuses on those properties of systems and associated problems that emanate from the general notion of structures and organizations, while the division of the traditional science has been done largely on properties of particular objects. Therefore, the former naturally transcends all the disciplines of the classical science and becomes a force making the existing disciplinary boundaries totally irrelevant and superficial.

The importance of this second dimension of knowledge cannot be in any way over-emphasized. By making use of this extra dimension, the exploration of knowledge has gained additional strength in terms of the capability of solving more problems that have been challenging the very survival of the mankind since the beginning of time. Such strong promise that systems research holds relies materialistically on the particular speaking language and thinking logic – the systemic yoyo model (Lin, 2007), Figure 1, similar to how the Cartesian coordinate system plays its role in the development of modern science (Kline, 1972).

Specifically, on the basis of the blown-up theory Wu and Lin (2002) and the discussion on whether or not the world can be seen from the viewpoint of systems (Lin, 1988; Lin, et al., 1990), the concepts of black holes, big bangs, and converging and diverging eddy motions are coined together in the model shown in Figure 1 for each object and every system imaginable. That is, each system is a multi-dimensional entity that spins about its axis. If we fathom such a spinning entity in our 3-dimensional space, we will have such a structure as artistically shown in Figure 1(a). The black hole side pulls in all things, such as materials, information, energy, profit, etc. After funneling through the “neck”, all things are spit out in the form of a big bang. Some of the materials, spit out from the end of big bang, never return to the other side and some will (Figure 1(b)). For the sake of convenience of communication, such a structure as shown in Figure 1(a), is referred to as a (Chinese) yoyo due to its general shape.

What this systemic model says is that each physical or intellectual entity in the universe, be it a tangible or intangible object, a living being, an organization, a culture, a civilization, etc., can all be seen as a kind of realization of a certain multi-dimensional spinning yoyo with an eddy and meridian field around. It stays in a constant spinning motion as depicted in Figure 1(a). If it does stop its spinning, it will no longer exist as an identifiable system. What Figure 1(c) shows is that due to the interaction between the eddy field, which spins perpendicularly to the axis of spin, of the model, and the meridian field, which rotates parallel to axis of spin, all the materials that actually return to the black-hole side travel along a spiral trajectory.

As expected, this yoyo model has successfully played the
role of intuition and playground for scholars who investigate the world and explore new knowledge holistically, just as what the Cartesian coordinate system did for the traditional science (Lin, 2009; Lin and Forrest 2011; Forrest 2013; 2014; Forrest and Tao, 2014; Ying and Forrest, 2015). In particular, this yoyo model of general systems has been successfully applied in the investigation of Newtonian physics of motion, the concept of energy, economics, finance, history, foundations of mathematics, small-probability disastrous weather forecasting, civilization, business organizations, the mind, among others. Along this same line of logic, in this paper we will use this model as our intuition to establish our conclusions on the basis of rigorous reasoning.

3. THE MAXIMIZATION PROBLEM OF SALES ASSOCIATES’ COMPENSATION

Forrest, et al. (2017) shows that the dynamics of market competition affects firms that exist within the market or intent to enter the market both externally and internally in terms of pricing strategies. In other words, although the existing firms might not grow their expected profits by participating in market competition through adjusting their prices, they still have to compete in order to prevent new competition from entering the market by sufficiently reducing the magnitude of the consumer surplus. So, a natural question arises for the managers of individual firms: How could each existing firm encourage its sales associates to sell more?

To this end, Forrest and Orvis (2016) indicates that sales associates’ compensation has to be aligned with the associates’ personal value systems in order to promote organizational efficiency. So, when dealing with the problem of sales associates’ compensation, let us assume that the goal of the associates is to provide quality service to the consumers while maximize their personal incomes, and that the mission of the company is the same: maximize its profits by providing quality products to as many satisfied consumers as possible. In order to make the goal of maximizing personal incomes and the goal of optimizing the company profits consistent, let us consider aligning sales associates’ compensation with the company’s profits. (Note: Our model discussed in this section is inspired by Bagnoli and Watts (2015)).

To address the problem of sales associates’ compensation, let us assume that the firm of concern has two sales associates, named 1 and 2. The portion of the variable compensation beyond the fixed base salary of associate $i$ is proportional to

$$P_i = \pi_i + \lambda_i S_i, \ i = 1, 2,$$

where $\pi_i$ stands for the portion of the firm’s profits realized by associate $i$, $S_i$ associate $i$’s completed sales, and $\lambda_i > 0$ the parameter the firm chooses to maximize its expected profits.

The fixed base salary for the associates is employed to encourage associate $i$ to work together with the other associate as a team so that when necessary, one will be willing to provide the needed support to the other in order for the latter to complete a successful sale. The first term $\pi_i$ in eqn. (1) is employed to encourage associate $i$ to generate as much profits as possible, while the second term is used to stimulate more sales, because after all in practice the firm can only observe the number of completed sales and the amount of profits generated without any effective way to measure efforts of the associates (Joseph and Thevaranjan, 1998). Based on Forrest, et al. (2017), increasing sales are important in terms of bringing in additional profits with the potential of more than doubling the profits. And together, the sum of these two terms encourages the associates to complete as many and as profitable sales as possible. Here, the parameter $\lambda_i$ is contractually determined by the firm at the start of the employment cycle of associate $i$ and is used to get rid of the problem of free riders.

In this model we introduced the information/decision structure to investigate the impact of associates’ efforts in the product market on the profit sharing decision of the firm. One feature of this model is that the firm offers its associates contracts that depend on both of the firm’s profits and revenues, delegates sales choices and reward the associates based on revenues and profits as a means of pre-committing to sell more and generate more profits than would be optimal absent delegation and pre-commitment. The firm adopts such contracts to specifically change the marginal benefit/marginal cost calculation of its associates in order to motivate them to sell more and to generate more profits. The second feature is the assumption that the incentive contracts chosen by the firm are observable by all parties. This observability of the contracts simplifies the analysis without changing the qualitative nature of the results (Kockesen and Ok, 2004; Kockesen, 2007).

In the second stage of employment, given the incentive weights $\lambda_i$, $i = 1, 2$, chosen by the firm, each associate engages in Cournot competition in her sales efforts by choosing the sales level $q_i$ in the product market, $i = 1, 2$, that maximizes her expected payoffs conditional on all information available to her. We assume that the risk-neutral associates make their sales decisions to maximize their own expected payoffs.

Assume that the demand curve of the firm is

$$p = \alpha - q_i - q_j, \ i,j = 1,2, \ i \neq j$$

where $\alpha$ is the intercept of the firm’s demand curve. Because
both of the associates work for the same firm, we assume that they sell identical or completely substitutable products. Both associates know this demand curve; and each of them only knows their own marginal costs \( c_i \) of sales, assuming that there are no fixed costs of sales. Here, we introduce the private information \( c_i \) to take into account the reservation utility of associate \( i \).

To complete the description of the model, we assume that the firm and the associates have common priors such that all variables are drawn from known distributions with finite and positive means and variances. We also assume that the marginal costs \( c_i \) and \( c_j \) are independent so that the distribution of \( c_i \) given \( c_j \) is independent of \( c_j \), for \( i, j = 1, 2 \), \( i \neq j \). To ensure interior solutions in the second stage of the game, the firm’s demand function satisfies the condition that the value of the intercept exceeds the largest value of each associate’s marginal costs. We seek a perfect Bayes-Nash equilibrium of the model and begin by solving the second stage of the game, in which the associates compete in the product market.

So, associate \( i \) solves the following maximization problem

\[
\max q_i E[\pi_i + \lambda_i S_i|\phi_i],
\]

where \( \phi_i \) represents the information associate \( i \) has about \( c_i \) and \( c_j \) at the time of her sales’ choice, \( \pi_i = \text{the profits generated by associate } i = \text{(price – marginal cost of associate } i) \times q_i \), and \( S_i = \text{the revenue produced by associate } i = \text{price } \times q_i \).

4. INDIVIDUAL ASSOCIATES’ SALES AT COURNOT EQUILIBRIUM

The maximization problem in equ. (3) can be rewritten as follows:

\[
\max q_i E[(1 + \lambda_i)(\alpha - q_i - q_j)q_i - c_i q_i|\phi_i].
\]

The first order condition of this maximization problem is

\[
q_i = E\left[\frac{1}{2}(\alpha - q_j) - \frac{c_i}{2(1 + \lambda_i)}\right] \phi_i.
\]

If both associates know both \( c_i \) and \( c_j \), then the associates play a game of complete information. To find the Nash equilibrium at this second stage, we solve the following system of first-order conditions:

\[
\begin{align*}
q_i &= \frac{1}{2}(\alpha - q_j) - \frac{c_i}{2(1 + \lambda_i)} \\
q_j &= \frac{1}{2}(\alpha - q_i) - \frac{c_j}{2(1 + \lambda_j)}
\end{align*}
\]

and obtain

\[
q_i(c_i, c_j) = \frac{1}{3}(\alpha - \frac{2c_i}{1 + \lambda_i} + \frac{c_j}{1 + \lambda_j}).
\]

where \( q_i(c_i, c_j) \) stands for the amount of sale of associate \( i \) if she knows both \( c_i \) and \( c_j \).

If associate \( i \) knows \( c_i \) while associate \( j \) knows both \( c_i \) and \( c_j \), then the associates play such a game that associate \( i \) only knows her own private information \( c_i \) while associate \( j \) has the complete information. To find the Nash equilibrium at this second stage, we solve the following system of first-order conditions by substituting the second equation into the first one:

\[
\begin{align*}
q_i &= \frac{1}{2}(\alpha - E[q_j|c_i]) - \frac{c_i}{2(1 + \lambda_i)} \\
q_j &= \frac{1}{2}(\alpha - q_i) - \frac{c_j}{2(1 + \lambda_j)}
\end{align*}
\]

and obtain

\[
q_i(c_i, \text{not } c_j) = \frac{1}{3}(\alpha - \frac{2c_i}{1 + \lambda_i} + \frac{E[c_j]}{1 + \lambda_j}).
\]

where and \( q_i(c_i, \text{not } c_j) \) stands for the amount of sale of associate \( i \) if she knows \( c_i \) but not \( c_j \).

If associate \( i \) knows both \( c_i \) and \( c_j \) while associate \( j \) knows \( c_j \), then the associates play such a game that associate \( i \) has the complete information while associate \( j \) only knows her own private information \( c_j \). To find the Nash equilibrium at this second stage, we solve the following system of first-order conditions:

\[
\begin{align*}
q_i &= \frac{1}{2}(\alpha - q_j) - \frac{c_i}{2(1 + \lambda_i)} \\
q_j &= \frac{1}{2}(\alpha - E[q_i|c_j]) - \frac{c_j}{2(1 + \lambda_j)}
\end{align*}
\]

where \( q_i = q_i(\text{not } c_i, c_j) \) represents the amount of sale of associate \( i \) if associate \( j \) does not knows \( c_i \) while associate \( i \) knows both \( c_i \) and \( c_j \), and \( q_i = q_j(\text{not } c_j, c_i) \) the amount of sale of associate \( j \) if associate \( j \) does not knows \( c_j \), and the formula of the latter is given by equ. (7) by using symmetry. Substituting this expression for \( q_j(\text{not } c_j, c_i) \) into the first equation of this system, we obtain

\[
q_i(\text{not } c_i, c_j) = \frac{1}{3}(\alpha - \frac{E[c_i]}{2(1 + \lambda_i)} + \frac{E[c_j]}{1 + \lambda_j}) - \frac{c_i}{2(1 + \lambda_i)}
\]

If both associates only know their own private information \( c_i \) and \( c_j \), respectively, then to find the Nash equilibrium at this second stage, we solve the following system of first-order conditions:

\[
\begin{align*}
q_i(\text{not } c_i, c_j) &= \frac{1}{3}(\alpha - \frac{c_i}{1 + \lambda_i} + \frac{E[c_j]}{1 + \lambda_j}) - \frac{c_i}{2(1 + \lambda_i)}
\end{align*}
\]
At Cournot equilibrium, the amount of sales for associate $i$ is given by

$$q_i = \frac{1}{2} \left( \alpha - E[q_i | c_i] \right) - \frac{c_i}{2(1 + \lambda_i)}$$

where $q_k = q_k$ (not $c_k$, not $c_j$), $k, \ell = 1, 2, k \neq \ell$, stands for the amount of sale of associate $k$ if she only knows her own private information $c_k$. Because $E[q_i | c_i] = E[q_i(\text{not } c_j, \text{not } c_i) | c_i] = E[q_i(\text{not } c_j, c_i) | c_i]$, the symmetry between associates $i$ and $j$ and equ. (8) lead to the following:

$$E[q_j | c_i] = E[q_j(\text{not } c_j, c_i)]$$

$$= E \left[ \frac{1}{3} \left( 2\alpha - \frac{E[c_j]}{1 + \lambda_j} + \frac{E[c_i]}{1 + \lambda_i} - \frac{c_j}{2(1 + \lambda_j)} \right) \right]$$

$$= \frac{1}{3} \left( 2\alpha - \frac{E[c_j]}{1 + \lambda_j} + \frac{E[c_i]}{1 + \lambda_i} \right)$$

Therefore, we have

$$q_k (\text{not } c_k, \text{not } c_k) = \frac{1}{6} \left( 2\alpha - \frac{E[c_k]}{1 + \lambda_k} + \frac{E[c_i]}{1 + \lambda_i} \right)$$

**Proposition 1.** At Cournot equilibrium, the amount of associate $i$’s sales is an increasing function of $\lambda_i$ and decreasing function of $\lambda_j$.

Proof. The result follows readily from equ. (6) – (9), where each term with denominator $(1 + \lambda_i)$ is negative, while each term with denominator $(1 + \lambda_j)$ is positive. QED

What this proposition says is that when the firm’s demand curve is given in equ. (2), the efforts and achievements of associates $i$ and $j$ are limiting and constraining each other. It is just as what is depicted in Figure 2, where the spinning field represents the operation of the firm of our concern, and when one of the associates, say $A_i$, grows larger, then the out of proportional growth of $A_i$ will definitely affect the development of $A_j$. In other words, assigning incentives to revenues generated by individual associates really helps boost sales. In particular, assume that associate $i$ is provided with an incentive weight $\lambda_i > 0$ while associate $j$ is not (that is, $\lambda_j = 0$). Then, the revenue incentive would cause associate $i$ to sell more than that of associate $j$, even when associate $j$ attempts to maximize her profits. And the demand curve in equ. (2) implies that associate $j$ would have to accommodate the effects of the incentives by reducing her amount of sales. As a result, associate $i$’s sales would be disproportionally larger than those of associate $j$.

**5. ASSOCIATES’ PAYOFFS AT COURNOT EQUILIBRIUM**

Based on what has been established in the previous sections, we have

**Theorem 1.** At Cournot equilibrium, the equilibrium payoffs to associate $i$ are proportional to

$$P_i = (1 + \lambda_i)q_i^2,$$

and the equilibrium profits of the firm are

$$\Pi = \pi_i + \pi_j = q_i^2 + q_j^2,$$

where $\pi_i = q_i^2$, for $i = 1, 2$.

Proof. From equ. (1), it follows that

$$P_i = E[\pi_i + \lambda_i S_i | \phi_i] = (1 + \lambda_i)E[q_i (p - \frac{c_i}{1 + \lambda_i}) | \phi_i].$$

For the case when associates $i$ and $j$ know both $c_i$ and $c_j$, from equ. (6), we have

$$P_i(c_i, c_j) = \pi_i + \lambda_i S_i = (1 + \lambda_i)q_i (p - \frac{c_i}{1 + \lambda_i})$$

where $p - \frac{c_i}{1 + \lambda_i} = q_i$. So, we have $P_i = (1 + \lambda_i)q_i^2$.

For the case when associate $i$ only knows $c_i$ while associate $j$ knows both $c_i$ and $c_j$, we have from equ. (12) that

$$P_i(c_i, \text{not } c_j) = (1 + \lambda_i)q_i (p - \frac{c_i}{1 + \lambda_i})$$

$$= (1 + \lambda_i)q_i (c_i, \text{not } c_j) \left( \alpha - q_i(c_i, \text{not } c_j) \right)$$

$$- E[q_i(\text{not } c_j, c_i) - E[c_i]|1 + \lambda_i]$$

$$= (1 + \lambda_i)q_i(\text{not } c_j, c_i) \frac{c_i}{1 + \lambda_i}$$

$$= (1 + \lambda_i)q_i(\text{not } c_i, c_j)^2.$$
\[ P_i(\text{not } c_i, \text{not } c_j) = (1 + \lambda_i)q_i(\text{not } c_i, \text{not } c_j) \cdot \left( \alpha - q_i(\text{not } c_i, \text{not } c_j) - E[q_j(\text{not } c_i, \text{not } c_j)c_j] - \frac{c_i}{1 + \lambda_i} \right) \]
\[ = (1 + \lambda_i)[q_i(\text{not } c_i, \text{not } c_j)]^2. \]

So, what is produced above proves equ. (10).

For the equilibrium profits of the firm \( \Pi = \pi_i + \pi_j \), where because

\[ P_i(d_i, d_j) = (1 + \lambda_i)[q_i(d_i, d_j)]^2 = \pi_i + \lambda_iS_i, \]

for any \( d_i \in \{c_i, \text{not } c_i\} \) and \( d_j \in \{c_j, \text{not } c_j\} \). If we treat the last two expressions as polynomials in variable \( \lambda_i \), then comparing the corresponding coefficients leads to \( \pi_i = [q_i(d_i, d_j)]^2 \). Therefore, equ. (11) is established. QED

6. PRIVATE COST INFORMATION AND EXPECTED INCOMES

In terms of the relationship between private cost information of the associates and their individual incomes, we have

**Theorem 2.** When the associates \( i \) and \( j \) are Cournot competitors, making the private cost information \( c_i \) known to associate \( j \) does expectedly increase the incomes of \( i = 1, 2, i \neq j \).

Intuitively speaking, when the firm makes the associates’ private information not that private among its members, it actually encourages competition between its sales associates. For example, when the firm spends more on associate \( A_i \) in Figure 2, it means the area of \( A_i \) half is greater than that of \( A_j \) half. That naturally puts pressure on associate \( A_i \). Now, for \( A_i \) she has two choices: being squeezed out of her job or measuring up to the challenge. If \( A_i \) chooses the former choice, then she will be simply replaced by another sales associate, which is an optimal personnel decision for the firm. That is, no matter who particular \( A_i \) is, the systemic field structure in Figure 2 always exists in terms of \( A_i \) and \( A_j \) individually. On the other hand, \( A_j \) does not want her existence costs too much to the firm, either; otherwise, she runs the risk of being let go or facing a tougher challenge of a newly hired more capable colleague. For related studies, see (Chan, et al., 2014).

Proof. For the situation in hands, it suffices to show that

\[ E[P_i(c_i, \not c_j)] > E[P_i(\not c_i, \not c_j)] \]  

and

\[ E[P_i(c_i, c_j)] > E[P_i(\not c_i, c_j)], \]  

\[ (13) \]

\[ (14) \]

for \( i = 1, 2 \). That is, what equus. (13) and (14) imply is that no matter whether or not associate \( j \)’s cost information \( c_j \) is known to associate \( i \), making her own cost information \( c_i \) known to \( j \) expectedly leads to greater amount of profits for associate \( i \). According to Theorem 1, instead of equus. (13) and (14), it suffices to show

\[ E \left( \left( q_i(c_i, \not c_j) \right) \right) > E \left( \left( q_i(\not c_i, \not c_j) \right) \right) \]

\[ (15) \]

and

\[ E \left( \left( q_i(c_i, c_j) \right) \right) > E \left( \left( q_i(\not c_i, c_j) \right) \right), \]

\[ (16) \]

for \( i = 1, 2 \). To this end, we have

\[ E \left( \left( q_i(c_i, \not c_j) \right) \right) - E \left( \left( q_i(\not c_i, \not c_j) \right) \right) = E \left( \left( q_i(c_i, \not c_j) \right) \right) - \left( q_i(\not c_i, \not c_j) \right) \]

\[ = \frac{1}{9} \left( \alpha^2 - 4X \frac{\epsilon[c_i]}{\lambda_i} + \frac{4\epsilon[c_i]}{\lambda_i(1+\lambda_i)^2} \right) - \frac{1}{3\epsilon} \left( 4X^2 - 4X \frac{\epsilon[c_i]}{\lambda_i} + \frac{2\epsilon[c_i]}{\lambda_i(1+\lambda_i)^2} \right) \]

\[ = \frac{1}{2(1+\lambda_i)^2} \left( E[c_i^2] - E[c_i]^2 \right) \]

\[ = \frac{1}{2(1+\lambda_i)^2} \text{var}[c_i] > 0, \]

where \( X = \alpha + \frac{\epsilon[c_i]}{\lambda_i} \). That is, equ. (15) holds true. For equ. (16), we have

\[ E \left( \left( q_i(c_i, c_j) \right) \right) - E \left( \left( q_i(\not c_i, c_j) \right) \right) = E \left( \left( q_i(c_i, c_j) \right) \right) - \left( q_i(\not c_i, c_j) \right) \]

\[ = \frac{1}{9} \left( \text{var}[c_i] + \frac{7\text{var}[c_i]}{\lambda_i(1+\lambda_i)^2} \right) \]

\[ > 0. \]

That is, equ. (16) holds true. QED
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What is implied by Theorem 2 is that no matter whether individual sales associates like or not, the firm needs to make sure somehow its associates know about other associate’s cost information in order to stimulate more profits and more revenue.

7. HOW ASSOCIATES’ INCENTIVE WEIGHTS ARE DETERMINED

Next, let us look at the firm’s decision on the incentive weights \( \lambda_i, \ i = 1, 2 \), at the first stage of the game. At this stage, the firm chooses \( \lambda_i, \ i = 1, 2 \), to maximize its expected profits,

\[
E[\Pi] = E[\pi] + E[\pi_i]
\]

\[
= E \left( \left( q_i(d_i, d_j) \right)^2 \right) + E \left( \left( q_j(d_j, d_i) \right)^2 \right)
\]

by taking into account of how the sales associates subsequently find it optimal to compete in the firm’s product market. In particular, the firm solves the following maximization problem:

\[
\max_{\lambda_i(d_i, d_j), \lambda_i(d_i, d_j)} E \left( \left( q_i(d_i, d_j) \right)^2 + \left( q_j(d_j, d_i) \right)^2 \right),
\]

for \( d_i = c_i \) and \( d_j = c_j \), because as the employer the firm knows exactly how much each sales’ associate would costs itself. The first order conditions are

\[
2q_i(c_i, c_j) \frac{\partial q_i(c_i, c_j)}{\partial \lambda_i} + 2q_j(c_j, c_i) \frac{\partial q_j(c_j, c_i)}{\partial \lambda_i} = 0 \quad (17)
\]

and

\[
2q_i(c_i, c_j) \frac{\partial q_i(c_i, c_j)}{\partial \lambda_j} + 2q_j(c_j, c_i) \frac{\partial q_j(c_j, c_i)}{\partial \lambda_j} = 0 \quad (18)
\]

Now, equs. (17) and (18) reduce to the following system of equations:

\[
\begin{align*}
\alpha - \frac{5c_i}{1+\lambda_i} + \frac{4c_j}{1+\lambda_j} &= 0 \\
\alpha - \frac{5c_j}{1+\lambda_j} + \frac{4c_i}{1+\lambda_i} &= 0.
\end{align*}
\]

By solving this system we establish the following result:

**Theorem 3.** At the Bayes-Nash equilibrium, the firm would define its incentive weights by \( \lambda_i = c_i/\alpha - 1, \ i = 1, 2 \). QED

What Theorem 3 indicates is that when an associate costs more to the firm, the firm expects her to generate a greater level of revenue by providing a greater incentive weight to her. Systemically, this result is clear: If the A, half in Figure 2 costs more to maintain within the overall spinning field, then the A, half in the 3-dimensional structure in Figure 1(a) has to give out more to balance its structural stability.

Although the results in this section are established for two sales associates, if we are willing to get caught with tedious symbolic computations, we will be able to develop the same results for \( m \) many sales associates with their individual incentive weights.

8. SOME FINAL REMARKS

This paper shows the importance of systemic thinking in general and the yoyo model in particular, which, different from that of Cartesian coordinate system, provides another platform for scholars to think and to imagine holistically before they rigorously prove what they intuitively see. And by employing such a new tool for intuitive thinking and reasoning, this paper shows some theoretically very significant results, such as why firms should somehow make private cost information of their sales associates known to their respective members, and what incentive weights a firm should give to its individual sales associates in order to optimize its profits.

At the same time, we need to realize that what is done in this paper cannot be directly generalized to other situations of workers’ compensation. For example, when individuals’ performance is highly dependent on the collaboration and support of others, such as the situation with a basketball team, then what is established in this paper needs to be reconsidered and enriched with relevant details (Antonietti, 2006). The major difference involved here is the following: The sales associates considered in this paper are treated mostly as isolated individuals, whose achievements are not heavily dependent on other sales associates’ support (that is, the conflict of interest in terms of individual performance is minimal), while for an athlete on the basketball team, his performance is highly correlated to a host of factors, including, but not limited to,

- How much the coach allows him to play, or communication between the coach and the athlete (Rosca, 2010);
- Rivalries between team mates on and off the court (Tiago, et al., 2016; Arai, et al., 2014);
- Team-mates collaborations (Jane, 2015);
- Commercial endorsements (Fizel, et al., 2008);
- How well the athlete could stay healthy.

In particular, the basic setup in equs. (1) and (2) needs to be altered when studying a different setup of employees’ performance. In other words, the presentation in this paper is expected to open up a wide area of study of workers’ compensation for different employment scenarios.
Figure 1. (a) The eddy motion model of the general system; (b) the meridian field of the system; (c) the trajectory along which matters return back into the system

Figure 2. Competition between sales associates within a firm

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DESCRIPTIVE MODEL OF ECONOMIC DEVELOPMENT FRAMEWORK

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ABSTRACT

A descriptive model of economic development is a long-run framework for enhancing production factors through a supportable economic development infrastructure contributing and exploiting physical and human technological innovations. When supportable, the developmental impact results in a per capita increase with a demand for goods and services change as income increases. The structure of the labor shifts to a greater skilled and technological demanded workforce therefore contributing greater innovation in a reinforced economic development model. Costs and regulations, quality of life, innovation or competitiveness, and constitutional/institutional framework underlie an economic development infrastructure focusing upon Pennsylvania for any gaps to supportability.

I. INTRODUCTION

Long-run economic development is the developmental process when the economy increases its productivity capacity or increases the quality of goods and services it consumes over time. Bearse and Vaughan (1981) state that development is the qualitative change in the economic development structure of an economy including innovations in institutions, behavior, and technology. Continual technological and “knowledge” innovations are requisite to increase a region’s productivity and enhance standards of living. Governments, businesses, and educational institutions are significant contributors to an economic development infrastructure that can support continual economic development over time. Once economic development is supportable, economic growth is accelerated.

Economic growth is the rate of increase in an economy’s output or income per capita, which measures the increase in material goods and services available to residents over time. Long-run economic growth results primarily from economic development activities such as committing resources leading to a subsequent rise in productivity where greater outputs require fewer inputs.

Economic growth may occur without economic development such as an economy experiencing a high demand for an unexpected resource such as natural gas extraction. However, an economy with sustainable economic development is a prerequisite for long-term economic growth. Economic growth requires continuous innovations and structural institutional changes. For example, an active government economic development strategy requires a mixture of institutional or non-tax and tax innovations. The purpose is to improve the likelihood of increasing technology innovation resulting in an increasing economic growth (Armstrong and Meuser, 2015; Fisher and Peters, March/April 1997).

With growth in the economy, new businesses, products, and innovations will be created. Income is increased impacting differences in the changes in demand for goods and services over time. Businesses will produce those changes in goods and services demanded resulting in the structural transformation of society upon three sectors: agricultural, industrial/manufacturing, and service sectors.

As economic development advances with an increase in income per capita, industrial/manufacturing and especially the service sectors produce the greater percentage of output. The composition of the workforce changes where the industrial structure of the labor force becomes proportionally greater in the service sector. The occupational structure shifts away from a less skilled to a greater skilled and technological demanded workforce. This skilled workforce thereby contributes to on-going greater technological innovation that reinforces the economic development infrastructure for continual advancement of technological innovation (Mandle, 1982).

Failure or gaps in an economic development infrastructure may contribute to relatively less economic development resulting in slower economic growth in the long-run. To accelerate economic development requires a change in policy and a shift in resources to new institutional and structural changes. Nations, regions and local areas can inventory and measure gaps within an economic infrastructure. Once catalogued, policies can be developed to eliminate the gaps for sustainable economic development.

This paper will discuss an economic development framework in a six-part feedback model. When economic development is supported and sustained through an innovative economic development infrastructure by government, businesses, and higher
Educational institutions, economic growth and technological innovation is accelerated. The paper will focus upon Pennsylvania when outlining the economic development framework. Lastly concluding comments are provided.

II. DESCRIPTIVE MODEL OF ECONOMIC DEVELOPMENT

Economic development is concerned with enhancing the factors of productivity capacity, land, labor, physical or human capital, and technology, of a nation, state or local economy. A continuous improved economic development infrastructure supported by innovative economic development policies provides a greater likelihood for factors of production enhancement, economic growth, the skill sets required by workers in an advanced technological economy, and feedback to further enhance technology innovation. The six stages of the Descriptive Model of Economic Development are as follows:

- Economic Development Infrastructure
- Δ Technological Innovation
- Output or Income per Capita
- \( \Delta m \), Income Elasticity of Demand
- Structural Transformation of Society or Workforce Composition Change
- Feedback to Δ Technology Innovation or Sustainable Economic Development Feedback

Figure 1: Framework of the Descriptive Model of Economic Development provides an overall pictorial six-part framework. The details of the model are provided below.

(1) Economic Development Infrastructure: This describes the cultural, institutional and government policies that affect market and non-market behavior, where input resources and outputs are used most efficiently and commercialization of technological innovation occurs most rapidly. Mandle (1982) mentions that the presence of profit-seekers is not sufficient to ensure technological advance, but a positive development infrastructure is required to encourage the capability and incentive for technological innovation.

The economic development infrastructure can be loosely categorized within an economic social structure of four areas: (A) costs and regulations, (B) quality of life issues, (C) innovation or competitiveness areas, and (D) constitutional/institutional frameworks (Eathington, Todd, and Swenson, April 2005; Scully, February 20, 1991).1

(A) Costs and regulations are government fiscal policies that impact the degree and pace of technological innovation and commercialization of such innovation. Excessive costs, including over and above optimal taxation and excessive regulations, impact a state’s long-term economic development resulting in less than optimal research and development investment considerations, new business creation, and existing business location or expansion (Armstrong, 2002; Walczak, Drenkard, and Henchman, 2017).2

Costs that are not excessive maybe reflected in appropriate government financial discipline with a budgetary balance and high bond ratings. Government failure is minimized in the use of economic resources resulting in a likelihood of greater economic development (Armstrong and Gulibon, 2003; Haughton, Conte, and Jardim, 2014).

(B) Quality of life issues focus on residential and business amenities, where quality of life concerns can

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2 Armstrong, 2002; Walczak, Drenkard, and Henchman, 2017.
impact residential/worker’s menu of attribute considerations and businesses investments/location selections (Salvesen and Renski, January 2003). Salvesen and Renski (January 2003) discuss quality of life factors that may differ for residents and businesses to include presence of a local university for recruitment, training availability, cultural accessibility, recreational opportunities, education quality and opportunities, community attitudes, environmental quality, climate, crime and public safety, reasonable cost of living including housing costs, and nearby restaurants, retail and personal services. From 2003 to 2007, the percentage change in NPAFs is 85.5% for Pennsylvania relative to the US average percentage change of 49.2%.

Given the percentage change in NPAFs have been relatively constant from 1996 to 2002 and 2003-2007 for Pennsylvania relative to the fall in United States figures, there will be a potential increase in the number of protected intellectual property to be used for licensing or commercialization start-up purposes potentially located in Pennsylvania relative to the United States in the years reported.

Higher education institutions, including research universities and government research agencies, can increase society’s basic knowledge. Basic research is fundamental inquiry that results in a wide range of applied research and developed products. If only private firms determined the amount of R&D spent on basic research, the amount would be smaller than what is socially optimal. Basic research produced by government research facilities and higher educational institutions leads to an increase in technology knowledge and produces important positive externalities including the opportunities for commercial firms to develop this basic knowledge into commercially usable products.

Armstrong (Fall 2010) reports summary data from AUTM annual survey of Total Research Expenditures (TREs) by State from 1996 to 2007. TREs are expenditures made by the institution in support of its research activities that are funded by all sources including the federal government, local government, industry, foundations, health organizations, and other nonprofit organizations. The numbers of TREs for each state, as well as figures for subsequent AUTM tables, are primarily from U.S. Institutions of Higher Education as well as U.S. Hospitals and Research Institutes that voluntarily reported to AUTM. From 1996 to 2007, the percentage change in TREs is 106.5% for Pennsylvania relative to the US average percentage change of 123.70%.

From 2003 to 2007, the percentage change in TRE is 30.6% for Pennsylvania relative to the US average percentage change of 31.8%. In 2007, Pennsylvania’s ranked 5th in the nation relative to the states that reported TREs.

(C) Innovation or competitiveness areas emphasize microeconomic policies including science and engineering education focus, technology research funding, and attractiveness to business especially start-ups (Porter, 2000). Tax and regulatory considerations may also be considered having an impact in this area. If relatively positive, the economic social structure or ecosystem will result in continuous increase in the stock of technological knowledge and business use of the knowledge through new business start-ups and/or existing businesses within a region.

An economic development infrastructure, which includes the incentive through profit maximization and the capability through private and public resources to increase the stock of knowledge, will provide on-going advancement and use of technology innovation. Demand for technological innovation occurs, because commercial firms and individuals will seek to maximize profits and income by utilizing new products or seek to minimize costs by utilizing new processes that yield the same products at lower costs. Private and public institutions demanding the use of new technologies will accelerate the technological change.

While competitive forces have an incentive to demand greater technology innovation, the supply or stock of scientific knowledge is advanced through institutional assistance which includes intellectual property protections through patent protections. Armstrong (Fall 2010) summarizes the Association of University Technology Managers (AUTM) data on New Patent Applications from 1996 to 2007. New Patent Applications Filed (NPAFs) is the first filing of the patentable subject matter. If NPAFs figures are relatively positive, the economic social structure or ecosystem will result in continuous increase in the stock of technological knowledge and business use of the knowledge through new business start-ups and/or existing businesses within a region.

From 1996 to 2007, the percentage change in NPAFs is 222.0% for Pennsylvania relative to the US average percentage change of 244.5%.

(D) Constitutional/institutional frameworks. This category considers constitutional and institutional rules that define a set of sanctioned activities that when undertaken may or may not enhance welfare or utility (Scully, February 20, 1991). The rules are behavioral choices within long-run constraints restricting agents in the private and public market where inefficient use of
resources are constrained; thereby enhancing efficiency and long-run economic growth (Buchanan, 1990; Scully, February 20, 1991, Armstrong, 1994). Included in the rules are sanctioned core functions of government, which include law enforcement and the protection of private property rights, the judicial and corrections system, essential public health and safety standards, basic social services, and the maintenance and expansion of the infrastructure used by citizens (e.g., roads, bridges and education).

Tables 2a, 2b, 2c, and 2d: Economic Development Infrastructure utilize various business climate analysis to categorize in greater detail the infrastructure into the four areas: (A) costs and regulatory measures, (B) quality of life measures, (C) innovation or competitiveness measures, and (D) constitutional/institutional frameworks respectively. The climate analysis may have depictions that cross over into the four areas. Fisher (2005) raises concerns about the usefulness of business climate studies and their rankings; however, the studies provide valuable information on economic infrastructure and their incentives for long-run economic development (Tax Foundation, February 27, 2006).

The Tables focus are upon Pennsylvania’s strengths and weaknesses - where improvements could be considered for future increases in economic development and economic outcomes. While the analysis is not a complete depiction on an economic development infrastructure, it provides an avenue for research of local, regional, and state considerations.

<table>
<thead>
<tr>
<th>Studies</th>
<th>Org.</th>
<th>PA Index</th>
<th>Pennsylvania Comments</th>
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<tbody>
<tr>
<td>Costs and Regulatory Measures</td>
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<tr>
<td>2017 State Tax Business</td>
<td>Tax Foundation</td>
<td>24</td>
<td>Pennsylvania’s capital stock and foreign franchise tax was fully phased out in 2016. In tandem with improvements to the state’s previously worst-in-the-nation unemployment insurance tax structure, the elimination of the capital stock tax drove an improvement from 28th to 24th overall. Pennsylvania’s corporate tax structure consists of a flat rate of 9.99% on all corporate income. Among states levying corporate income taxes, Pennsylvania’s rate ranks 2nd highest nationally. Pennsylvania will be one of only five states to levy an Inheritance Tax. The Inheritance Tax imposes costs that may hurt savings and investment, encourages some senior citizen and resource movement out of the Commonwealth, and prevents some family-owned businesses and family farms from being passed on to family members. A state with lower tax costs will be more attractive to business investment and more likely to experience economic growth.</td>
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<tr>
<td>Climate Index</td>
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<tr>
<td>2017 State Tax Business</td>
<td></td>
<td></td>
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<tr>
<td>Small Business Policy Index</td>
<td>Small Business and Entrepreneurship Council</td>
<td>31</td>
<td>Pennsylvania ranks in the latter half of states for its policy climate for entrepreneurship and small business growth among the 50 states. Pennsylvania has low personal income and capital gains taxes, a fairly low level of state and local government employment, a fairly low crime rate, and has no added minimum wage mandate. However, Pennsylvania imposes the highest corporate income, corporate capital gains, gas and diesel taxes. In addition, the state has high wireless taxes, a high energy regulatory burden, a fairly high level of state and local government debt, high local income taxes, an inheritance tax, and is not a right-to-work state.</td>
</tr>
<tr>
<td>Freedom in the 50 States:</td>
<td>Cato Institute</td>
<td>26</td>
<td>Pennsylvania’s tax burden is about average, but the state is a bit more fiscally decentralized than average, with local governments making up a larger share of the total tax take. Pennsylvanians have ample choice of local government, with more than 4.9 effective competing jurisdictions per 100 square miles. State and local debt and subsidies are higher than average, but public employment is much lower than average (10 percent of the private workforce). Pennsylvania has drifted down on regulatory policy over time. It does reasonably well on land-use freedom, a fact that economist William Fischel attributes to the Pennsylvania Supreme Court’s willingness to strike down minimum lot sizes and other zoning regulations that have exclusionary intent. Pennsylvania is not as bad as most other northeastern states on labor-market regulation, but it lacks a right-to-work law. By most measures, occupational licensing is not very extensive in Pennsylvania, but there was a big jump upward in 2009–10. Nurses enjoy little practice freedom. Insurance freedom is extremely low, with “prior approval” of rates and forms and rating classification prohibitions. The civil liability system is much worse than the national average. The state has partisan judicial elections and has made none of the tort reforms we track. Pennsylvania’s criminal justice policy has worsened over time, at least as measured by crime-adjusted incarceration rates. Nonsentient victimless crime arrests are down since 2006, however. Civil asset forfeiture is mostly unreformed. Pennsylvania has lagged other center-left states in implementing medical cannabis and same-sex marriage, although the latter was imposed by judicial ruling in 2014. Gun rights are much better respected than in other progressive states, with carry licenses affordable and not terribly restricted; all Class III weapons legal, and a right to defend oneself in public, legally recognized in 2009–10. Since legalizing casinos in 2007–8, Pennsylvania has risen to become one of the best states in the country for gambling liberty. On the other hand, Pennsylvania is one of the worst states for alcohol freedom. A notoriously inefficient state bureaucracy monopolizes wine and spirits. On education, Pennsylvania has a long-standing, liberal tax credit scholarship program, but private schools and homeschooleds are tightly regulated. Smoking bans have gone far but are not total.</td>
</tr>
</tbody>
</table>

* Scores of 1 indicates best ranking and scores of 50 indicates worst ranking among 50 states.
### Pennsylvania Economic Association
#### 2017 Conference Proceedings

**Table 2b: Economic Development Infrastructure**

<table>
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<tr>
<th>Studies</th>
<th>Org.</th>
<th>PA Index</th>
<th>Pennsylvania Comments</th>
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<tbody>
<tr>
<td><strong>Quality of Life Measures</strong></td>
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<tr>
<td>15th Annual State Competitiveness Report (<a href="http://www.beaconhill.org/Compete15/Compete2015.pdf">http://www.beaconhill.org/Compete15/Compete2015.pdf</a>)</td>
<td>The Beacon Hill Institute for Public Policy Research</td>
<td>36</td>
<td>The competitiveness index is based on a set of 45 indicators divided into eight subindexes. Out of the subindexes, Pennsylvania has competitive advantages within the security (crime is low and public officials are trusted), infrastructure (access to high-speed broadband), human resources (percent of population without health insurance and number of active physicians per 100,000), and technology (research funding and number of science and engineering degree students) subindexes. However, Pennsylvania has an overall competitive disadvantage within government and fiscal policy (less than moderate state and local taxes and financial discipline), business incubation (business births, potential costs of tort liability, and education-adjusted cost of labor), openness (relatively positive incoming foreign direct investment per capita offset by the lack of exports per capita), and environmental policy (levels of air pollution and toxic releases) subindexes.</td>
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<tr>
<td>America’s Health Rankings: Annual Report 2016 (<a href="http://assets.americashealthrankings.org/app/uploads/ahlr16-complete+v2p.pdf">http://assets.americashealthrankings.org/app/uploads/ahlr16-complete+v2p.pdf</a>)</td>
<td>United Health Foundation</td>
<td>28</td>
<td>The report analyzes a set of health behaviors, community and environment policy, clinical care and outcomes data to provide a relative benchmark of a state’s health. Pennsylvania’s strengths are the low incidence of Salmonella, high immunization coverage among adolescents, and higher number of primary care physicians. The Commonwealth’s challenges are the high rate of drug deaths, high levels of air pollution, and low per capita public health funding. Some of the highlights reported are in the past year, physical inactivity increased 19% from 23.3% to 27.8% of adults; HPV immunization among males aged 13 to 17 years increased 47% from 26.0% to 38.3%; diabetes decreased 7% from 11.2% to 10.4% of adults; in the fourth year of smoking, smoking decreased 14% from 22.7% to 18.1% of adults; and in the past five years, drug deaths increased 36% from 14.6 to 19.8 deaths per 100,000 population.</td>
</tr>
<tr>
<td>2015 Lawsuit Climate Ranking Survey Ranking of the States: A survey of the Fairness and Reasonableness of State Liability Systems (<a href="http://www2.itif.org/2014-transformation-in-the-states/50state-liability-systems">http://www2.itif.org/2014-transformation-in-the-states/50state-liability-systems</a>)</td>
<td>US Chamber Institute for Legal Reform</td>
<td>37</td>
<td>The report asked respondents were also asked to give the state an overall grade for creating a fair and reasonable litigation environment. The eleven elements were then combined to create an overall ranking of state liability systems. Pennsylvania relative to other states have the following disadvantages: having and enforcing meaningful venue requirements, overall treatment of tort and contract litigation, treatment of class action suits and mass consolidation suits, damages, timeliness of summary judgment or dismissal, discovery, scientific and technical evidence, judges’ impartiality and competence, and juries’ fairness.</td>
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* Scores of 1 indicates best ranking and scores of 50 indicates worst ranking among 50 states.

**Table 2c: Economic Development Infrastructure**

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<th>Studies</th>
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<th>PA Index</th>
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<tbody>
<tr>
<td><strong>Innovation or Competitiveness Measures</strong></td>
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<td></td>
<td></td>
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<tr>
<td>The 2014 State New Economy Index: Benchmarking Economic Transformation in the States (<a href="http://www2.itif.org/2014-state-new-economy-index.pdf">http://www2.itif.org/2014-state-new-economy-index.pdf</a>)</td>
<td>The Information Technology and Innovation Foundation</td>
<td>22</td>
<td>The 2014 State New Economy Index uses 25 indicators, divided among the following five categories: knowledge jobs, globalization, economic dynamism, the digital economy, and innovation capacity. Pennsylvania’s strengths are high wage traded services, foreign direct investment, fast growing firms, E-government, industry investment in R&amp;D, non-industry investment in R&amp;D, movement toward a clean energy economy, and venture capital investment. Pennsylvania’s weaknesses are the low level of immigration of knowledge workers, the export focus of manufacturing and services, entrepreneurial activity, and online agriculture.</td>
</tr>
<tr>
<td>The Kauffman Index: Pennsylvania (<a href="http://www.kauffman.org/kaufman-index/profiles?loc=42&amp;name=pennsylvania&amp;breakdowns=startup-activity">http://www.kauffman.org/kaufman-index/profiles?loc=42&amp;name=pennsylvania&amp;breakdowns=startup-activity</a></td>
<td>overall,main-street</td>
<td>overall</td>
<td>growth</td>
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* Scores of 1 indicates best ranking and scores of 50 indicates worst ranking among 50 states.
(2) **Technological Innovation:** While human capital, as well as physical capital, is important to explaining improvements in living standards, these inputs, combined with technological innovations, are central to explaining economic development. Firms and individuals seek to maximize profits and income by producing new products or seek to minimize costs by developing more efficient processes that produce the same goods at a lower cost. Competition drives firms to demand greater technological innovations and seek institutional assistance, including higher education institutions and research laboratories, to provide needed knowledge for such innovations.

Consideration of technology innovation on output production is provided below in a simplified production function relationship which specifies the maximum amount of output that can be produced given certain amounts of inputs such as labor, capital and technological innovation. Ferleger and Mandle (1992) point out that productivity is best enhanced by improving the quality of education and augmenting the stock of physical public capital through continuous innovation.

\[ Y = f(\text{labor, capital, } \Delta \text{technological innovation}) \]

**Figure 2** shows that improvements in knowledge and technology can shift the production function up, \( P_0 \) to \( P_1 \) at each level of capital per worker, \( K_0 \) (same level of inputs), where higher levels of output, \( Y_0 \) to \( Y_1 \), can be achieved.

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The Pennsylvania constitutional rules attempt to prevent the state government from interfering inefficiently within the state economy. Generally, the constraints are weak and ineffective. The Pennsylvania Constitution directs the state government to pursue goals by intruding into the state economy that may diverge from the goals of its citizens. The Constitution does not significantly restrict rent seeking by political leaders and special interest groups. The result is an inefficient use of Pennsylvania's resources.
The impact of technological innovation upon output can be classified four ways: as disembodied technological innovation ($\Delta$ technological innovation), innovation irrespective of inputs, embodied technological innovation ($\Delta$ technological innovation), and innovation embedded within the inputs of capital and labor (human capital).

$$Y = \Delta\text{technological innovation}_D \left[ f(\text{labor\{human capital\}}, \text{capital\{\Delta\text{technological innovation}_E\}}) \right]$$

For embodied technological change, the result of technological innovation is the following: (a) input resources are allocated to new products, (b) economies of scale are increased by the introduction of new process plants to reduce average costs, or (c) economies of scope are increased by the introduction of a variety of products where cost sharing can reduce the sharing of fixed overhead costs of producing a variety of products together.

It is recognized that quality of labor increases as output production increases. Labor quality rises due to an increase in human capital formation and when embedded with more productive capital, the regional economy will experience greater increases in output and thereby production of goods and services.

For the United States, from 1959-1998 the average annual change in output due to increases in capital services was about 1.8%. Of that, labor services increased about 1.2% and technological innovation by 0.6% for an average annual rate of 3.6% (Jorgensen and Stiroh, 2000). The authors of this paper point out that from 1995-98 relative to 1990-95, the surge in information technology investment and consumption accounted for more than 40% of the total growth contribution for broadly defined capital services – suggesting an embedded technological innovation within the capital service component for output production. Also, the paper points out that labor input increased by 0.8% from 1995-98 relative to 1990-95 primarily due to growth in hours worked. The authors noted that only 10% of the growth in labor productivity was due to the quality of labor services, reflecting demographic trends and exhaustion of the pool of available workers. This quality, then, is dependent upon the educational level and composition of workers.

The firm combines the efficient use of resources and technology to produce the output of goods and services demanded by society. Business assistance designed to make already existing firms more efficient help advance business start-ups and enhances the ability of firms to produce goods and services. Higher education institutions contribute to economic development by providing entrepreneurial
education and assistance as well as support for existing businesses. Curricular and non-curricular entrepreneurial activities can aid in supporting small business development and promoting new business start-ups.

Three examples of business assistance within Pennsylvania are the Ben Franklin Technology Partners (BFTP), Pennsylvania Small Business Development Centers (Pa-SBDCs) and business incubators. BFTP provides both early-stage and established companies in Pennsylvania with funding, business and technical expertise and access to a network of innovative, expert resources (http://benfranklin.org/). The Pa-SBDCs help aspiring entrepreneurs convert ideas into businesses, encourages small firms to expand, and provides information to individuals making critical business decisions (http://www.pasbdc.org/). The 21 Pennsylvania business incubators nurture the development of entrepreneurial companies during their start-up phase with support services and resources (http://www.innovatorsguide.org/incubators/pennsylvania_business_incubators.htm). These three programs help create and expand a regional economy’s production.

Regional higher education institutions can help facilitate an increase in production. Higher education universities and colleges can partner with private firms to commercialize intellectual property. Furthermore, highly skilled workers trained from those same universities and colleges will increase the likelihood of greater economic development with more goods and services produced. Below are three examples:

Harrisburg Area Community College’s Institute for Entrepreneurial Studies allows students to choose the credit program that best fits their educational needs whether it be a certificate, diploma, or associate degree in Entrepreneurial Leadership. In addition, other non-credit programs assist individuals in the planning and training required to develop and/or manage a successful business venture (https://www.thumbtack.com/Individual-Business-Counseling-Harrisburg-PA/service/80249).

York College of Pennsylvania’s J.D. Brown Center for Entrepreneurship prepares graduates for three career paths: to start a business sooner rather than later, join a family enterprise and take it to the next level, and become an entrepreneur within a large organizational setting. An entrepreneur continues to be engaged in entrepreneurial activities by starting a small on-campus business, participating in an elevator pitch competition, working with entrepreneurs in the field, creating business models and marketing plans and other hands-on activities (https://www.ycp.edu/academics/academic-departments/business/programs/entrepreneurship/).

Wilson College’s Richard Alsina Fulton Center for Sustainability provides opportunities for students and community members to interact on environmental issues and solutions to problems including food production, energy, transportation, and land stewardship (http://www.wilson.edu/fulton-center-sustainability-studies).

3 Output or Income per Capita: Output divided by population size is used to determine whether the goods and services produced in an economy are greater than the increase in population size. Correspondingly, income divided by population size is used to determine whether the income received in an economy is greater than the increase in population size. If so, there are more goods and services in the economy for the population to consume or more income to consume or save. Outputs can be measured at the national level (Gross Domestic Product), state level (Gross State Product), or at a regional/local level. Personal Income is money that is received by all persons from all sources and is calculated by the place of residence of the income recipients.

In 2015, Pennsylvania’s per capita nominal Gross State Product (GSP) was $52,925, which was 5.3% less than the U.S. GSP of $55,904. Pennsylvania’s per capita Personal Income was $49,745, which was slightly higher than the U.S. figure of $48,112. Pennsylvania’s income growth rate from 2005 to 2015 was 4.13% relative to the U.S. rate of 5.07% (Source: Bureau of Economic Analysis). At that rate, it will take Pennsylvania about 17 years to double its income while the rest of the U.S. will take about 14 years. These data suggest Pennsylvania needs to enhance and leverage its economic development infrastructure for faster economic income growth.

4 Income Elasticity of Demand: When there are rapid changes in technology due to economic development, output and income rise faster than the increase in labor. When output and income both rise over time, people demand different types of output produced from different sectors of the economy. Firms will then produce those products with relatively higher income elasticity of demands.

The income elasticity of demand indicates the percentage increase in quantity demanded for goods due to a one percent increase in income. Agricultural, manufacturing, and service products have a range from lower to higher income elasticity of demand, indicating a greater demand for services relative to agricultural products as income increases over time. For example, food has an income elasticity of 0.28 (Walter, 1995), goods from 0.93 - 1.07, and services at 1.12 (Fuchs, 1968). As economies develop, demand for manufactures tends to settle at 20 – 25%; for agricultural products at 10% and hence for services at 70% of GDP (Clark, 1951). As income rises during sustained economic development, firms responding to quantity demanded requirements cause a structural transformation and workforce composition change in society.
(5) Structural Transformation of Society: As an economy develops and grows, the composition of output, the industrial structure of labor, and the occupational structure of labor change over time. The composition of output needed determines the proportion of output coming from different sectors in the economy. If an economy is developing, relative output coming from the service sector will increase while declining in the agricultural sector as a percentage of total output production. For example, as income rises, people buy less food as a percentage of their incomes.

The industrial structure of labor determines the proportion of the labor force working in each sector. As development occurs, employment shifts will occur as firms hire relatively more workers for goods demanded. For example, in the U.S. economy, the industrial structure of labor shifted from agriculture to manufacturing in the first half of the twentieth century, and from manufacturing to services in the second half. As income rises per person over time, people demand more services than food; hence, labor will be employed more in the service sector relative to the agricultural sector. In addition, the occupational structure of labor indicates the type of work performed. As economic development occurs, white collar occupations increase as more work is needed in the service sector.

The change in the worker composition of an economy places greater skill requirements upon workers. Included within this human capital dimension is the fact that businesses require a skilled workforce to enhance their productivity and profitability (Resek, et.al., 2000). Workforce development programs partnering with education institutions provide resources to increase the skills of workers. For example, universities and colleges that participate in variety of workforce development programs including WEDnetPA provide a training network where in-state businesses that show solid growth and out-of-state businesses that decide to relocate in Pennsylvania are eligible for free job training. One of the key considerations used by firms to determine where to locate their investment dollars is an already skilled workforce within a regional area. Higher education institutions train many individuals with these workforce skills.

(6) Feedback to A Technology Innovation for Sustainable Economic Development: Since white collar and certain blue collar workers generally have high levels of formal education, educated workers are more receptive to technological and knowledge innovation and have a greater opportunity to create technological and knowledge-based innovations. This process is at the advanced or sustainable economic development stage where output per population continues to rise over time. Indeed, in a sustainable economic development state, higher education institutions, workforce development and vocational training programs play a critical role. Firms demand workers with greater human capital skills that are usually provided by higher education and workforce/vocational training institutions and workers require workforce development life-long learning programs to update their skills in an advanced technological society--again provided by higher education and workforce/vocational training institutions.

III. CONCLUSION

The failure of economic development within local, regional or national areas is the gaps between actual and an optimal economic development infrastructure. Failure to enhance technological innovation through private and public resources may result in relatively slower output per capita and standard of living for its citizens.

Atkinson and Nager (June 2014) argue that to enhance economic development, countries, states, regional, and local areas need to develop a comprehensive economic development analysis and strategy by benchmarking against other competitive areas. Economic development strategies can be pursued to improve upon development gaps such as in in business climate factors like costs (taxes) and regulations; financial incentives for innovation; education reform for innovation including technology commercialization platforms; and start-up support through idea to revenue generating commercialization economic development processes. In addition, an enhanced quality of life environment will provide appropriate economic development ecosystem to further the economic development infrastructure.

Pennsylvania requires a comprehensive economic development analysis and strategy. Pennsylvania’s costs and regulations are generally on average with other states, while improvements needed on certain regulations and taxes, such as the high statutory Corporate Net Income Tax rate of 9.99%. Quality of life improvements are needed in budgetary financial discipline and on-going liability reforms. Innovation or competitiveness areas require improvements in start-up activity and entrepreneurship growth to be greater than average of all states (for greater detail see Miller, October 15, 2007; Greenberg and Woolever, 2014). Constitutional and institutional frameworks require additional institutional policy constraints to reduce the likelihood of government failure and inefficient use of resources.

ENDNOTES

* The author would like to thank Malcolm Furman, Nevin Mindlin, Robert Keaton, and discussant for comments. All possible errors are the author’s.
1. Eathington, Todd, and Swenson (April 2005) state that general economic climate or business climate lack concrete definitions across studies. The “business climate” term is used more frequently within discussions of regional economic development relative to national issues.

2. From Walczak, Drenkard, and Henchman (2017), taxes diminish profits. If taxes take a larger portion of profits, the cost is passed along to either consumers (through higher prices), employees (through lower wages or fewer jobs), or shareholders (through lower dividends or share value), or some combination of the above. Thus, a state with a relatively lower tax costs will be more attractive to business investment and commercialization possibilities.

3. An important quality of life attribute is when citizens are consuming higher education capital. This can result in societal benefits in other ways, such as a reduced dependency on social safety nets, reduced criminal activity, and higher levels of civic participation. In the absence of government funds to higher education, individuals will consume less higher education than what is socially optimal (Baum, 2004).

4. The data are from institutions that responded to the annual AUTM survey. The Pennsylvania respondents to the FY2007 survey are Allegheny-Singer Research Institute, Carnegie Mellon University, Children’s Hospital of Philadelphia, Drexel University, Duquesne University, Fox Chase Cancer Center, Lehigh University, Penn State University, Temple University, Thomas Jefferson University, University of Pennsylvania, University of Pittsburgh, and Wistar Institute.

5. The Pennsylvania Keystone Innovation Zone (KIZ) program facilitates research and intellectual property commercialization through partnerships with higher education institutions. KIZs were established in geographic areas adjacent or linked to institutions of higher education. Firms in KIZs receive assistance in commercializing research developed at colleges and universities (Armstrong and Yazdi, 2004).

6. Morawetz (1977) suggests that maximization of GDP per capita is one goal but other goals such as income distribution, increasing employment, and fulfilling basic needs to reduce poverty are important results for economic development too.

7. The analysis applies the Rule 72 that shows how small differences in growth rates affect the length of time needed for income to double. The analysis does not consider per capita changes to avoid the interaction of population growth differences with income differences.

REFERENCES


Haughton, Jonathan; Conte, Frank; and Pedro Jardim. 2014. “14th Annual State Competitiveness Report,” Beacon Hill Institute, 1-68.


CUSTOMERS' INDECISIVENESS: A PRICING STRATEGY APPROACH

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ABSTRACT

This paper investigates the characteristics of the market competition, and studies how these characteristics can be comprehended by employing the thinking logic of systems science. Then, rigorous deductions of the results are provided in the language of game theory. Among other results, this paper shows when market competition will intensify, under what conditions the existing loyal consumer base of an established firm will start to deteriorate. The established results and the reasoning employed in this paper can be directly applied to design new strategies for competition between firms in order for the firms to optimize their profits.

1. INTRODUCTION

One characteristic of the market economy is the competition that widely exists in the market place. Continuously finding a new profitable market niche, an entrepreneurial behavior that makes competition increasingly intensive, is the key for success in running business enterprises. So, a natural question arises for anyone who dreams to acquire success in the business world: What characterizes a market that begets new opportunities or competition?

In this paper, we try to partially address this question by investigating a condition under which market competition will intensify, how the existing loyal consumer base of an established firm will start to deteriorate. In particular, we will show the following main results: 1) When the consumer surplus of the market is sufficiently large, market competition will intensify with additional profits to be made; 2) When there is a large number of competitors, the number of loyal customers will approach zero; and 3) How different pricing strategies could be employed to potentially double expected profits.

The literature on market competition is quite intensive. For example, Belu and Caragin (2008) analyze the possibilities that a company has when considering to enter a foreign market, and the decision that is very important and involves market assessment and analysis. Kopalle and Lehmann (2006) develop a two-period model, where, which determines consumers’ satisfaction formed on the gap that exists between the actual quality and the expectations; that satisfaction in turn impacts the sales of the second period. Siebert (2015) investigates the optimal entry strategies for firms to use when entering into new or empty markets by considering how many products of different qualities the firms should introduce. Guo, et al. (2012) addresses the role of downstream market competition under symbiotic production and demonstrates that incorporating different types of competition in product markets will partially eliminate the inefficiency as caused by double marginalization. Chang, et al. (2015) consider the effect of market competition on the relationship that exists between corporate governance and capital structure dynamics. Debruyne and Reibstein (2005) investigate when incumbents should enter into new market niches created by technological innovation. Kumar and Sudharshan (1988) investigate the development of optimal defensive strategies based on an understanding of the possible reactions of all the defenders to an optimal attack. Similar results are also obtained by Hauser and Shugan (1983), where different consumer response models and a different equilibrium assumption are used.

Comparing to what exists in the literature this paper greatly enriches the known knowledge on market competition and carries that knowledge many steps forward. Additionally, another main contribution of this paper is that it shows vividly how the relevant reasoning and intuitive thinking in marketing research can be based on systems science in general and systemic yoyo model in particular. At this junction, we like to use this opportunity to particularly acknowledge Zhou, et al. (2015) for the fact that their work inspired the basic thinking logic underneath what is presented in this paper.

The rest of this paper is organized as follows: Section 2 prepares the basic terminology of systems research and the systemic yoyo model. Section 3
considers the case when only one firm becomes strategic with its loyal customers and price switchers. Section 4 looks at the case when all firms become strategic. Section 5 studies which price strategy leads to higher expected profits. And Section 6 concludes the presentation of this work.

2. SYSTEMS RESEARCH / YOYO MODEL

Von Bertalanffy (1924) pointed out that the fundamental character of living things is their organization, the customary investigation of individual parts and processes cannot provide a complete explanation of the phenomenon of life. Since then, this holistic view of nature and social events has permeated the entire spectrum of science and technology, see (Lin, 2009). And in the past 90 some years, studies in systems science and systems thinking have brought forward brand new understandings and discoveries to some of the major unsettled problems in the conventional science (Klir, 1985; Lin, 1999). Because of these studies of wholes, parts, and their relationships, a forest of interdisciplinary studies has appeared, revealing the development trend in modern science and technology of synthesizing all areas of knowledge into a few major blocks, and the boundaries of conventional disciplines have become blurred (“Mathematical Sciences,” 1985). Underlying this trend, one can see the united effort of studying similar problems in different scientific fields on the basis of wholeness and parts, and of understanding the world in which we live by employing the point of view of interconnectedness. As tested in the past 90 plus years, the concept of systems and results of systems research have been widely accepted by the world of learning (Blauberg, et al., 1977; Klir, 2001).

Similar to how numbers and algebraic variables are theoretically abstractions, systems can also be proposed for any object, event, and process. For instance, behind collections of objects, say, apples, there is a set of numbers such as 0 (apples), 1 (apple), 2 (apples), 3 (apples), …; and behind each organization, such as a business firm, a regional economy, etc., there is an abstract, theoretical system within which the relevant whole, component parts, and their interconnectedness are emphasized. As a matter of fact, it is because of these interconnected wholes and parts, the totality is known as a firm, an economy, etc. In other words, when internal structures can be ignored, numbers and algebraic variables can be very useful; otherwise the world consists of dominantly systems (or structures or organizations).

When the traditional science is joined with systems science that investigates systemhood, that collectively gives rise of a 2-dimensional spectrum of knowledge, where the traditional science, which is classified by the thinghood it studies, constitutes the first dimension, and the systems science, which investigates structures and organizations, forms the genuine second dimension (Klir, 2001). In other words, systems research focuses on those properties of systems and associated problems that emanate from the general notion of structures and organizations, while the division of the traditional science has been done largely on properties of particular objects. Therefore, the former naturally transcends all the disciplines of the classical science and becomes a force making the existing disciplinary boundaries totally irrelevant and superficial.

The importance of this second dimension of knowledge cannot be in any way over-emphasized. By making use of this extra dimension, the exploration of knowledge has gained additional strength in terms of the capability of solving more problems that have been challenging the very survival of the mankind since the beginning of time. Such strong promise that systems research holds relies materialistically on the particular speaking language and thinking logic – the systemic yoyo model (Lin, 2007). Figure 1, similar to how the Cartesian coordinate system plays its role in the development of modern science (Kline, 1972).

Specifically, on the basis of the blown-up theory of Wu and Lin (2002) and the discussion on whether or not the world can be seen from the viewpoint of systems (Lin, 1988; Lin, et al., 1990), the concepts of black holes, big bangs, and converging and diverging eddy motions are coined together in the model shown in Figure 1 for each object and every system imaginable. That is, each system is a multi-dimensional entity that spins about its axis. If we fathom such a spinning entity in our 3-dimensional space, we will have a structure as artistically shown in Figure 1(a). The black hole side pulls in all things, such as materials, information, energy, profit, etc. After funneling through the “neck”, all things are spit out in the form of a big bang. Some of the materials, spit out from the end of big bang, never return to the other side and some will (Figure 1(b)). For the sake of convenience of communication, such a structure as shown in Figure 1(a), is referred to as a (Chinese) yoyo due to its general shape.
What this systemic model says is that each physical or intellectual entity in the universe, be it a tangible or intangible object, a living being, an organization, a culture, a civilization, etc., can all be seen as a kind of realization of a certain multi-dimensional spinning yoyo with an eddy field around. It stays in a constant spinning motion as depicted in Figure 1(a). If it does stop its spinning, it will no longer exist as an identifiable system. What Figure 1(c) shows is that due to the interaction between the eddy field, which spins perpendicularly to the axis of spin, of the model, and the meridian field, which rotates parallel to axis of spin, all the materials that actually return to the black-hole side travel along a spiral trajectory.

As expected, this yoyo model has successfully played the role of intuition and playground for scholars who investigate the world and explore new knowledge holistically, just as what the Cartesian coordinate system did for the traditional science (Lin, 2009; Lin and Forrest 2011; Forrest 2013; 2014; Forrest and Tao, 2014; Ying and Forrest, 2015). In particular, this yoyo model of general systems has been successfully applied in the investigation of Newtonian physics of motion, the concept of energy, economics, finance, history, foundations of mathematics, small-probability disastrous weather forecasting, civilization, business organizations, the mind, among others. Along this same line of logic, in this paper we will use this model as our intuition to establish our conclusions.

3. ONE STRATEGIC FIRM

In terms of customer behaviors, indecisiveness is a commonly seen phenomenon (McWilliams, 2004; Mittal, Sarkees and Murshed, 2008; Shin, Sudhir and Yoon, 2012), where customers do not seem to know exactly what they want in the eyes of the sales people. This end in fact can be fundamentally explained by using the concept of personal value systems (Forrest and Orvis, 2016), where the indecisiveness is rooted in the fact that differences in personal value systems lead to varied perceptions about how goods could be used and services enjoyed because generally no good or service perfectly matches an existing personal value system and the consequent perception.

At the same time, the systemic yoyo model provides another explanation. Specifically, when the yoyo field of the customer is obligated to absorb from the environment in order to fill an existing void, since her field is located within a vast, dynamic ocean of different yoyo pools, she is not exactly sure what she needs in the first place and then she is not sure where she could acquire whatever that might fit the need about which she is uncertain about.

From the previous two paragraphs, it follows that when a customer is indecisive in her purchase decision making, there generally is a whole host of reasons for her indecisiveness. So, corresponding to different situations, appropriate sales’ approaches need to be taken by the sales associates in order to complete successful sales. In the following let us focus on the reason of pricing. That is, we assume that the indecisiveness of a potential purchase reflects the fact that the particular customer is a price switcher who makes purchase decisions based on the best price available to her (for a related study, see (Homburg et al., 2012)). To this end, we assume that the oligopoly market of our concern has $m$ firms, named 1, 2, ..., $m$, which provide horizontally differentiated products at constant marginal costs, which we set to zero without loss of generality. Assume that each Firm $k$ has a market share $\alpha$ of the loyal customers such that these customers only purchase the product of Firm $k$ provided that the price is no more than their reservation value, which is set to 1. Let $\beta = 1 - m\alpha$ be the portion of the switchers who base their purchase decisions on which price is lower. The risk-neutral managements of these $m$ firms are well aware of the pricing strategies of the other firms and have established their best responses by playing the Nash equilibrium through pure self-analyses.

**Lemma 1.** In the symmetric Nash equilibrium, each of the existing firms’ expected profits stay constant and are equal to $\alpha$ although the firms try to attract as many switchers as possible.

From the angle of the systemic yoyo model, this result is quite intuitively clear. In particular, let us imagine the market as the entire spinning yoyo field in Figure 2, while each of the $m$ firms is one of the local eddy leaves so that the $m$ local eddies in the spinning dish have reached their balance in their movements. Hence, no matter how hard each of the local eddy spins in order to pull more of the fluid particles into its field, some of the fluid particles always tend to wonder around the large field without actually becoming part of any of the local eddies. In other words, as soon as such a pattern of fluid movement as the one shown in Figure 2 is formed and becomes stabilized, it will be difficult
or impossible for the local eddies to grow any larger. (Note: The pattern shown in Figure 2 was initially discovered by Raymond Hide (1953) of Cambridge University, England, and then by Dave Fultz and his colleagues of University of Chicago (1959). The evolution of the pattern has been well observed and studied by scholars in fluid dynamics and meteorology.)

Proof. Firstly, this game does not have any pure strategy equilibrium, where each firm’s available strategy is the selling price of the firm’s product. In fact, for any pure strategy portfolio \((x_1, x_2, \ldots, x_m)\), if there is a unique index \(i \in \{1,2,\ldots,m\}\) such that

\[ x_i < x_j, \quad \text{for} \quad j \in \{1,2,\ldots,m\} \quad \text{and} \quad j \neq i, \quad (1) \]

then Firm \(i\) has successfully attracted all the price switchers and can therefore slightly raise its price \(x_i\) to bring in additional profits as long as the new price still satisfies the condition in equ. (1), while all other firms maintain their respective strategy unchanged. So, the pure strategy portfolio \((x_1, x_2, \ldots, x_m)\) is not a Nash equilibrium.

If the set

\[ I = \{i \in \{1,2,\ldots,m\} : x_i = \min_{j=1}^m \{x_j\} \} \]

has cardinality \(|I|\) greater than 1, then the Firms \(k, k \in I\), have absorbed all the price switchers. Due to the fact that everything in this scenario is set up symmetrically, we can see that each of these firms would have taken in \(\beta/|I|\) portion of the switcher segment of the market. So, Firm \(k\)'s profits, \(k \in I\), are \(\alpha x_k + (\beta/|I|) x_k\). So, one of these firms, say Firm \(k\), can lower its price slightly to \(x_k'\), satisfying

\[ \frac{x_k'}{x_k} > \frac{\alpha + \beta/|I|}{\alpha + \beta} \]

to bring in additional profits by attracting all the switchers. That is, the pure strategy portfolio \((x_1, x_2, \ldots, x_m)\) is not a Nash equilibrium. Similar argument can be used to show that even when not all firms \(k \in I\) share the same portion of the price switchers, then the Firm with the fewest price switchers could slightly lower its price to increasing its profits by attracting all the price switchers. That is, once again, the pure strategy portfolio \((x_1, x_2, \ldots, x_m)\) is not a Nash equilibrium.

Lastly, if for any \(i \in \{1,2,\ldots,m\}\), \(x_i = 1\), then Firm \(j\), for any chosen \(j \in \{1,2,\ldots,m\}\), can slightly lower its price from the reservation value \(1\) to anywhere in the interval \((\alpha/(\alpha + \beta), 1)\) to produce more profits by taking in the entire segment of the switchers. So, \((1,1,\ldots,1)\) is not a Nash equilibrium, either. That is, the game we are looking at does not have any pure strategy Nash equilibrium.

Secondly, this game does have a symmetric mixed strategy Nash equilibrium (Zhou, et al., 2015). To this end, let \(F_i(P)\) stand for the price distribution of Firm \(i\), \(i \in \{1,2,\ldots,m\}\). Then, the profits \(\Pi_i\) Firm \(i\) generates when the firm sells its product at price \(P\) are

\[ \alpha P + \prod_{j=1}^m [1 - F_j(P)] \beta P, \]

and the objective function of Firm \(i\) is

\[ \max_{F_i(P)} E(\Pi_i) = \int_0^1 [\alpha P + \prod_{j=1}^m [1 - F_j(P)] \beta P] dF_i(P) \]

Firm \(i\) can earn \(\alpha\) by charging the reservation value \(1\), because all the firm’s loyal customers will purchase its product at that price. However, to maximize the profits, each firm likes to adjust the price \(P\) in order to take in as many of the switchers as possible. At the same time each firm does not have any incentive to price its product below the price of \(\alpha/(\alpha + \beta)\), because any price below \(\alpha/(\alpha + \beta)\) will yield profits less than \(\alpha\) despite of attracting all the switchers.

The equilibrium indifference condition for Firm \(i\) is

\[ \alpha \times P + \prod_{j=1}^m [1 - F_j(P)] \beta \times P = \alpha \times 1, \quad (2) \]

for \(\frac{\alpha}{\alpha + \beta} \leq P \leq 1\), \(i, j = 1, 2, \ldots, m\), and \(i \neq j\). So, the symmetric equilibrium price distribution is

\[ F(P) = F_i(P) = F_j(P) = 1 - \left[ \frac{(1-P)\alpha}{P(1-\alpha)} \right]^{1/(m-i)}, \quad (3) \]

and each firm's expected profits are

\[ E(\Pi) = \int_{-\infty}^{+\infty} \left\{ \alpha P \right. \]

\[ \left. + \prod_{j=1}^m [1 - F_j(P)] \beta P \right\} dF(P) \]

\[ = \int_{\frac{\alpha}{\alpha + \beta}}^{1} \alpha dF(P) = \alpha F(P) \bigg|_{\frac{\alpha}{\alpha + \beta}}^{1} = \alpha. \quad \text{QED} \]

What Lemma 1 indicates is that if an identical pricing strategy is employed by all firms, the competition will intensify while the consequent profits do not increase. So, a natural question is:
While holding on to the intensifying competition, can a firm adopt a different pricing strategy that is additional to the one already used in the competition at the same time so that it can increase its profits? According to the following result the answer to this question is YES, it can be done when the consumer surplus $\beta$ is big enough.

**Theorem 1.** Assume that the consumer surplus $\beta$ of the marketplace satisfies $\beta = 1 - ma \geq \alpha$, and that other than Firm $i$ no other existing firms plan to market their products differently. Then the particular Firm $i$ could potentially double its expected profits by uniformly randomizing its price $P$ over the interval $[0,1]$ when dealing with price switchers.

Proof. What is given here implies that Firm $i$ now employs two separate and unrelated pricing strategies: one, which is that shown in the proof of Lemma 1, for its loyal customers, and the other for price switchers. So, for the sake of communication convenience, let us theoretically treat Firm $i$ as two separate firms, named Firm $i$ and Firm $ia$, where the former stands for the original Firm $i$ that employs the firm’s originally adopted pricing strategies, while the latter deals only with price switchers by uniformly randomizing its price $P$ over the interval $[0,1]$.

From $\beta = 1 - ma \geq \alpha$, it follows that $\alpha/\beta \leq 1$. So, for any price $P$, satisfying $\alpha/\beta \leq P \leq 1$, the following function $F(P)$,

$$ F(P) = 1 - \left(\frac{\alpha}{\beta P}\right)^{\frac{1}{m-1}}, \quad (4) $$

represents a well-defined strategy for each of the $m$ existing firms, which satisfies the following equilibrium indifference condition of Firm $k$, $k = 1, 2, \ldots, m$,

$$ \alpha \times P + \beta \times P \prod_{j=1}^{m} (1-P) [1-F_j(P)] = \alpha \times 1, \quad (5) $$

which implies that for the $m$ existing firms, their lowest allowed price is $\alpha/\beta$.

Next, we show that the expected profits of Firm $i$ are still $\alpha$, the same as that before adopting the new pricing strategy for price switchers. In fact, from equ. (5) we have

$$ E_i(\Pi) = \int_{\alpha/\beta}^{1} QdF(P) + \alpha \times \left(\frac{\alpha}{\beta}\right)^{\frac{1}{m-1}} $$

$$ = \int_{\alpha/\beta}^{1} adF(P) + \alpha \left(\frac{\alpha}{\beta}\right)^{\frac{1}{m-1}} = \alpha \quad (6) $$

where $Q = \alpha \times P + \beta \times P(1-P) \cdot \prod_{j=1}^{m} [1-F_j(P)]$.

For the rest of this proof, it suffices based on equ. (6) to show that there is such an opportunity that Firm $ia$ could expect to make at least as much profits as $\alpha$. To this end, because $\lim \frac{F(P)}{P-1} = 1/(\alpha/\beta)^{m-1}$, the cumulative price distribution function $F(P)$ has a jump discontinuity at the reservation value $P = 1$, where the amount of jump is $1/(\alpha/\beta)^{m-1}$. So, the expected profits of Firm $ia$ are the following:

$$ E_{ia}(\Pi) = \int_{0}^{\alpha/\beta} \beta P dP + \int_{\alpha/\beta}^{1} \beta P[1-F(P)]^m dP $$

$$ = \int_{0}^{\alpha/\beta} \beta P dP + \int_{\alpha/\beta}^{1} \beta P[1-F(P)]^m dP + \beta \left(\frac{\alpha}{\beta}\right)^{\frac{m}{m-1}} $$

$$ = \left\{ \begin{array}{ll}
\frac{-m}{2(m-2)} \frac{\alpha^2}{\beta^2} + \frac{m-1}{m-2} \frac{\alpha}{\beta} + \beta \left(\frac{\alpha}{\beta}\right)^{\frac{m}{m-1}}, & \text{if } m \geq 3 \\
\frac{\alpha^2}{2\beta} - \frac{\alpha^2}{\beta} \ln \frac{\alpha}{\beta} + \beta \left(\frac{\alpha}{\beta}\right)^{\frac{m}{m-1}}, & \text{if } m = 2
\end{array} \right. $$

And because $\frac{\partial}{\partial \alpha} [E_{ia}(\Pi) - \alpha] > 0$ and when $\alpha = 1/(m+1) = \beta$, $E_{ia}(\Pi) - \alpha > 0$, it follows that there is $\alpha^*_i \in (0,1/(m+1))$ such that when $\alpha \geq \alpha^*_i$, $E_{ia}(\Pi) > \alpha$. QED

What Theorem 1 indicates is that when confronting with indecisive customers, first find out what is beneath the purchase indecisiveness. If it is the price, then the firm could use such a sales’ strategy that it materially randomizes the selling price uniformly over the interval $[0,1]$. By doing so, the firm could potentially achieve two advantages in the market place:

Increase its consumer base; and Grow its baseline of profits.

At the same time, Theorem 1 and its proof imply that if the consumer surplus $\beta$ is not taken care of by the existing firms, potentially new competitors will enter the market. In particular, Firm $ia$, introduced in the proof of Theorem 1, can be a completely different firm not related to Firm $i$. When such a situation occurs, it means a new firm enters into the market to compete with the existing
4. ALL FIRMS ARE STRATEGIC

Although the situation described in Theorem 1 would not appear in real life according to the structure of the spinning field in Figure 2, where all the eddy leaves move and behave in concert, this result still naturally leads to the belief that many of the existing firms, if not all, would like to adopt a similar strategy as Firm $i$ in the theorem. To this end, we have the following result.

**Theorem 2.** A sufficient and necessary condition for each existing Firm $i$, $i = 1, 2, \ldots, m$, to increase its expected profits by uniformly randomizing its price $P$ over the interval $[0,1]$ when dealing with price switchers, while still employing its mixed pricing strategy at the Nash equilibrium with the loyal customers, is that the consumer surplus $\beta$, and the objective function of Firm $i$, $\alpha P$ and $\beta P$, switchers only by uniformly randomizing its price over the interval $[0,1]$ when dealing with price switchers. Just as what is done in the previous proof can be deducted backward to show that there are price levels $\bar{P}$ and $\tilde{P}$, satisfying $0 \leq \bar{P} < \tilde{P} \leq 1$, such that $F(\bar{P})$, as defined in equ. (9), is a valid symmetric pricing strategy for the existing firms $i$, $i = 1, 2, \ldots, m$, and that $F(\tilde{P})$ satisfies the Nash equilibrium indifference condition in equ. (8). In other words, each Firm $i$, $i = 1, 2, \ldots, m$, can be conceptually run as two firms with Firm $i$ employing the mixed strategy $F(P)$ while the shadow Firm $i$ deals with price switchers only by uniformly randomizing its price over the interval $[0,1]$.

Now, for Firm $i$, its expected profits $E(\Pi_i)$ are

$$E(\Pi_i) = \int_0^1 \{\alpha P + \beta P(1-P)^m \prod_{j \neq i} [1 - F_j(P)]\}dF_i(P).$$

The equilibrium indifference condition for Firm $i$ is

$$\alpha \times \tilde{P} + \beta \times \tilde{P}(1-\tilde{P})^m \prod_{j \neq i} [1 - F_j(\tilde{P})] = \alpha \times \bar{P}.$$  \hspace{1cm} (8)

So, the symmetric equilibrium price strategy of each Firm $i$, $i = 1, 2, \ldots, m$, is

$$F(P) = F_{\bar{P}}(P) = 1 - \frac{1}{1 - \beta P} \left(\frac{\alpha}{\beta}P\right)^{m-1}. \hspace{1cm} (9)$$

For this strategy to be valid, we must have $F(P) = 0$, for $P \leq \bar{P}$, $F(P) = 1$, for $P \geq \bar{P}$, and $F(P) \geq 0$, for $P \leq \bar{P} \leq \tilde{P}$, where $\bar{P}$ and $\tilde{P}$ are some fixed price levels such that $0 \leq \bar{P} < \tilde{P} \leq 1$.

Next, let us see when such price levels $\bar{P}$ and $\tilde{P}$ can exist. To this end, define

$$h(P) = (1 - P)\frac{1}{m^{m-1}} - \left(\frac{\alpha}{\beta}\right)^{m-1},$$

so that $F(P) = h(P)/(1 - P)\frac{1}{m^{m-1}}$. Then it can be readily checked that $F(P)$ is well defined if and only if $h(P) \geq 0$, for $P \leq P \leq \tilde{P}$, where $\bar{P}$ and $\tilde{P}$ are some fixed price levels such that $0 \leq \bar{P} < \tilde{P} \leq 1$, and that $h(0) < 0$ and $h(1) < 0$. Since

$$h'(P) = \frac{\frac{1}{m^{m-1}}}{m^{m-1}}(P^{-1} - m),$$

it can be shown that $h(P)$ reaches its maximum at $P = 1/m$. That is, in order for the previously mentioned price levels $\bar{P}$ and $\tilde{P}$ to exist, $h(P)$ must satisfy

$$h\left(\frac{1}{m}\right) = \frac{m-1}{m^{m+1}} - \left(\frac{\alpha}{\beta}\right)^{m-1} > 0. \hspace{1cm} (10)$$

That is, equ. (7) holds true.

(\iff) Assume that equ. (7) holds true. Then the reasoning in the previous proof can be deducted backward to show that there are price levels $\bar{P}$ and $\tilde{P}$, satisfying $0 \leq \bar{P} < \tilde{P} \leq 1$, such that $F(\bar{P})$, as defined in equ. (9), is a valid symmetric pricing strategy for the existing firms $i$, $i = 1, 2, \ldots, m$, and that $F(\tilde{P})$ satisfies the Nash equilibrium indifference condition in equ. (8). In other words, each Firm $i$, $i = 1, 2, \ldots, m$, can be conceptually run as two firms with Firm $i$ employing the mixed strategy $F(P)$ while the shadow Firm $i$ deals with price switchers only by uniformly randomizing its price over the interval $[0,1]$. 


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\[
\alpha(d) = \beta < r \quad \text{when the competition of a market} \quad \alpha = E(P_{i\alpha}) = \alpha F_i(P) \bigg|_{P=P} = \alpha, \quad (11)
\]

and the profits \( E(P_{i\alpha}) \) of Firm \( i\alpha \) are

\[
E(P_{i\alpha}) = \int_0^P (1 - P)^{m-1} \beta P dP \] 
\[+ \int_0^P (1 - P)^{m-1} [1 - F(P)]^m \beta P dP + \] 
\[+ \int_1^P (1 - P)^{m-1} \beta P dP, \quad (12) \]

where the first and third terms respectively represent the expected profits of Firm \( i\alpha \), when its price is lower than or higher than that of Forms \( j, j = 1, 2, \ldots, m \), and the second term is the expected profits of Firm \( i\alpha \) when it is in direct competition with all other firms, be they real or shadow.

Because the first term in equ. (12) is given by

\[
\int_0^P (1 - P)^{m-1} \beta P dP = \beta \left[ \frac{e^{m \min(1-P)}(mp + 1)}{m^2 + m} \right]_{P=0}^P, > 0
\]

while the second term in equ. (11) is non-negative and the third term is 0, because no price switchers exist in that price interval, we conclude that \( E(P_{i\alpha}) > 0 \). So, from equs. (11) and (12), we can conclude that each existing firm can increase its expected profits by uniformly randomizing its price \( P \) over the interval \( [0,1] \) when dealing with price switchers, while still employing its symmetric mixed pricing strategy at the Nash equilibrium with the loyal customers. QED

**Corollary 1.** When the competition of a market grows with an increasing number of firms entering the market, the base of loyal customers for each firm will gradually diminish.

Proof. From Theorem 2, it follows that the consumer surplus \( \beta \) and the market share \( \alpha \) of Firm \( i \) satisfy the condition

\[
\frac{\alpha}{\beta} < \left( 1 - \frac{1}{m} \right) m = \frac{1}{e} \times 0 = 0, \quad \text{for} \quad m \to \infty.
\]

That is, the ratio \( /\beta \to 0 \), as \( m \to \infty \). QED

Before we move on to the next result, let us first take a closer look at equ. (7). If \( m = 2 \), \( (\alpha/\beta)_{m=2} < 1/4 \); if \( m = 3 \), \( (\alpha/\beta)_{m=3} < \frac{1}{27} \); if \( m = 4 \), \( (\alpha/\beta)_{m=4} < \frac{27}{256} \); \ldots And in general, we can prove that \( (m-1)^{m-1}/m^m \) is a decreasing function in \( m \). So, if we look at the market with the concept of evolution in mind, where the market could be either expanding or shrinking, then the dynamics of market competition is described by Theorems 1 and 2 very well. For example, if the market is expanding quickly, then that means that the size \( \beta \) of consumer surplus segment increases quickly when compared to the magnitude of \( \alpha \), the base of loyal customers of an existing firm. So, the existing firms would have to expand their consumer bases by employing competitive pricing strategies; otherwise, Theorem 1 implies that new firms would enter the market to grab the segment of consumer surplus. And, as more firms enter the market, Corollary 1 implies that the consumer bases of the existing firms would dwindle, while the traditional pricing strategies would have to be replaced by new strategies.

The systemic intuition for this scenario is given in Figure 3. Different from the model in Figure 2, the expanding spinning field in Figure 3 does not have a solid periphery. Instead various elements from the neighborhood, which is relatively motionless when compared to the center of the field, constantly join into the field, making the field grow bigger. Another strikingly different characteristic is that the eddy leaves in Figure 3 spin in directions opposite those in Figure 2 due to the effect of the relatively motionless neighborhood. Now, if the existing eddy leaves do not grow bigger, more eddy leaves have to appear with the expansion of the overall field in order to have the overall field occupied due to uneven distribution of forces.

On the other hand, if the market shrinks, it initially means that the segment of consumer surplus disappears gradually first, followed by the decline of the loyal consumer bases of the existing firms. That means that as soon as the segment of consumer surplus shows clear signs of contraction, the existing firms need to investigate their exit strategies from the market and explore new market options. To this end, the research on personal values (Forrest and Orvis, 2016) comes into play nicely: Those employees with personal value systems not in total agreement with their firm’s mission would potentially discover new market directions for the firm, because their perceptions of the world, which are different from that of the firm, might help the firm to uncover one or several new markets with enough consumer surplus for the firm to enter with the potential of making more profits than any of the existing firms within the newly discovered market.

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This discussion actually shows that organizational inefficiencies (Forrest and Orvis, 2016), which exist at different time moments throughout the development of an organization, might not be all bad in the growth of the organization in terms of evolutions and developments.

5. WHICH PRICE STRATEGY LEADS TO HIGHER EXPECTED PROFITS?

Example 1. Let us look at the special case of \( m = 2 \) when equ. (7) becomes \( 4\alpha < \beta \), where each Firm \( i \) is divided theoretically into the real Firm \( i \) and the shadow Firm \( ia \) as described in the proof of Theorem 2. In particular, Firm \( i \) deals only with its loyal customers by employing the mixed strategy \( F(P) \) in equ. (9), which is simplified as follows:

\[
F(P) = 1 - \frac{\alpha}{\beta} \cdot \frac{1}{(1-P)\beta}, \quad 0 < P \leq P \leq \tilde{P} < 1.
\]

while the shadow Firm \( ia \) deals with price switchers only by uniformly randomizing its price over the interval \([0,1]\).

By solving \( F(P) = 0 \), we get \( P = (1 - \sqrt{1 - 4\alpha/\beta})/2 \). And because \( F(P) \) reaches its maximum at \( P = 1/2 \), we have \( \tilde{P} = 1/2 \). Since \( F(P) \) has a mass point of size \( 4\alpha/\beta \) at \( \tilde{P} = 1/2 \), the expected price of Firm \( i \) is

\[
E_i(P) = \int_0^P P \times dF(P) + \frac{1}{2} \frac{4\alpha}{\beta} = \frac{1}{2} - \frac{1}{\beta} \ln \frac{1}{1 + \sqrt{1 - 4\alpha/\beta}} + \frac{2\alpha}{\beta}.
\]

where the second term on the left hand side is positive and could be very close to 0 if \( 4\alpha \lesssim \beta \).

Define the following auxiliary function

\[
H(x) = x - \sqrt{1 - x}, \quad 0 < x < 1,
\]

then \( H(x) \) is an increasing function satisfying \( \lim_{x \to 1} H(x) = 1 \) and \( \lim_{x \to 0} H(x) = -1 \). So, there is a unique \( x \in (0,1) \) such that \( H(x) = 0 \), which leads to \( x = (1 + \sqrt{5})/2 \). In other words, when \( \frac{-1 + \sqrt{5}}{2} \leq \frac{4\alpha}{\beta} < 1 \), \( E_i(P) > E_{ia}(P) = 1/2 \).

The expected profits of Firm \( ia \) are

\[
E(\Pi_{ia}) = \int_0^P (1 - P)\beta PdP + \int_P^1 (1 - P)[1 - F(P)]^2\beta PdP + (1 - \frac{1}{2})\frac{\beta}{\beta} \left(4\alpha\right)^2
\]

\[
= \int_0^P (1 - P)\beta PdP + \frac{\alpha^2}{\beta} \int_P^1 \frac{1}{1 - P}\beta PdP + \frac{\beta}{\beta} \left(4\alpha\right)^2
\]

\[
= \frac{\beta}{6} \left(2 - \frac{1}{\sqrt{1 - 4\alpha/\beta}}\right)^2 \left(2 + \sqrt{1 - 4\alpha/\beta}\right) - \frac{\alpha}{\beta} \ln \frac{1}{1 + \sqrt{1 - 4\alpha/\beta}} + \frac{2\alpha}{\beta}.
\]

where \( \frac{-1 + \sqrt{5}}{2} \leq \frac{4\alpha}{\beta} < 1 \) such that

\[
E(\Pi_{ia})\bigg|_{\frac{-1 + \sqrt{5}}{2} \leq \frac{4\alpha}{\beta} < 1} = 0.94409\alpha
\]

\[
\lim_{\frac{4\alpha}{\beta} \to 1} E(\Pi_{ia}) = 4\alpha/3. \text{ So, the continuity of }\ E(\Pi_{ia}) \text{ in }\alpha/\beta\text{ implies that there is }\frac{-1 + \sqrt{5}}{2} \leq P^* < 1\ \text{ such that }\ E(\Pi_{ia}) > \alpha \text{ when } P^* \leq \frac{4\alpha}{\beta} < 1. \text{ QED}
\]

What is analyzed in Example 1 implies that there is an interval \( [P^*, 1) \subseteq [P, 1) = [(-1 + \sqrt{5})/2, 1) \) such that when \( 4\alpha/\beta \notin [P^*, 1) \), the expected price \( E_i(P) \) of Firm \( i \) is greater than the expected price \( E_{ia}(P) = 1/2 \) of the shadow Firm \( ia \), while the expected profits \( E(\Pi_i) \) of Firm \( i \) is less than that of the shadow Firm \( ia \) \( E(\Pi_{ia}) \). In other words, what is confirmed in Example 1 is that when the two existing firms occupy consumer bases of a good size, they might become content with what they could make from their loyal customers; and the sufficiently large segment of consumer surplus would conveniently encourage new competitions to foray into the market with the potential of making more profits than any of the existing firms. As for the general case of \( m \geq 3 \), let us see how to establish Theorem 3 below.
Lemma 2. The upper limit $\bar{P}$, $0 \leq \bar{P} \leq 1$, for the pricing strategy $F(P) = 1 - \frac{1}{1-P} \left( \frac{\alpha}{\beta} \right)^{m-1}$, $0 \leq P \leq \bar{P} \leq 1$, as given in equ. (9), is equal to $1/m$. And, $F(P)$ has a mass point of size $rac{m}{m-1} \left( \frac{\alpha}{\beta} \right)^{1/m-1}$ at $P = 1/m$.

Proof. It is easy to show that

$$F'(P) = \left( \frac{\alpha}{\beta} \right)^{1/m-1} \frac{1-mP}{(m-1)(1-P)^2 \beta^{m-1} P^{m-1}}$$

satisfying $F'(\frac{1}{m}) = 0$, $F'(\frac{1}{m}) > 0$, for $P \leq P < 1/m$, and $F'(\frac{1}{m}) < 0$, for $\frac{1}{m} < P < 1$. Therefore, $F'(\frac{1}{m})$ reaches a local maximum so that we know $P = 1/m$. And because

$$F\left(\frac{1}{m}\right) = 1 - \frac{m}{m-1} \left( \frac{\alpha}{\beta} \right)^{1/m-1},$$

the pricing strategy $F(P)$ has a mass point of size $rac{m}{m-1} \left( \frac{\alpha}{\beta} \right)^{1/m-1}$ at $P = 1/m$. QED

Lemma 3. The lower bound $\underline{P}$, as given in Lemma 2, satisfies the following properties:

$$\frac{dP}{d(\alpha/\beta)} > 0, \quad \lim_{\alpha/\beta \to 0^+} P = 0$$

and

$$\lim_{\alpha/\beta \to ((m-1)m^{-1}/m^m)^-} P = \frac{1}{m}$$

Proof. The lower bound $\underline{P}$ satisfies the equation $F(P) = 0$. So we have

$$\frac{1}{P_{m-1}} - \frac{1}{P^{m-1}} = \left( \frac{\alpha}{\beta} \right)^{1/m-1}.$$ (14)

Differentiating this equation with respect to $\alpha/\beta$ produces

$$\frac{dP}{d(\alpha/\beta)} \cdot \frac{1}{P_{m-1}(P^{m-1} - m)} = \left( \frac{\alpha}{\beta} \right)^{1/m-1}$$

Because $P^{m-1} > 0$, $(\alpha/\beta)^{1/m-1} > 0$, and $P < 1/m$ (so that $P^{m-1} - m > 0$), we get $\frac{dP}{d(\alpha/\beta)} > 0$.

By re-writing equ. (14), we have

$$\frac{1}{P_{m-1}}(1-P) = \left( \frac{\alpha}{\beta} \right)^{1/m-1},$$ (15)

So, we obtain

$$\lim_{\alpha/\beta \to 0^+} P = \lim_{\alpha/\beta \to 0^+} \frac{1}{P_{m-1}} = \lim_{\alpha/\beta \to 0^+} \left( \frac{\alpha}{\beta} \right)^{1/m-1} = 0.$$

And, equ. (15) implies that when $\alpha/\beta \to ((m-1)m^{-1}/m^m)^-$, we have

$$(mP)^{m-1}(1-P) = 1 - \frac{1}{m}$$

so that $P = 1/m$. That is, we have shown

$$\lim_{\alpha/\beta \to ((m-1)m^{-1}/m^m)^-} P = \frac{1}{m}, \text{ QED}$$

So, Lemma 2 implies that the expected price of Firm $i$ is

$$E_i(P) = \int_{P}^{1/m} P \times F'(P)dP + \frac{1}{m} \times \int_{\frac{1}{m}}^{m} \left( \frac{\alpha}{\beta} \right)^{1/m-1}$$

$$= PF(P)\frac{1}{P} - \int_{\underline{P}}^{1/m} F(P)dP + \frac{1}{m} \times \int_{\frac{1}{m}}^{m} \left( \frac{\alpha}{\beta} \right)^{1/m-1}$$

$$= 1 - \frac{1}{m} + P + \int_{\underline{P}}^{1/m} \left[ 1 - F(P) \right]dP$$

which, according to Lemma 3, is greater than the expected price $E_{ia}(P) = 1/2$ of the shadow Firm $ia$.

For the expected profits of Firm $ia$, we have

$$E_\Pi(ia) = \int_{\underline{P}}^{P} (1-P)\beta PdP$$

$$+ \int_{\underline{P}}^{1/m} (1-P)^{m-1}(1-F(P))\beta PdP + \alpha$$

$$\cdot \int_{\underline{P}}^{1/m} \left( \frac{\alpha}{\beta} \right)^{1/m-1}$$

Because $\frac{dE_\Pi(ia)}{d(\alpha/\beta)} > 0$, $\lim_{\alpha/\beta \to ((m-1)m^{-1}/m^m)^-} P = \frac{1}{m}$ (Lemma 3), and $E_\Pi(ia) \to \int_{\underline{P}}^{1/m} (1-P)^{m-1}\beta PdP + \alpha$ when $\alpha/\beta \to ((m-1)m^{-1}/m^m)^-$, it follows that there is a $\gamma$ satisfying $0 < \gamma < (m-1)m^{-1}/m^m$ such that the expected profits $E_\Pi(ia)$ of the shadow Firm $ia$ is greater than the expected profits $\alpha$ of Firm $i$, when $\gamma < \alpha/\beta < (m-1)m^{-1}/m^m$. That is, by combining Example...
1 and the discussion above we have shown the following general results:

**Theorem 3.** If each existing Firm \( i, i = 1, 2, \ldots, m \), increases its expected profits by uniformly randomizing its price \( P \) over the interval \([0,1]\) when dealing with price switchers, while still employing its mixed pricing strategy at the Nash equilibrium with the loyal customers, then there is \( \gamma \) satisfying \( 0 < \gamma < (m - 1)^{m-1}/m^m \) such that the expected price \( E_i(P) \) of Firm \( i \) is greater than the expected price \( E_{ia}(P) = 1/2 \) of the shadow Firm \( ia \), while the expected profits \( E(\Pi_i) \) of Firm \( i \) is less than that of the shadow Firm \( ia E(\Pi_{ia}) \). QED

6. **SOME FINAL REMARKS**

To find the market characteristics that beget new opportunities and competition, this paper establishes several interesting results: a condition under which market competition will intensify, how the existing loyal consumer base of an established firm will start to deteriorate, among others. At the same time, this work shows the importance of systemic thinking and the yoyo model in visualizing the dynamics of the market competition. In particular, the yoyo model, different from that of Cartesian coordinate system, provides another platform for scholars to think and to imagine before they can rigorously prove what they first see intuitively.

Other than the fact that the results established in this paper can be readily employed in practice, this work contributes to the existing literature in two noticeable ways: Signs of the market that is ripe for new competition, and an innovative tool for visualization. Based on the development history of science, either natural or social, being able to visualize is the key for new discoveries. In this regard, it is very reasonable to expect that this work will play the role of a flying pebble that will attract many beautiful gemstones in the areas of marketing research, consumer behaviors, business decisions, etc.

![Figure 1](image.png)
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Lin, Y. 1999. General Systems Theory: A


POTENTIAL OF RENEWABLE ENERGY IN INDIA
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ABSTRACT
India is the fourth largest energy consumer in the world. The growth rate of energy demand in India is 6.8% annually, while the supply is expected to increase at an annual rate of only 1%. This energy shortage acts as a major limitation on India’s economic growth. Renewable energy is the only technology that offers India the theoretical potential to service all its long-term power requirements. Solar energy is the best option. This paper details the challenges India faces, what the Indian government has started towards and the direction they need to go in as they work towards renewable energy.

India’s economy is the world’s eleventh largest by Gross Domestic Product (GDP), and the fourth by purchasing power. Today, India is the fourth largest energy consumer in the world after the US, China and Russia. The growth rate of energy demand in India is around 6.8% annually, while the supply is expected to increase at an annual rate of only 1%. This path represents a completely untenable course for India, and could potentially spell catastrophe for India's economy, an economy that should it too greatly suffer would also simultaneously represent a serious blow to the world economy.

There is direct correlation between human development index and energy consumption. In general, a higher human development index means more energy consumption; however, this correlation does not hold for India (See figure 2). At present, energy consumption per capita is very low in India, especially compared to developed and many developing countries (refer to Figure 1). One such reason for this discrepancy is likely India's massive population coupled with its presently weak energy economy.

The power supply in India is well distributed across the state, central and private sectors (See Tables 1 and 2). Most of India’s power capacity is from fossil fuel sources such as coal, natural gas and oil. The contribution of renewable energy sources, other than hydroelectricity, are about 12% and the contribution of hydro power is about 19%. Supply-demand gap is increasing rapidly over time in India (See Figure 3).

CASE FOR RENEWABLE ENERGY SOLUTIONS IN INDIA
Renewable energy is the only technology that offers India the theoretical potential to service all its long-term power requirements. According to a report, Solar Radiant Energy over India, by the India Meteorological Department, “The solar energy received by Earth is more than 15,000 times the world’s commercial energy consumption and over 100 times the world’s known coal, gas and oil reserves. And this energy is readily available during the day for anyone to tap and that too free.”

India's domestic coal supply is limited and in poor quality. Meanwhile, foreign supply of hydrocarbons have a serious impact on the country’s energy security. Renewable Energy (RE) sources are not depleted. RE is non-polluting. Reinvestment can be used for many decades without affecting the environment.

Present India’s Renewable Energy Capacity
Wind 20,294 MW
Solar Power 2,208 MW
Small Hydropower 3,774 MW
Biomass Power & Gasification 1,286 MW
Bagasse Cogeneration 2,513 MW
Waste to Power 99 MW

Renewable Energy Development Potential for India
India has abundant Solar Energy resources:
> 100,000 MW by 2020
> 200,000 MW by 2025
India can also harness Wind Energy near the sea
shore and other windy sites

> 50,000 MW by 2020
> 100,000 MW by 2025

Additionally, India has the potential for Small Hydro Power plants, Biomass, Biogas, Geothermal power, etc. (Source: Ministry of New and Renewable Energy, Government of India)

**CHALLENGES FOR RENEWABLE ENERGY DEVELOPMENT IN INDIA**

Though there are many benefits to using RE in India, there are just as many challenges. Some of these challenges include the optimal pricing of power generated from the renewable energy sources, maintaining the quality and consistency of renewable energy sources, the cost of technology development and production, availability of financing for production, slow pace of rural electrification, and the pace of reforms in the rural electricity sector.

**Development Opportunities for Renewable Energy**

There are many development opportunities for renewable energy. Some of these opportunities are: grid interactive renewable energy generation systems, renewable energy for urban, industrial and commercial applications as well as rural applications, irrigation, enterprises, cooking, lighting etc. There would also be research, design, and development of new renewable energy generators and applications.

With all of these developmental opportunities in mind, the best renewable energy option is solar. Solar energy will be able to meet most future energy needs for India. Solar energy provides an equivalent of nearly 5,000 trillion kWh/year were it all to be perfectly harnessed. There is solar radiation level of 4 to 7 watts /square meter in India. Most parts of India have 300-330 sunny days in a year. Power generation potential using solar PV technology is around 20MW/sqkm and, using solar thermal generation, around 35MW/sqkm. India could build 1,000 GW of solar generators on just 0.5% of its land. India’s Present Total Generation Capacity is about 210 GW.

There are many benefits in utilizing solar energy. Solar energy is a decentralized source of energy. It can be harnessed close to where energy is demanded and has a reliable and predictable performance for over 25 years. Solar energy also requires low operational maintenance. It is also a domestic and freely available energy source with zero human displacement. Most state tariffs are already established for this type of energy. Also, the average time to build locations to produce solar energy is about 1 year versus 13 years for nuclear plants. Potentially one of the biggest positives in using solar energy is that it does not have a negative environmental impact, unlike nuclear plants which, even when run without error, produce nuclear waste. Cost of solar power generation has decreased over several orders of magnitude in the past decades (See Figure 4).

Several measures have been undertaken by the Indian government to promote renewable energy development. One of them is the Jawaharlal Nehru National Solar Mission (JNNSM). Another is the REC or Renewable Energy Certificate. The Indian government has also created a renewable purchase obligation as well as implemented state policies to encourage renewable growth and has provided the encouragement of foreign direct investment. Foreign investors can enter into a financial/technical joint venture with an Indian partner. Foreign investors can also set up renewable energy-based power generation projects through a Build, Own and Operate (BOO) basis.

There are other future growth drivers for renewable energy in India, besides the support from the Indian government. One is that, in regard to the demand and supply gap, supply will regularly be overstripped by demand. There is also high renewable energy potential in the abundance of sites for tapping natural and renewable sources of energy. The availability of new forms of capital, like private equity, CDM, and an increase in the presence of PE funds in clean energy is another aspect of the positive growth of renewable energy. India is also emerging as a dominant player in CDM projects. The government is increasing state level initiatives
with states such as Punjab, Haryana, and Andhra Pradesh taking the lead in the development of a renewable energy project.

India has set a goal for 2022 (See Figure 5). Even though the Indian government has moved towards using renewable energy as an alternative source, they have still not made the switch. The following is a proposed action plan to boost renewable energy. First, India should invest more in renewable energy and energy efficiency. They also need to enact a National Renewable Energy Standard of 20% by 2020 to create demand, new industries, encourage innovation, and bring a new wave of millions of green jobs. Additionally, the government needs to boost the development of and implement nation-wide user-friendly comprehensive renewable energy policies. Other aspects that need to be considered are: depreciation, tax credits for venture capitalists and innovators, financing funds for renewable and energy efficiency projects, encouraging international partnerships/collaboration, creating incentives for new technology, having zero import and excise duty on materials, and ensuring low interest rate loans are available for relevant projects.

There is also an urgent need to develop a nation-wide comprehensive user-friendly roof-top solar policy to promote small-scale and decentralized solar power generation and to solve the energy crises by bridging the demand-supply gap. The government also needs to aggressively expand large utility-scale solar generation, using Photovoltaic (PV), Concentrated Solar Power (CSP) and Concentrator Photovoltaic (CPV) technologies. Lastly, they need to develop, promote and establish utility scale solar farms co-operatives, wind farms co-operatives, off shore wind farms and co-operatives.

CONCLUSIONS

India is a fast-growing economy. This phenomenal growth of the Indian economy may get hurt unless the energy crisis is being taken care of properly and efficiently. Renewable energy, especially solar energy, could be an answer for India’s increasingly high energy demand. There are many benefits and positives in using renewable energy as a source of power, many of which will not only improve the energy state of India but also the environment. The Indian government and the private sectors should take strong measures to promote renewable energy. They should also consider the major points of the action plan, which include investing in renewable energy and efficiency, enacting a standard to create demand, forming industries and encouraging innovation, and creating millions of green jobs, etc. There are so many benefits that should not be ignored. It would be unwise for India to continue on the path it has been on for several decades, both because to not deviate from its path could spells catastrophe for their energy sector but also because the alternative brings with it a myriad of benefits.
Figure 1: Low Per-capita Energy Consumption

![Electricity Consumption Per Capita](source: World Bank World Development Indicators)

Source: CBS News

Figure 2: Human Development Index to per Capita Energy Consumption

![Human Development Index](source: American Scientist)

Source: American Scientist

Table 1 and 2: Present Power Scenario in the Country

<table>
<thead>
<tr>
<th>Sector</th>
<th>MW</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Sector</td>
<td>86,343.35</td>
<td>40</td>
</tr>
<tr>
<td>Central Sector</td>
<td>62,963.63</td>
<td>30</td>
</tr>
<tr>
<td>Private Sector</td>
<td>62,459.24</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>2,11,766.22</td>
<td>100</td>
</tr>
</tbody>
</table>
### Table: Fuel Supply in India

<table>
<thead>
<tr>
<th>Fuel</th>
<th>MW</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Thermal</td>
<td>141713.68</td>
<td>67</td>
</tr>
<tr>
<td>Coal</td>
<td>121,610.88</td>
<td>57</td>
</tr>
<tr>
<td>Gas</td>
<td>18,903.05</td>
<td>9</td>
</tr>
<tr>
<td>Oil</td>
<td>1,199.75</td>
<td>1</td>
</tr>
<tr>
<td>Hydro (Renewable)</td>
<td>39,416.40</td>
<td>19</td>
</tr>
<tr>
<td>Nuclear</td>
<td>4,780.00</td>
<td>2</td>
</tr>
<tr>
<td>RES** (MNRE)</td>
<td>25,856.14</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,11,766.22</td>
<td>100</td>
</tr>
</tbody>
</table>

*Figure 3: Supply Demand Gap in India*

- **Source:** Money Control
Pennsylvania Economic Association
2017 Conference Proceedings

Figure 4: Cost of Solar Power

Source: Bloomberg New Energy Finance

Figure 5: India Sets Ambitious 2022 Solar Goal

Source: World Resources Institute
REFERENCES


AN ALTERNATIVE METHOD TO FIND OPTIMAL SOLUTIONS TO THE CUBIC COST FUNCTION

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ABSTRACT

This paper continues the development of an alternative, non-marginalist, algebraic method for calculating the profit-maximizing level of output based on an approach presented in earlier papers. Information from the familiar cubic total cost and linear total revenue functions is reconfigured in a linear form combining average profits and (net) average costs to arrive at the proper solution. Concepts of the triangle and break-even points are also used to provide an alternative to tangency analysis to show profit maximization. The implications for firm behavior are discussed concluding that, according to this model, firms arrive at theoretically precise answers using simple techniques based on algebra and averaging and that in doing so, the form or pathway, of decision-making is separated from a literal adherence to the cubic cost curve and total revenue function.

INTRODUCTION AND PROBLEM STATEMENT

The conventional textbook approach to solving profit-maximization problems presents the student with three dominant mathematical models, the linear, quadratic and cubic. This last one especially is important to mainstream economic theory in that it embodies the concepts of decreasing, constant, and increasing costs, and insures that the average cost function has the usual u-shape to it. The firm maximizes profit by determining its marginal revenue and marginal costs curves, setting them equal to one another and solving for the quantity. In graphical terms the firm continues to produce until the lines tangent to the total revenue and cost curves are parallel. This is marginal analysis.

However, it is also common to point out the shortcomings of such an approach as not always reflecting actual firm behavior. It is difficult for firms to know their marginal cost and revenues curves, for example, or else it is pointed out that they simply have a different basis for making production decisions such as using a rule of thumb like the full-cost approach with a standard mark-up, or that marginal cost curves are usually flat or nearly so, over the relevant range of production. Alternative methods are also introduced such as linear regression analysis to approximate relevant portions of the cost curve.

The purpose of this paper is to add another model to the economists’ tool box using a different technique, one which is simply algebraic and linear but which nevertheless solves the cubic cost problem, that is, gives the exact same answer, as marginal analysis does. The economic interpretation for such a model and its implications for firm behavior are also treated. While the basic method is fully developed in an earlier paper (Ancil, 2015), it is here applied to the problem of profit-maximization.

COMMENT ON THE LITERATURE: THE PROBLEM OF MARGINAL COST

The problem of marginal cost as reflected in the mainstream literature is quite familiar but it may be helpful to review some specific points especially as seen in the way basic concepts are taught to economics students. For example, Keat and Young (2009), after pointing out that the three total cost functions they have shown the reader (linear, quadratic and cubic) are the ones most commonly found in statistical studies, examine three representative studies of different industries covering different time periods. They conclude that in each case the study showed a linear cost with a constant marginal cost, a result not in keeping with the often used cubic function with its corresponding u-shaped average cost curve. Instead, the bottom of that curve “may represent a fairly wide interval, and unit costs may rise...only when physical capacity is reached.” They add: “A large majority of these studies have concluded that marginal cost in the short run is constant,” and that the familiar upward-sloping shape of the average and marginal costs curves “postulated by economic theory tend to be the exception in empirical findings.” They elaborate on the problem saying: “Many economists explain straight-line cost curves by pointing out that although theory requires capital inputs to be fixed in the short-run, they really are not. For instance, when production increases, a firm can easily set up an additional assembly line to keep the fixed/variable input ratio constant. Thus, because the fixed factor is used in a fixed proportion with the variable factor, increasing marginal cost will not necessarily occur.” So, the way to rescue the increasing marginal cost assumption is to eliminate the relevant ceteris paribus assumption.

Nicholson and Snyder (2015) make a similar argument when appraising the concept of marginal product writing:
“The concept of marginal product itself may sometimes be difficult to apply because of the *ceteris paribus* assumption used in its definition. Both the level of other inputs and the firm’s technical knowledge are assumed to be held constant when we perform the conceptual experiment of, say, adding one more worker to an orange grove. But, in the real world, that is not how new hiring would likely occur. Rather, additional hiring would probably also necessitate additional equipment … For this reason, it is more common to study the *entire* production for a good, using the marginal product concept to help understand the overall function.” (emphasis added).

In fact, questions have been raised about the appropriateness of marginal analysis to business behavior more generally and sustained over several decades. As Mark Blaug (1985) writes J.A. Hobson in his *The Industrial System* (1909) raised objections to marginal productivity theory arguing that if every change in, say, the quantity of labor hired is accompanied by a change in the organization of capital, then variations in output cannot be attributed to labor alone. Hobson’s answer was the use of average productivity. Blaug explains, though, that Alfred Marshall’s calculus-based response did not do away with the problem: “Either factor substitution is possible, and a factor’s marginal product can be defined, or factor substitution is ruled out and the concept of marginal product has no meaning.” (Cf. Marshall, 1920.)

The well-known Oxford University papers survey by Hall and Hitch (1939) also found problems with the theory: “A large proportion of businesses make no attempt to equate marginal revenue and marginal cost in the sense in which economists have asserted that this is typical behavior.”

In his classic study of modern economic theory, Seligman (1963) writes: “The economist may very well have an abiding faith in the predictive worthwhileness of his model of the firm, but how frustrated he becomes when he tries to tell the very practical businessman that he ought to behave according to his dictates of the theory. When rebuffed, the economist consoles himself with the fiction that his theory indeed possesses validity because all he, the theorist, need do is to suppose that businessmen behave in marginalist ways.”

Is there a way of bringing the theory and the models more closely in line with empirical evidence? Or is it that firms make decisions in a manner that is different from the commonly used models which may coincide with the empirical evidence referred to here but which have a different underlying reason? Should we separate the making of decisions from the making of the product? The following treatment is a step in that direction. A simple, short-run, algebraic model is presented which, though rooted in the cubic cost function, is linear. It assumes profit-maximization but the pathway to the firm’s decision about what level of output maximizes that profit is different. Instead of a marginal approach, concepts of average costs and average profits, taken together as an integral whole, are used to determine the optimal solution. Net average revenue is compared to (net) average variable costs and average profit. When the sum of the latter two is equal to the former, total profits are maximized.

**THE TOTAL VARIABLE COST CURVE**

In a previous paper (Ancil, 2015) it was shown that the cubic production function with a single variable input can be solved by algebraic considerations alone. Consider the following function,

\[ \text{TVP} = ax + bx^2 - cx^3. \]  

The key to finding the net return-maximizing input level in this linear model was to replace the term \( cx^3 \) with the expression under the square root sign indicated in equation (2) and solving for \( x \),

\[ x = a/\sqrt{(3ac + b^2)} - b. \]  

Clearly, the same basic mathematical expression can be applied to a cubic total variable cost function, set equal to a linear total revenue function, \( mx \), as:

\[ a_0 x + bx^2 + cx^3 = mx, \]  

where the left side is the total cost and the right side is the total revenue. See Figure 1. For this case, the algebraic solution for the profit-maximizing quantity of output is,

\[ x = a_1/[\sqrt{(3a_1 c + b^2)} + b]. \]  

We note that the constant, \( a_1 \), a key aspect of the model, is the difference between the price “\( m \)” and \( a_0 \), and is called the “net” price. The function is based on variable cost only since fixed cost term has no bearing on the solution. The denominator on the right side of equation (4) is a composite of average costs and average profits, and for convenience can be written as \( y_0 \). It has a constant slope and when multiplied by the appropriate \( x \) value equals the net price (net average revenue). The firm increases output so long as the net average revenue exceeds the net average costs to achieve the maximum profit when the two are equal \( (x/y_0 = a_1) \). Or, in other words, the average variable costs (as shown in Figure 2) are deducted from the net price, leaving average profit:

\[ \text{average profit} = a_1 - bx - cx^2. \]  

The linear average composite (LAC) model describing this is,
LAC = √(3a_c + b^2) + b)x.  

Each value of y can be decomposed into its constituent parts of average variable cost and average profit. The portion of the final x value that contributes to cost is, 

\[(\text{net}) \text{ AVC} = \frac{TC}{(a_1 y_0)} - a_0\]  

and, 

average profit = π/(a_1 y_0).  

See Figure 3.

The output of the linear average function is itself composed of two linear functions, the net average variable cost with a slope of \(-(bx + cx^2)/x\) and average profit with a slope of \[-(a_1 − (bx + cx^2))/x\]. At the solution value of x these two slopes must sum to \(1/y_0\). Also, the latter slope is the same as that derived for the derivative of the average cost function. Setting these two equal to one another one derives the marginal cost curve.

The linear average composite function can also be written as, 

LAC = \(a_1 - x/y_0\).  

The function intercepts the x-axis at the solution value. This function can be separated into two other functions by subtracting the net average variable cost (net avc) from the net average revenue (LAC (1)) and by subtracting the average profit (nx) from that result (LAC (2)),

\[
\text{LAC (1)} = a_1 - (1/y_0 - n)x, \quad \text{and} \\
\text{LAC (2)} = \text{LAC (1)} - nx.
\]

The slope “n” is the slope of the line tangent to the curve avc at the solution value of x. The sum of the slopes equals \(1/y_0\). Together they form a kinked curve which bisects the standard AVC curve at the solution value for x. The latter half of this kinked curve, LAC(2), if shifted to the right, becomes the line tangent to avc at the solution value of x. Again, refer to Figure 3. (We also observe the familiar result that the total profit box under the avc function is maximized.)

The results can be understood as being simple arithmetic averages derived by dividing \(a_1\) in half and the x-solution value \((x*)\) in half and rewriting the results as these half values plus or minus some deviation \((\frac{1}{2} a_1 +/- d\) and \(\frac{1}{2} x^* +/- d\)). The deviations are defined as \(d = \frac{1}{2} a_1 - \text{LAC(1)}\). The y-intercept for the tangent line is \(a_1 + [2d]\). The x-value deviations are defined as \(d = \frac{1}{2} x^* - \text{TC/m or π/m}\). The net average cost and average profit slopes can also be seen as averages with deviations: \(1/(2y_0) +/- [1/(2y_0) - n]\). See Figure 2. (This last function \(y = a_1 - x/(2y_0)\)) intersects the line \(y = (\frac{1}{2})a_1\) at the solution value for \(x\). The correct y value can be found by reading vertically up to the avc curve.)

The firm can be understood as following the common adage that “you have to spend money to make money.” It takes costs and profits together. The exact solution is mostly heuristically achieved by assuming a proportion of net average revenue is spent on output and the remainder is average profit. As stated above total profit is at a maximum when the slopes of the net average cost and average profit sum to \(1/y_0\).

We can also observe that the coordinates of one point whose ratio of \(y/x\) equals the slope of the line of which they are a part indicate the optimal result. This is unremarkable for functions whose y-intercept is zero, but when the intercept is non-zero and the slope negative there is only one coordinate pair that meets this condition. (There may be some use for the case where the y-intercept is negative and the slope positive, but we are concerned here only with quadrant I, that is, where the y-intercept is positive.)

Consider the equation,

\[
y = a_1 - (1/y_0) x.
\]

When \(y\) is zero, the coordinate values are \((a_1 y_0, 0)\) with the ratio of zero which is to be understood as no difference in the slope values from the value, “m”, on the TR function.

However, this can also be represented, as a function of the \(x\)- and \(y\)-intercepts \((x_i, y_i)\). It is evident that, just as the ratio of the intercepts equals the slope, so does the point \((x = \frac{1}{2}(x_i), y = \frac{1}{2}(a_i))\). Though this point does not directly indicate the solution value of \(x^* = (a_1 y_0)\), we need only multiply the resulting \(x\)-value by two to arrive at the correct solution. Alternatively, we can multiply the \(y\)-intercept by two so that equation (12) reads,

\[
y = 2a_1 - (1/y_0) x, \quad \text{and} \\
x^* = \frac{1}{2}(2x^*), y = \frac{1}{2}(2a_1).
\]

(Starting with equation (12), but replacing \(a_1\) with \(y_i\), and setting the equation equal to \(x/y_0\), we derive the result that the new \(y\)-intercept, \(y_n\) is equal to \(2(x/y_0)\), which is equal to \(2a_1\), thus giving us equation (13). See Figure 3.)

Economic Interpretation for the Simple Intersection Method
Firms visualize a constant average revenue stream, impacted by rising but linearized composite of average costs and

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average profits. When this composite equals the constant net average revenue, the profit-maximizing level of output has been reached. The situation described here is not unlike the shutdown decision where the firm keeps operating so long as price covers average variable cost. So here, too, so long as the net price covers the LAC, the firm should increase output. With the concept of averages the model emphasizes centrality rather than marginality and with the concept of a specific proportion of a₁ it emphasizes that the firm’s output decisions are an integral whole (spending and profits together as one decision) rather than as a number of infinitesimally small increments.

**THE TOTAL COST/TOTAL REVENUE: THE TRIANGLE APPROACH**

We can also look at the total revenue and total cost functions with this model, where,

\[
\begin{align*}
TR &= mx, \quad \text{and} \\
TC &= a₀x + bx² + cx³. 
\end{align*}
\]

We note the intersection of \(y = a₁\) with the TR function, \(mx\). A triangle is formed from \(a₁\) to this intersection to the origin. The hypotenuse is \(TR = mx\) over this interval. If, after finding the solution according to equation (4) we need a geometric check on it, we can in familiar fashion simply drop the triangle down by the amount of the calculated profit, \(π\). If the solution is correct, the hypotenuse, \(mx\), will be tangent to the curve, TC. The tangent line will be of the form,

\[
y = mx - π. \tag{17}
\]

In Figure 4, the triangle of \(y₁ = -π\) and \(y = 0\) gives \(x = π/m\). The hypotenuse on this triangle can be extended as needed to see the tangency effect.³ If this were not the maximum, it would bisect the branches of the preceding triangles or, if there were further increases in output, and hence more triangles, the hypotenuse would shift back in the leftward direction, again bisecting, not only the TC curve, but also the branches of the prior (maximum) triangle.

It should also be noted that the triangles “A” and “a” on the graph are the same. Following the tangent line, positive costs do not begin until the line crosses the x axis at \(x = π/m\). In triangle “a”, it is as if profits began at \(x = TC/m\). The sum of these two \(x\) values equals the solution value, \(x^*\).

The difference can be emphasized by reconfiguring the two triangles above the x-axis as shown in Figure 5. The first triangle (abd) represents output where costs and revenues are equal and the second one (bce) represents the remaining output as if it were costless, the cost having been accounted for in the first triangle.

The length of the hypotenuse is given by the familiar Pythagorean formula, the coordinate values of the break-even point squared and, in this case, normalized by scaling it by \(1/B₁\):

\[
h = \sqrt{(B₁² + B₂²)}/B₁ \tag{18}
\]

Multiplying this by the fraction of the profit, \(π/m\), gives the length of hypotenuse (\(h₀\)) on the original functions,

\[
h₀ = π\sqrt{(1 + 1/m²)}. \tag{19}
\]

Finally, one can also see the solution as a proportion of the positive break-even value on the x axis, that is, of \(B₁\) as described above:

\[
x = (|B₂|y₀)B₁. \tag{21}
\]

**Economic Interpretation for the TR/TC Triangle Method**

This is a model more of the effect of the firm’s profit-maximizing decision than a description of how that decision is made. It is primarily theoretical to elucidate the triangular nature of the method as opposed to marginal analysis. It is “as if” firms saw themselves as producing along the horizontal break-even line up to the total revenue line where revenues just cover costs at a price of “m.” Between this line and the total cost function is the second batch of output whose cost has already been covered in previous output so that this batch is essentially costless, that is, produces only profit. Firms are focused on making sure that second batch is produced. They are in effect maximizing output between these two functions which in turn maximizes profit. The emphasis is on provision maximization as the key to profit maximization, and the method isolates profits from costs in this manner.

**THE LAC/TR TRIANGLE METHOD**

We can also compare the differences between the linear average composite (with the positive slope as \((1/y₀)x\)) and the total revenue function as \((mx)\). As shown in Figure 6, for the case where \(1/y₀ > m\), the first function intersects \(a₁\) at the solution \(x\)-value. The vertical distance between this point and the TR function will be at a maximum, that is, the largest \(x\)-value it can have without going beyond \(a₁\). In the case where \(1/y₀ < m\), the vertical distance between the solution point and the TR function is the minimum difference between those functions understood as starting from the right and approaching the solution point (at \(a₁\)) as closely as possible without going beyond it. (Maximum profit will be when output is at \(a₁y₀\), and total revenue is at \((m)a₁y₀\) which is located on the line bc in Figure 6.)
Both approaches lend themselves to triangular analysis as discussed above. The triangle (abc in Figure 6) can be pictured as starting at the origin increasing in size as it passes upward to the limit of “a1.” It maximizes the length of both the vertical and horizontal components of the triangle and thus also the hypotenuse. The hypotenuse of this triangle faces, and in fact coincides, with one of the linear functions, for example, line ba with the LAC function in Figure 6. (A second triangle with line cd can be seen facing the other linear function, TR, resulting in a geometric figure with a common vertical component and two different horizontal ones.)

Another way to understand it is to see the triangle as adjusting the slope of the LAC function to that of the TR function by taking a fixed proportion (myo) of it, up to the limit of “a1,” which is the maximum difference. (We note the function, LAC, is tangent to the corner (point “a” in Figure 6 for the triangle abc), which is the correct proportion of these two components at the profit-maximizing level of output.)

Of course, this comparison is theoretical, that is, it shows how the linear average composite function relates to the total revenue curve and illustrates another way a maximum can be understood to be achieved and not a description of how the firm makes a decision.

BREAK-EVEN POINTS

Break-even points on the quadratic equation derived from the original TR and TC curves can be related to the maximum output as,

\[ x = \frac{|B1 + B2|}{\sqrt{3|A1| + (B1 + B2)^2}} \]  \hspace{1cm} (22)

See Figure 2.

Starting with the quadratic equation for each break-even point’s x value, we derive the product of the break-even point x values multiplying the two roots of the quadratic equation and working out the algebra to obtain,

\[ B1B2 = -\frac{a_1}{c}. \]  \hspace{1cm} (23)

Their sum is derived in a similar fashion and is,

\[ B1 + B2 = -\frac{b}{c}. \]  \hspace{1cm} (24)

With these relations of the coefficients we can then derive the linear TR/TC formula (equation 22).

The break-even points themselves are a function of the axis of symmetry in the quadratic equation. The equation (22) can then be re-written as,

\[ x = \frac{|A_1^2 - R|}{\sqrt{3|A_1| + (2A_1)^2}} \pm \frac{1}{(2A_1)}. \]  \hspace{1cm} (25)

where \(A_1\) is the axis of symmetry and R is the value under the square root sign. (The coefficient “c” is not needed for the solution value of x but is needed to obtain the original “a1” value which can be obtained by simply multiplying the product of the break-even points by “c” as implied in equation (23).)

SUMMARY AND DISCUSSION

The model of profit maximization in the short run discussed here has the following main characteristics: (1) it uses algebra rather than calculus; (2) it is linear; (3) it is a composite of profit and costs; (4) it is based on averages rather than marginal changes; and (5) it is based on a fixed proportion of average variable costs and average profits to net average revenue. Profits and costs are complements of the composite slope which can be decomposed into its constitutive parts and separately examined and when this is done the slope of the average profit function is seen to be identical to the slope of the line tangent to the average cost curve identifying the output for maximum total profit. The fixed proportion nature of this approach also surfaces from the break-even values arising in the quadratic equation. These values can be used to find the optimal output.

This approach separates the decision-making process of the firm from its production process. It does this by incorporating the information from the cubic cost curve, as well as total revenue, reflected in the coefficients, into a linear averaging equation, much like a road map may show highways as straight lines but with correct distances between destinations. This interpretation continues to assume implicitly that the underlying production function, ceteris paribus, adds only one input while holding all else constant. It achieves its linearity not by a complementarity of, say, a capital and labor as mentioned above, but by its composite nature of average costs and profits; the optimal bundle of average costs and average profits is assumed constant over the relevant range of production and constitutes a set proportion of net average revenue. Just as a good driver need not be an automotive engineer, a good manager may use the needed information in a form different from technical production expressions, one that is more easily managed consistent with the purpose at hand and which provides a more economical way to make its output decision, which is the perennial benefit of using a summary statistic. (In the case of the decomposition of the function into net average costs and average profit, one can see the familiar situation where the average cost is the slope of an implicit linear total cost function yielding a constant marginal cost, and looking as though capital and labor had been increased in a fixed proportion.) In doing so the approach outlined here may provide a partial reconciliation.
between mainstream economists’ desire to retain the cubic cost curve and those empirical studies which show the marginal costs curves are most often horizontal. On the other hand, the approach differs substantially from the mainstream model in that it emphasizes centrality (averages) rather than marginality (tangency), and integral wholeness of the decision rather than its division into infinitesimally small output quantities.

In a final observation we may note that the use of differential calculus is actually a form of averaging, as the consideration of the mean-value theorem implies. It is the economic perspective of marginalism that chooses to interpret the use of differential calculus in the received manner. The mathematical technique is itself neutral in this matter being interpretable as emphasizing either the changing tangent line or the changing breaking-even values. The usual perspective is to envision the decision-making process as one which involves increasing output so long as marginal revenue exceeds marginal cost. While the total revenue line is held constant the tangent line of the cost curve is examined with each additional unit produced to see if it is parallel to TR. When that slope is identical to that of the TR curve, the optimum has been reached. However, one could just as well conceive of the process as starting with the initial break-even points and, instead of sliding the tangent line up the cost curve until it is parallel to TR, one can envision shifting the TR line noting the changing break-even points with the total cost curve, and continue to shift it until the break-even points are identical, that is, until the x values from the right and the left are the same and the resulting simple arithmetic average yields the optimal result.

The heavy reliance on calculus and other mathematical techniques raises the question E.O Wilson asked about much math one needs to do research. As Krugman reports, Wilson’s answer is “not much.” While Krugman believes some mathematical intuition is needed “you don’t necessarily need to know a lot of formal theorems.” He concludes “that higher math isn’t usually essential; arithmetic is.” (Krugman, 2013a) In a subsequent post, Krugman elaborates that the purpose of mathematical models in economics is to help one think clearly, but that “too many economists have lost sight of this purpose” and instead, “…they treat their models as The Truth, and/or judge each others’ work by how hard the math is…And there are a lot of people in macro, some of them fairly prominent, who are what my old teacher Rudi Dornbusch used to call ‘fearful plumbers’ – people who can push equations around, but have no sense of what they mean, and as a result say quite remarkably stupid things when confronted with real-world economic issues.” (Krugman, 2013b). One of the purposes of this paper has been to use a simpler form of mathematics for clarity but not to the point of misunderstanding “real-world economic issues.”

With these points in mind, the approach offered here can be seen as another dish for the “moveable feast” of economic perspectives.
Figure 1  Total Revenue/TotalCost

\[ TR = 5x \]
\[ TC = x + 2x^2 + x^3 \]
\[ BEP(x) = 1.236 \]
\[ BEP(y) = 6.185 \]
\[ x^* = .667 \]

Figure 2  Average Variable Cost Curve

\[ AVC = 4 - 2x - x^2 \]
Figure 3 Using LAC and Average Functions

\[ a_1 = 4 \]
\[ y = 4.44 - 3.33x \]
\[ LAC_1 = 4 - 2.67x \]
\[ LAC_2 = 2.22 - 3.33x \]
\[ LAC = 4 - 6x \]
\[ AVC = 4 - 2x - x^2 \]
\[ TR = 5x \]
\[ TC = x + 2x^2 + x^3 \]

Figure 4 Triangular Sections

\[ TR = 5x \]
\[ = 3.33 \]
\[ TC = x + 2x^2 + x^3 \]
\[ = 1.85 \]
\[ \pi = 1.48 \]
Figure 5  Separating Costs from Profits

\[ \text{abd} = \text{TC} \]
\[ \text{bce} = \pi \]

Figure 6  Relation of LAC to TR

\[ \text{LAC} = 6x \]
\[ \text{TR} = 5x \]
1 In addition to Blaug’s criticism of Marshall’s rather elaborate example to illustrate marginal productivity theory to refute Hobson’s objection, we observe Marshall’s effort also fails in that the correct solution in his example can be arrived at by a simple arithmetic averaging. More broadly, however, the existence of fixed inputs still ultimately leaves us with the problem of a horizontal marginal cost (which is identical with average costs).

2 The condition for maximization based on the proportion of \( a_1 \) and the slopes is:

\[
p_{a_1}/x + (1 - p)a_1/x = 1/y_0.
\]

Substituting the quadratic equation for \( x \) and working the algebra gives:

\[
2ca_1/[(y(4ac + b^2) - b)] = 1/y_0.
\]

Where “\( p \)” represents the firm’s estimated proportion of spending that will lead to profit maximization.

The slopes for the net average variable cost and the average profit (\( n \)) can also be written as:

- slope of net avc = \(- (b + cx)\)
- slope of \( a_\pi \; n \) = \(- 1/y_0 + (b + cx)\).

The solution for the correct proportion is:

\[
p = (ca_1 y_0 + b)y_0.
\]

Corresponding to the value of “\( n \)” in the text,

\[
n = -1/y_0 + (b + cx).
\]

3 We can think of this function as the hypotenuse of a triangle about the origin and shift it to the right until it is tangent to point \((a_1y_0, a_1)\). We then arrive at the same solution values as above. However, in this form we not only have the illustration of a maximum by such a single shift, we can also see that the process and the solution can be understood as one of averaging. The equation,

\[
y = (1/y_0)x
\]

intercepts the one above (equation 12) at its midpoint so that a doubling of its intercepts describes a line identical to the transposed hypotenuse. This can be viewed as a process of simple averaging: taking the intercepts and dividing them in half to arrive at the first point, and then in like manner averaging the remaining differences until the line described by \( y = y_1 - (1/y_0)x \) (with changing \( y \)-intercepts) shifts up until it coincides with the hypotenuse tangent to the solution point and with an intercept \( y_1 = 2a_1 \), or until the difference in the \( y \) values and \( a_1 \) is zero. The same process holds for the \( x \) values and the initial \( x \) intercept (which is also the solution value), or in other words, until the shifting hypotenuse no longer bisects either branch of the triangle and the average \( y \) value and the average \( x \) value of each branch identify one and the same point.

(Endnote #4 applies the basic concept to the cubic cost curve.)

4 This is easily shown. Consider the curves in Figure 1. Assume the line TR shifts rightward to produce two new break-even points with the total cost curve whose \( x \)-values are \( x_1 \) and \( x_2 \) and the average is:

\[
(x_1 + x_2)/2 = x.
\]

However, \( x_2 \) is really \( x_1 + h \) so that we have,

\[
(x_1 + x_1 + h)/2 = (2x_1 + h)/2.
\]

Clearly, as the process proceeds, the distance between the \( x \) values, \( h \), becomes smaller and smaller and in the last iteration finally vanishes, leaving us with,

\[
x_1 = x_2
\]

\[
2x_1/2 = x_1
\]

\[
= x^*.
\]

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A FIFTH LOOK AT SWEDISH PUBLIC HOUSING – OPERATING UNDER BUSINESS-LIKE PRINCIPLES: WALKING THE WALK

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ABSTRACT

The Public Municipal Housing Companies Act of 2011 (PMHCA 2011) required Municipal Housing Companies (MHCs) in Sweden to act in a more business-like manner. The purpose of this paper is to ascertain if financial observations parallel the expression of intent observed in a previous study. Results are reported here for 19 of the original 20 companies used in a sample suggesting MPHs were acting in a business-like manner as required by PMHCA 2011. A t-test of slope difference was used to indicate the significance of any change. Sample results suggest that the industry as a whole has adjusted overall to the business-like mandate insofar as revenue generation illustrates an upturn starting in 2011. Results for return on assets, operating profit margin and solvency did not show statistically significant results. Results for two individual firms illustrate how extreme reactions have occurred.

INTRODUCTION

Previously, we have reported on a number of aspects of Swedish public housing at PEA conferences (Lindbergh et al, 2016, 2015, 2004, 2003, 2002). It is a system of interest insofar as it has avoided some of the problems associated with social housing across Europe and the U.S. That is, allowances in the Swedish system were not made by income, but rather need, and public housing was universally accessible. In July 2002, the European Property Federation lodged a complaint with the European Commission, objecting to the Swedish practice of allocating state aid to house “well-off people”. After a state inquiry and much debate, the Swedish parliament abolished public service compensation for municipal housing companies in order to maintain the principle of universal access. The Municipal Housing Act, which entered into force on 1 January 2011, liberalized the sector and set out the objectives and ground rules for public housing companies. Their aim was to promote public benefit and the supply of housing for all kinds of people (still) and-but they might operate under “business-like principles”. Under the new legal framework, public companies should charge market rents, including a certain profit margin. Furthermore, municipalities should require a market rate of return on investment, reflecting industry practice and level of risk.

Two years ago, our paper related to a content analysis of owner directives of companies in the system pre- and post-promulgation of the Housing Act (Lindbergh et al, 2015). As might be expected, there were statistically significant changes in content consistent with the companies becoming more business-like. The companies indeed were properly “talking the talk”. In brief, observations on content from a random sample of companies’ 2013 owner directives were compared with similar documents collected 10 years prior (2004) using commercially available software. Results suggested that statistically significant changes in directives had occurred and adaptation to the new regulation may already have started to take place at this relatively early date, which is consistent with Czische’s suggestion (2014) that adaptation might take place over a period of time. This year, we return with financial results to ascertain whether companies’ walking is consistent with the previous talking. That is, a recent study has been made of the impact of the 2011 regulation as it apparently affected owner directives of municipal housing companies (Lindbergh and Wilson, 2016).

The purpose of this paper, thus, is to ascertain if financial observations paralleled the text content in owner directives. As colorfully suggested (Lindbergh and Wilson, 2016), the outputs of the owner directives represented companies’ ability to “talk the talk”. It remained to be seen if they really have learned to operate more like businesses. In other words, have they learned to “walk the walk” as affected by their financial performance? Thus, the research hypothesis being investigated here is

A change in Municipal Housing Companies’ business-like activities, as reflected in financial performance, is expected as a consequence of the implementation of the Public Municipal Housing Companies Act of 2011 (PMHC Act2011).

This study provides the numbers determining the extent to which municipal public housing companies in Sweden have become more business-like. Results are reported here for 19 of the original 20 companies used in the order director sample suggesting municipal housing companies were acting in a business-like manner as required by the Municipal Housing Act 2011. Data suggest that the industry as a whole has begun the adjustment to the business-like mandate insofar as revenue generation illustrates an upturn starting in 2011. Results for return on assets, operating profit margin and solvency, however, did not show statistically significant results. Performance of two individual firms illustrate how extreme reactions have occurred. The study is important because the Housing Companies Act intentionally set out to change
practice in a system that had served the country for over half a century. Results therefore have implications for both state and municipal policy makers as well as residents of Swedish public housing who must live with changes. Further, because the Swedish system tends to be contrasted to social housing, there may be international implications as well.

BACKGROUND

Housing Policy in General

Pugh (2001, pp. 420-421) has summarized the general importance of a housing policy. “Environmental and housing improvement has a dialectic in the economic, social, and political beyond anything planned in project design. It can both increase human capital, thereby adding to productivity, and significantly influence the way long-term social development as patterned in childrearing, in social education and in social interaction. Improved housing standards, and whole sector development, can facilitate and respond to long-term, progressive social development”. Put another way, there is very little in public policy that housing does not touch and affect. As a result, there has been recent discourses on topics as different as comments on the evolution of housing policy in developing countries to the needs of millennials in London and New York (Marom and Carmon, 2015). The subprime crisis of 2008-2009 is a cruel reminder of the importance of the housing sector in not only a locality or country, but the world (cf. Taffin, 2014).

Housing in Sweden

Considering its relative size, recent academic interest in Swedish housing has been significant and has tended to come in waves. Part of the early activity was driven by Bengt Turner at the Institute of Housing Research (Uppsala), who was one of the founding members and first chairperson of the European Network of Housing Research (ENHR). The first wave came around the year 2000 and was undoubtedly affected by Sweden’s entry into the EU in 1995 and associated with a relatively successful housing policy and practice at difference from other member states. Consequently, during this time of normalization, the success of the Swedish system held the interest of people in housing (cf. Bengtsson, 1999; Priemus and Boelhouwer, 1999; Turner, 1999). In the meantime, there were efforts within the Swedish system itself toward reducing housing subsidies (Turner and Whitehead, 2002). In fact, it had been Turner (1999) who first suggested that there have been elements of financial uncertainties in the Swedish system. He noted that a low solidity, in combination with increasing vacancies, had created a negative yield for some companies. A good summary of developments during this period can be found in Turner’s (2007) chapter on social housing in Europe.

The second wave of activity has come more recently and has been more concerned with practices in the system and not always with the activities of MHCs. Azasu (2012) conducted a survey of reward management practices in the Swedish real estate. Blomé (2012) discussed corporate social responsibility within the context of real estate management. The results indicated that social responsibility led to approximately 4.5 percent lower annual operating and maintenance costs, which of course tends to improve profitability. Lind and Blomé (2012) found slum lords in the system whose activities have gone on without retribution. Lind and Muyingo (2012) looked at the importance of adapting maintenance planning to the specific characteristics of the real estate sector. Palm (2011, 2013) in the study of real estate companies found the majority of the companies tended to be customer oriented, and self-assessment of managers suggested they were satisfied with their results.

Most recently, interest has turned toward refurbishment – particularly with regard to improving energy efficiency. Lind et al. (2014) reported on the renovation strategy of an MHC company in Stockholm. In addition to economic/ecological factors commonly considered in refurbishment, the company considered both social and technological sustainability in its approach. Similarly, Langlet et al. (2014) conducted a study to identify factors that facilitate energy efficiency initiatives as well as those that constitute significant barriers to such initiatives. Renovation projects intended to improve energy efficiency in three Swedish cities examined drivers and barriers in building projects (the ClueE-project). Although results cannot be generalized, energy efficiency policies tended to be driven by locally driven ambitions, and national policies tended to legitimize the locally-anchored work.

The Current Status

Lind (2014) has provided a current, complete and comprehensive description of housing in Sweden. Statistics indicate that in 2010 (the most recent year of comprehensive information) there were around 4.5 million housing units in Sweden. Of these, 37% were rental units, 22% were cooperative apartments and 41% were owner-occupied single-family homes. Municipal housing companies (MHCs) owned 45% of rental units (or 20% of housing stock), which established the importance of these organizations in housing policy. Until PMHC Act2011, rents were negotiated between the local Union of Tenants and MHCs, which were also binding upon the private sector and thus further affected the importance of MHCs. Since PMHC Act 2011, however, private landlords have been equal parties in negotiations and sign their own agreements with unions – business-like in this context could include price competition, something rather new to this sector. Further, construction has lagged population growth and thus there has tended to be a shortage of housing units in the three major cities – Stockholm, Gothenburg and
Pennsylvania Economic Association  
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Malmö (see also Ho, 2015).

To make a long story short, it was concluded “The debate on housing policy is making it increasingly clear that a new model is needed. There is agreement that MHCs should no longer bear any special social responsibility, even though in practice many still do to a lesser degree. There is no new construction of affordable housing, which makes it more and more difficult for outsiders to rent apartments in metropolitan areas. If housing allowances do not go hand-in-hand with new construction, then helping one household leads to problems for another household just above the support line. As house prices and apartment prices have not fallen, access to owner occupation remains difficult. There are indications of increased overcrowding and illegal subletting. It is becoming more and more obvious that a new programme for large-scale production of affordable housing is needed, but how this can be carried out is very much an open question” (Lind, 2014).

The situation continues to evolve. Essentially Swedish public housing companies are moving into what might be called the brave new world of municipal public housing. That is, they are moving from a prior position that might be characterized as part of a planned economy to one that would be better characterized as a free market economy. Even in the prior situation, problems were recognized. As noted previously, Turner (1999) who first noted that a low solidity, in combination with increasing vacancies, had created a negative yield for some companies. Somewhat along the same lines, Nesslein (2002 and 1981) was critical of the Swedish planned system. In brief, Swedish housing had been made affordable for the general Swedish population through large housing production subsidies and massive income redistribution (private communication, 2016). Specifically, it was indicated that Swedish building and operating costs were significantly higher that private rental housing in other countries, and it appeared that the supply of housing was not well-matched to the kind of housing consumers desire. Presently, as the industry evolves, more difficulties may be encountered. To name a few, new construction has not kept pace with population growth particularly in the larger cities (Ho, 2015); in all three major metropolitan areas, the increase in the number of finished residential properties has only been one-fifth of the population increase (Housing Crisis Committee, 2014). According to the latest survey carried out by the National Board of Housing, Building and Planning, 240 out of 290 local municipalities have a shortage of housing (Swedish Radio-1, 2017). The average wait time for a Stockholm County apartment has grown to 9.1 years. For a contract on a city-center apartment, the wait is 13.5 years (Swedish Radio-2, 2017). Immigration of course has accentuated the capacity problem. A regulation introduced in 2016 meant that municipalities were required to house more than 20,000 immigrants who have been distributed throughout the country (Swedish Radio-1, 2017). Whatever the case, the situation is not the same everywhere; individual companies have entered this period facing different local environments and with different resources. All firms in the industry will not adopt the same strategy, nor should they. Nevertheless, those that possess superior resources and make appropriate decisions in their adoption might be expected to do well or not so well (cf. Hunt, 2000, pp. 127-132).

Going forward, Swedish Municipal Public Housing Companies must now operate under “business-like principles” – by law. Czischke (2014, pp. 338-339) has described how this situation arise, citing the circumstances leading to the Public Municipal Housing Companies Act, which entered into force in 2011. “In July 2002, the European Property Federation (EPC) lodged a complaint with the European Commission, objecting to the Swedish practice of allocating state aid to house well-off people. After a state inquiry and much debate, the Swedish parliament abolished public service compensation for municipal housing companies in order to maintain the principle of universal access (although the phasing of state subsidies for housing construction had begun in the early 1990s. ... The Municipal Housing Act, which entered into force on 1 January 2011, liberalized the sector and set out the objectives and ground rules for public housing companies. Their aim is to promote public benefit and the supply of housing for all kinds of people, and they must operate under ‘business-like principles’ (emphasis added). … Under the new legal framework, public companies should no longer apply the cost-rent principle but instead should charge market rents, including a certain profit margin. Furthermore, municipalities should require a market rate of return on investment, reflecting industry practice and level of risk”.

In summary, it might be said that Swedish housing policy is at a turning point (cf. Lind, 2014). On the one hand, the historical feeling among political parties has been that the country would not have social housing. That need was covered adequately and affordably by the Municipal Public Housing system. Allowances were not made by income, but rather need, and public housing was universally accessible. The common opinion within the country was that the system worked well. Nevertheless, municipal companies, which for 50-60 years provided housing now have found themselves operating under new guidelines.

METHODOLOGY

Information for the study was obtained from the Retriever Business database. Retriever Business is a subsidiary of Retriever. Retriever is the Nordic Region’s leading supplier of media monitoring and tools for news research, media analysis and corporate information. Retriever is owned by Tidningsarnas Telegrambyrå (TT), Sweden’s largest news agency and Norsk Telegrambyrå (NBT) the Norwegian press agency and wire service. Retriever Business includes information on all Swedish companies, including sole proprietorships. Information in this database is available, for
example, on the organization, number of employees, contact information, board information and annual reports. It also includes group structures as well as complete financial statements for public companies. Company information is available both as searchable parameters and rechargeable pdfs, which goes back to 2000/2001. In the database one can search for companies in a particular industry, region or size and compare companies and industries. Search results can be exported to Excel for further processing and analysis.

This study relates to the published results developed by Lindbergh and Wilson (2016) that involved a qualitative assessment of Owner’s Directives (ODs) in a random sampling of Municipal Housing Companies. In essence the authors were saying that except for coordination of activities, it appeared that companies in aggregate had responded to the directive – and had statistical information to support that observation. The conclusion was, “The study suggests that among the companies included in this sample, organizations have seriously addressed the 2010 mandate as far as the OD’s content goes. That is, they have learned to ‘talk the talk’”.

In addressing whether companies have likewise established financial results consistent with more businesslike practices, i.e., learned to “walk the walk”, this study was initiated. The financial information required to make this assessment came from the Retriever compendium of data for the 20 firms in the Lindbergh-Wilson (2016) study. This compendium provides the opportunity to scan 176 columns of information. Only a few of these, of course, related to statements that have been made concerning the possible businesslike nature of municipal public housing in Sweden. The financial information was digested in three steps. First the data from the individual firms was summed to produce an overall assessment of the aggregate performance of MHCs in the sample. Four parameters were used to characterize the financial performance of these firms and this sample, which generally reflect the final status of any business and thus might be expected to change as organizations became more businesslike. They were

- Revenue or Turnover (TO in SEK), in Swedish Omsättning = Total Turnover. Would be expected to increase (or perhaps decrease) depending upon control of rent setting.
- Return on assets (ROA in %), in Swedish Avkastning på totalt kapital = (Earnings Before Interest and Taxes (EBIT) + Financial Income) divided by Total Assets. Likely expected to increase as companies have to provide incentives for investment.
- Operating Profit Margin in %, in Swedish Rörelsemarginal = EBIT/Net Turnover (Net turnover is almost always equal to Total turnover). More business-like is virtually synonymous with more profitable. By focusing on operating profit, the fact that the organizations are likely to remain non-profits is less of a problem.
- Solvency in %, or maybe better to express it in terms of equity ratio, in Swedish Soliditet = (Total Equity + Untaxed reserves after tax)/Total capital. In this regard Turner (1999) early on saw problems in the industry when solvency dropped among some firms. Thus, the present interest in this parameter.

The examination of these items gave a general idea of whether there was a significant change in any or all of these parameters during the period of interest. Accordingly, a longitudinal analysis was made for the aggregate sample and results are reported in subsequent tables and illustration of results in associated figures. As part of this examination, best straight lines were constructed through individual company data from 2005 to 2010 (pre-regulation) and 2010 to 2014 (post-regulation). A t-test of slope difference was used to indicate the significance of any change. These results are summarized and discussed in the next section.

Subsequently, two companies, Båstadhem AB (BAB) and TranemöBostäder AB (TBAB) were analyzed in detail. These two companies were selected because of their similarities in the Lindbergh and Wilson (2016) compilations (Table 1), although visual examination suggested extremely different results. That is, their reports in terms of the number of pages included in their pre- and post-regulation owner directives were identical (two and three pages respectively). Further, changes in perspectives were similar (10 to 14 for BAB and 9 to 13 for TBAB), although there were minor differences of the order of one citation each in individual categories. These results are also reported and discussed in the next section.

**OBSERVATIONS**

**General Results**

Recall that the earlier study (Lindbergh and Wilson, 2016) indicated that as a whole, analysis of the ODs suggested that the industry expressed a resolve to become more businesslike in its operations. These results are reproduced in columns two and three of Table 1 for the 20 firms in column one, which were randomly selected for analysis; results were statistically significant at the 0.000 level. (Only 19 organizations were available for analysis in this study because Bergsbostäder AB merged with another organization in 2011. Thus financial information was incomplete. No attempt was made to replace information from another organization because of a lack of information for comparison.)

Generally speaking, this tendency was confirmed by the results in revenue generation among Swedish MHCs starting in 2011 – as indicated by overall industry results and a number of individual company results (columns 4 to 7). This correlation is most apparent in viewing the results of revenue as a function of time as shown in Figure 1. Post-regulation,
the regression slope ($m_2$) of revenue was 7,414 MM SEK per year. During the baseline period, 2003 to 2010, the slope ($m_1$) for the same sample was 2,071 MM SEK per year, and both branches of the curve had significant adjusted $R^2$'s (0.86 and 0.98 respectively). The observations produced a ratio in slopes ($m_2/m_1$) of 3.58. Put another way, the rate of increase in annual revenue for an average MHC in the industry was over 350 percent. On the other hand, although revenue generated by these organizations supported a positive change for the industry, it is not possible to reject a null hypothesis indicating that financial results the other three parameters did not support a businesslike turn as a consequence of the public housing act of 2011. In that regard,

1. *Operating profit* was statistically insignificant (NS) for the industry (sample) and 11/19 firms in the sample. Four (4/19) firms illustrated statistically significant increases in operating profit; 4/19 showed statistically significant decreases (columns 8 through 11).

2. *Return on assets* was statistically insignificant (NS) for the industry (sample) and 9/19 firms in the industry. Seven (7/19) firms illustrated statistically significant increases in ROA: only three (3/19) a decrease (columns 12 through 15).

3. *Solvency* for the sample was statistically insignificant (NS), as was the situation for six organizations (6/19). Among the firms with statistically significant results, five were positive (5/19) while eight (8/19) were negative (columns 16 through 19).

That being said, closer attention was made for the individual organizations in the sample because statistical significance is really a strong test in assessing behavior. That is, improvement in practice could be incremental instead of discontinuous. Put another way, the markets served by these organizations might not permit large changes in returns that would support statistical changes in the four parameters selected for study. A 20th column was thus added to Table 1 that captured the nature of the changes in the four results for the individual organizations. This column indicated that 16 of the 19 organizations had shown improvement in at least one parameter. Or, put another way, only three of the 19 organizations appeared to be performing contrary to anticipated “improved businesslike” practices (see the last column in Table 1).

**Details on Two Companies**

Not all companies, of course, experienced the same changes, which are suggested here in a series of tables and figures. The initial disparity is shown in Figure 2 by the lower two branches the revenue-time curves. Post 2010, Båstadhem AB’s revenue grew at a rate greater than industry observations ($m_2 = 11,564$ compared to 7,414 for the industry); TranemoBostäder AB, on the other hand, grew at a much slower rate ($m_2 = 487$ compared to 7,414 for the industry). In fact, it appears that the growth in revenue *decreased* for TranemoBostäder post 2011 ($m_2 \sim 487$ compared to $m_1 \sim 1,400$ – see Figure 1). Each of these results was statistically significant at the 0.000 level. That is, progress in revenue growth for both MHCs changed significantly, as measured by t-tests, coincident with the implementation of PMHC Act 2011 – in one case the trend in revenue growth was higher than the baseline (BAB), in the other case, grew slowed (TBAB).

Likewise, there were major differences in solvency – even more so. Båstadhem’s rate changed and post 2010 its solvency grew at about a rate of 150 percent of baseline. TranemoBostäder’ rate also changed, but its solvency *decreased* at a rate of about 100 percent of baseline (Figure 2). These results suggest the two MHCs were participating in two very different markets – Båstadhem in one that permitted growth and expansion; TranemoBostäder in one very restrictive.

To complete our observations of financial performance, notes are made on profit relating to two bases, revenue (operating profit) and the respective asset base (return on assets). The operating profit for the industry was quite scattered. Over the period covered in this study, it had a range of over 20 percentage points – a high of 27.7% in 2009 and a low of 6.8% in 2013. This scatter makes trend projections tenuous, but it appears that over the time period cover, there has been a slow decline in profitability.

There is less scatter in the observations for the two companies, so it is safer to suggest that operating profit has decreased for both companies over the period 2003 to 2014. With regard to their asset bases, these operations are not high return on asset types of businesses. Neither company had a year during the 2003 to 2014 period in which they had an ROA greater than five percent. In fact, returns of more than four percent were unusual, rather returns of three to four percent were more common. Secondly, return on assets and operating profit tended to be linearly related (see Figure 3), suggesting perhaps that the asset base was rather constant over the period. Finally, Figure 3 illustrates quite clearly, that the two companies, BAB and TBAB, were much different in regards to where they operated in a ROA-Op Profit space. That is, TranemoBostäder spent nearly half the period (5 of 12 years) in which it had negative operating profits and thus had commensurately low ROAs; Båstadhem did markedly better – functioning in the 12 to 30 percent range, thus being consistently in the three to four percent ROA range.

**DISCUSSION**

It is an exciting time for studying municipal public housing in Sweden. A change in practice has been mandated by law and we now have a chance to watch the transition and monitor the
process of change. The quote from Lord Kelvin goes something like this, “When you can measure what you are speaking about, and express it in numbers, you know something about it”. The Public Municipal Housing Companies Act of 2011 suggested that Municipal Public Housing Companies should become more business-like in their activities. A qualitative study (Lindbergh and Wilson, 2016) suggested that was in the process of development. This study was initiated to determine if financial observations supported the qualitative study of Lindbergh and Wilson (2016).

From the financial data available, it can be suggested that the Public Municipal Housing Companies Act of 2011 can be associated with the alteration of business practices of Municipal Public Housing Companies – as far as revenue generation is concerned. That is, net income data for the same sample used in the Lindbergh and Wilson (2016) study do indeed turn upward in 2011 and subsequent years. The same cannot be said for the other three parameters that were selected for “more business-like” evaluation – operating profit, return on assets and solvency. Statistical significance was lacking to support such an association. Nevertheless, reflections on individual MHCs in the sample suggested that most of them (16/19) were making moves in the “right” direction. They thus on their way toward compliance with the regulation asserting more business-like behavior.

The process being followed would thus seem to be:

1. Development of intentions within the company as expressed in owner directives.
2. Immediate follow-up in the one parameter that is most closely controlled by the companies – increase in revenue through the increase in negotiated rents.
3. Continued improvement in profitability as indicated by operating profit, return on assets and solvency.

It will be interesting to follow the three firms in the sample to see what happens with them. Put another way, becoming more business-like does not imply becoming more successful, or more profitable, which appears to be the case with these three MHCs. It is not the purpose of this study to make judgment on companies or their management, but it might seem that these companies are worth watching. The record of these three do not appear as if they are working from a position of strength. As time plays out, we will see what happens. It is unlikely that MHCs will go out of business because municipalities depend upon them for critical housing. It is not clear, however, what will be done, what must be done, for weaker ones to survive.

The second part of the study dealt with performance of individual firms. Clearly the two companies selected for preliminary investigation illustrated very different behavior. One, Båstadhem AB, had the financial results that were expected. Its revenue curve followed typical industry observations with a “hockey stick” up-turn subsequent to implementation of Public Municipal Housing Companies Act: 2011. The anticipation was that once free of government introspection, companies would feel freer to raise rents, thereby increasing revenues, and indeed it appeared as the whole sector followed this pattern. TranemoBostäder AB appeared to be an outlier. Instead of being a hockey stick, it was more like wet spaghetti, i.e., post-implementation, it turned down instead of up. It is not known at this time how many other MHCs there might be in the sample with this behavior, but there cannot be many, else the industry behavior would be flatter.

Solvency results of these two MHCs turned out to be even more extreme. Both MHCs had hockey stick behavior, but Båstadhem’s went up (the preferred, anticipated behavior); TranemoBostäder’s went down (the perilous path toward potential bankruptcy). One might ask, why are these observations important? At the very least, they illustrate that just the production of updated owner directives did not necessarily produce the anticipated financial changes for all companies, and solvency (def. Retained Earnings/Total Capital) is perhaps the critical parameter to investigate. At least in Sweden, it is the parameter of choice in making judgements on company solidity because it indicates a company’s abilities to meet obligations in the long run. Secondly, it reflects a situation that when industries are freed from government support, there may be winners and losers, i.e., the strong get stronger and the weak get weaker – perhaps even die.

Along the way we had a look at the firms’ business, at least the profitability end in terms of ROA and Operating Profit. The returns on investment seemed low for both firms, more so for TranemoBostäder than Båstadhem, but in the three to four percent range for even Båstadhem. One would wonder why anyone would borrow money to construct rental properties when the returns on assets must be about equal to borrowing costs. It must be noted, however, that these are municipal companies. Consequently, they realistically function as a quasi-municipality organization. Historically, they have borrowed money through the municipality and their performances are judged by the municipality, so for the services rendered, three or four percent may not be too bad.

In summary, the overall study is likely to be strengthened by these observations. Because a weak firm was uncovered, one wonders why it was weak and got weaker after Public Municipal Housing Companies Act: 2011 was implemented. It is known that the act provided not only for “increased business-like behavior”, but also brought independent rental providers into rental negotiations. What impact might that have? Previously, negotiations with MHCs set the independent rental rates also. That could affect the financial health of an MHC in situations where independents pushed for
lower rents. Further, municipal payouts were liberalized post-PMHC Act2011. MHCs have tended to be cash cows for municipalities; increasing the rate naturally would have an impact on solvency. Additionally, it is generally recognized that some MHCs do better than others based on location – larger cities being more solid than outliers. The factors behind that observation should be examined.

In concluding this section, it is common to comment on the weaknesses of the study and to suggest further work. One weakness for sure is the sample size. To some extent this study was constrained by the extent of the previous work (Lindbergh and Wilson, 2016), but a larger sample, however, obviously would give greater confidence in observations. Another weakness is the size of the firms in the sample. When a random sample is drawn, one takes what one gets. In this case, there were many more small MHCs than large ones in the population of MHCs, so the sample was biased toward small firm performance. It would be worthwhile to see how larger firms reacted and performed to the regulation. Further, because 2011 to the present is a transition period, an ongoing study is warranted. There has been a significant change imposed on this industry and it is worthwhile following developments with regard to industry performance, its structure and subsequent policy developments in its regulation. Finally, attention should be paid to individual firms and their strategies – what will happen to the strong and the weak? The discussant to the paper suggested use of Gray system analysis could prove worthwhile in that regard (private communication, 2017).

CONCLUSIONS

Originally, a study was planned that would relate changes in financial performance to known changes in Owner Directives and answer a simple question – were MHCs following up on things that were said in their individual publications. As put in an earlier paper, were they walking the walk after talking the talk? From this study, it is now realized that this is a complex situation. Nevertheless, revenue information tended to substantiate the observation that the industry had changed and in the supposed direction of being more business-like. The changes in operating profit, return on assets and solvency were not statistically significant. Closer investigation of individual companies in the sample suggested that the majority (16/19) was in the process of making positive changes in operations. Consequently, from information both statistically significant and other softer observations it was concluded that indeed companies were following up on their OD goals. Two companies were selected for individual study. The extremes in performance suggested that the industry would be an interesting one to follow.

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Table 1 – Comparison: Financial Observations against Qualitative Assessment

<table>
<thead>
<tr>
<th>PHC Name</th>
<th>Summery</th>
<th>Revenue</th>
<th>Operating Profit</th>
<th>ROA</th>
<th>Solvency</th>
<th>Comments</th>
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<td></td>
<td>2004</td>
<td>2013</td>
<td>m_pos</td>
<td>m_Pre</td>
<td>Z</td>
<td>sig</td>
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<td>Båstadhem AB</td>
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<td>2,76</td>
<td>4</td>
<td>2,19</td>
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<td>7</td>
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<td>105</td>
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<td>90</td>
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<td>7,59</td>
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<td>80</td>
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<td>1</td>
<td>2,09</td>
<td>8</td>
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<td>Kumla Bostäder AB</td>
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<td>9</td>
<td>8,62</td>
<td>3,69</td>
<td>3.</td>
<td>5</td>
</tr>
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<td>Laholmshem AB</td>
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<td>3,84</td>
<td>2,21</td>
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</tr>
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</table>

1 ROA not tracked through 2010.
### Table

|                           | 0.7 | 2.0 | 0.9 | 2.1 | 0.8 | 2.2 | 0.7 | 2.3 | 0.6 | 2.4 | 0.5 | 2.5 | 0.4 | 2.6 | 0.3 | 2.7 | 0.2 | 2.8 | 0.1 | 2.9 | 0.0 | 2.10 |
|---------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| **Strömbstadbyggen AB**   | 6   | 9   | 6   | 8   | 40  | +   | 16  | 1.6 | -   | 4   | -   | -   | -   | 31  | -   | 2NS |
| **Tanums Bostäder AB**   | 8   | 13  | 1.48| 0.3 | 6   | 0   | 0.1 | 3.6 | 0.1 | 0   | 0.08| 0.15| 3.72| 0   | 2NS |
| **TranemoBostäder AB**   | 9   | 13  | 1.40| 0   | 487 | 3   | 0.56| 0.4 | 1   | 0.80| 0   | 0.16| 3.95| 9   | -   | 1NS |
| **Vadstena Fastighets AB**| 12  | 12  | 8.38| 2   | 5   | 23  | +   | 0.2 | 0   | 0.7 | 0   | 0.15| 6   | 24  | 01  | -   | 1NS |
| **Vallentuna Ösebyhus²**  | 11  | 11  | 0.08| 0   | 17  | 3   | 20  | 0   | 1   | 95  | 0   | 0.10| 41  | 72  | 65  | N   | -   | -   | -   | -   | -   | -   | 1+ |
| **Sum**                   | 16  | 9   | 25  | 2   | 577 | 17  | NS  | 3   | 20  | 1.03| 0.00| 0.09| 6   | 9   | 12  | N   | 39  | 88  | 43  | NS  | 2NS |
| **Industry (Sample)**     | 7.41| 2.07| 7   | 0.00| 4   | 1   | 44  | 0.05| 1   | 0.30| 0.00| 1   | 0.30| 0.00| 1   | NS  | 0   | 0.99| 0   | 0.30| NS  | 2NS |

### Figure 1

**Annual Revenue (Turnover) Båstad, TranemoBostäder and Industry**

- **Båstadhem AB**: $m_2 = 11,564, m_1 = 3,650$
- **TranemoBostäder AB**: $m_2 = 487, m_1 = 1,400$

² Financial Results affected by sale of holdings in 2009.
Figure 2 – Solvency at Båstadhem and TranemoBostäder (2003 to 2014)

Figure 3 – The Linear Relationship between Return on Assets and Operating Profit at Båstadhem and TranemoBostäder
SPATIAL EFFECTS OF COUNTY INCOME DISPARITIES AND GROWTH IN PENNSYLVANIA, 1980-2015

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ABSTRACT

The paper aims to offer empirical insights in the regional income disparities and growth giving emphasis on exploring spatial effects of income growth and convergence in the sixty-seven counties of Pennsylvania from 1980-2015, inclusive. While spatial relationships have long been overlooked in empirical work, recent evidence shows that regional data cannot be regarded as independently generated, due to the presence of spatial dependencies among the neighboring regions. Thus, the standard estimation procedures, employed in many empirical studies, can be invalid and lead to serious biases and inefficiencies in the estimates of the β-convergence measure. The estimators based on the counties in Pennsylvania data of per real net income and real per capita net earnings for the Sala-i-Martin (1996) regression model to assess absolute β-convergence. However, not all counties will have the same initial capital endowments and/or populations. That is, there are variations by country. Because of these differences, the original model by Sala-i-Martin (1996) will be extended to include variables that hold constant the additional conditions that can affect change in per capita income and per capita earnings.

INTRODUCTION

Will relatively poorer counties of Pennsylvania remain poor for many generations? Will the richer counties of today in Pennsylvania remain so 50 years from now? Is the degree of income inequality across the counties across Pennsylvania increasing or falling over time? The importance of these questions, which lie at the heart of the convergence debate, is obvious to anyone interested in general regional welfare and its economic growth.

Barro and Sala-i-Martin (1992) started the intensive interest in the empirical analysis of convergence and its implications on regional and national welfare. The standard empirical assessment of convergence typically revolves around three measures: (1) σ-convergence, which concerns the statistical distribution of incomes across a set of geographical observations; (2) absolute β-convergence, which is measured in the simple regression of income growth on income level; and (3) conditional β-convergence, also determined through regression analysis (de la Fuente, 1997).

This paper investigates spatial dispersion and the process of convergence of real per capita earnings and real per capita income across the counties in Pennsylvania in the period 1980-2015, inclusive. While spatial relations have long been overlooked in the standard empirical work and most studies still treat regions as isolated in space, recent evidence shows that regional data cannot be regarded as independently generated, due to the presence of spatial dependencies among the neighboring regions, namely counties in this paper.

The paper consists of five main sections. In the next section we introduce data and set out methodological considerations which are relevant to our analysis. Section 3 presents the empirical results of β-convergence analysis taking into account possible spatial dependence of the counties in Pennsylvania. Finally, the conclusions are presented in section 4.
METHODOLOGY AND DATA

The Methodology of Convergence

Two main concepts of convergence appear in the classical literature. They are called β convergence and σ convergence (Sala-i-Martin, 1990). The two measures are really only fully applicable under the ideal neoclassical conditions in which variations among places are in their capital endowments alone. If convergence is occurring, the standard deviation in per capita income should be observed to decrease over time across the set of geographical observations. The coefficient of variation (CV) statistic, taken as the standard deviation divided by the mean, is often used to assess σ-convergence. Mean income tends to rise over time, and the CV statistic allows intertemporal distributions to be compared (or from one set of geographical observations to another) controlling for that effect. Absolute convergence is ongoing as a process if the relevant CV statistics decrease with time, and has occurred if it is equal to zero.

Sala-i-Martin (1996) proposed a regression model to assess absolute β-convergence. Suppose that we have data on real per capita income for a cross-section of economies, say for counties. Let $Y_{i,t}$ be economy $i$’s annualized growth rate of income between $t$ and $t+T$ and let $ln \left( \frac{Y_{i,t+T}}{Y_{i,t}} \right)$ be economy $i$’s per capita income at time $t$. Then, we can estimate the following regression

$$Y_{i,t+T} = \alpha - \beta \ln(Y_{i,t}) + \epsilon_{i,t}$$

(1)

and we find $\beta > 0$, then we say that the data set exhibits absolute β convergence.

As for the concept of σ convergence can be defined as follows: a group of economies are converging in the sense of σ if the dispersion of their real per capita income levels tends to decrease over time. That is, if $\sigma_{i,t+T} < \sigma_i$, where $\sigma_i$ is the time $t$ standard deviation of $ln \left( Y_{i,t} \right)$ across $i$.

However, not all regions will have the same initial capital endowments and/or populations. That is, there are regional variations. Because of these regional differences, Sala-i-Martin (1996) extended equation (1) to assess the absolute β convergence model

$$Y_{i,t+T} = \alpha - \beta \ln(Y_{i,t}) + \gamma X + \epsilon_{i,t}$$

(2)

Where $X$ is a vector of variables that hold constant the additional conditions that can affect change in per capita income.

In the literature, extensive criticism of classical convergence analysis has been presented (Bliss 1999; Cannon and Duck 2000; Carlino and Mills 1996; Drennan 1999; Durlauf 1996). The main criticism of the empirical analysis concerning the absolute and conditional β convergence focused on the lack of the incorporation of the spatial concepts (Badinger, Müller, and Tondl 2004; Le Gallo and Dall’erba 2006). More specifically, the problems of the β convergence is that the cross sectional regression do not account for the spatially autocorrelated dependent income growth that may lead to spatially autocorrelated errors, which is an obvious violation from OLS. Consequently, parameter estimates are inefficient in the presence of autocorrelated errors, so the results of hypothesis testing may be misleading.

The first is by extending it to directly treat any spatial dependence in the errors, so the residual term $\epsilon$ in equations (1) and (2) is decomposed into two parts. The first part is its spatial pattern, $\gamma$, and the second part, $\mu$, is random error, which is independently and identically distributed (iid). Thus, equation (2) can be rewritten to accommodate the spatial error as

$$Y_{i,t+T} = \alpha - \beta \ln(Y_{i,t}) + \gamma X + \gamma + \mu$$

(3)

Spatial Econometric Models

Once spatial dependencies have been identified, spatial econometric models are applied to deal with dependencies that take place in space. That is, these interactions among spatial units, the counties in Pennsylvania in this paper, are modelled by introducing a spatial weight matrix, $W$, which imposes the structure of the spatial interactions.

In our $W$ matrix, we define neighbors by applying distances between each of the counties in Pennsylvania. Once the $W$ matrix has been identified, the weight matrix is transformed into a spatial lag, which is the average of the neighboring counties if the weight matrix is row standardized. Row standardization means that

$$w^*_{ij} = \frac{w_{ij}}{\sum_j w_{ij}} = \frac{w_{ij}}{\varphi_i} \quad \text{where} \quad \sum_j w^*_{ij} = 1$$

(4)

SPATIAL AUTOREGRESSIVE (SAR) MODEL
In the specification of the spatial autoregressive (SAR) model, also called the spatial lag model, spatial dependency means that the dependent variable is not defined only by a set of exogenous explanatory variables, but also by the value of the dependent variable in surrounding counties in Pennsylvania, and this spatial dependence is given by the parameter on endogenous spatial lag in the dependent variable \( W_y \). The SAR model for convergence becomes:

\[
Y_{i,t+T} = \alpha - \beta \ln(Y_{i,t}) + \rho \sum w_{ij} Y_{j,t+T} + \epsilon_{i,t}
\]

where \( w_{ij} \) represents elements of spatial weight matrix, \( W \) and \( \rho \) is the autoregressive spatial parameter.

The spatial lag parameter in the dependent variable \( \rho \) determines the strength of the average (across all counties in Pennsylvania) association between growth of wages for county \( i \) and the average of those rates of wage growth for their neighboring counties (Fischer and Getis, 2010). More important, the simultaneity between the spatially lagged variable \( W_y \) and the error term is an obvious violation of the Gauss-Markov assumptions in OLS; consequently, this means that alternative estimation methods such as the maximum likelihood (MLE) methods must be used.

**THE SPATIAL ERROR (SER) MODEL**

Spatial dependence can also be present in the form of spatially autocorrelated errors, which can be decomposed to

\[
\epsilon_i = \rho \sum w_{ij} \epsilon_j + u_i
\]

where \( \rho \) is the spatial autoregressive coefficient and \( u \) is the vector of i.i.d. errors. Inserting the spatially lagged error term leads to the following specification of the convergence equation:

\[
Y_{i,t+T} = \alpha - \beta \ln(Y_{i,t}) + \rho \sum w_{ij} Y_{j,t+T} + \rho \sum w_{ij} \epsilon_j + u_i
\]

The SER model may be preferred when the autocorrelation is viewed more as a nuisance than a substantive parameter, which means that a random shock in a county affects growth rates in that county and impacts other counties. The problem with the SER model is that it often only reflects a common reaction of counties due to undefined, spatially correlated omitted variables. In general, empirical models of convergence tend to use the SER specification; however, the SER has a weaker theoretical and interpretational meaning as opposed to the SAR specification (Fingleton and López-Bazo, 2006).

**Data Requirements for this Analysis**

This analysis addresses both per capita earnings (from employment) and per capita income (earnings plus nonemployment income) convergence across the sixty-seven counties of Pennsylvania during the period 1980-2015, inclusive. Nonemployment income’s share of total income has become increasingly important throughout the United States including Pennsylvania, during the last twenty years (Nelson and Beyers, 1998). Table 1 summarizes the variables used in the empirical analysis as well as a brief description and source.

**CONVERGENCE ANALYSIS TAKING INTO ACCOUNT SPATIAL DEPENDENCE OF THE COUNTIES IN PENNSYLVANIA**

**Descriptive Statistics**

The process of \( \beta \)-convergence requires a negative relation between the growth rate of the real per capita earnings and real per capita income variables and its initial level. In fact, the convergence hypothesis was initially intended to explain income disparities between nations, but it later proved to be more useful in the study of regional disparities within a country or group of countries (Arbia, 2006).

Summary statistics concerning levels and dispersion of per capita earnings and per capita income in Pennsylvania’s counties over the period are listed in constant year 1984 dollars in Tables 2 and 3, respectively. As in the rest of the United States, real per capita earnings and income grew considerably in Pennsylvania between 1980 and 2015, inclusive. As those values grew, each seems to have been marked by divergence rather than convergence. In the case of per capita earnings, the interquartile range increased from about $2,411.32 to over $10,026.27 during the period. The pattern is the same for per capita income. Its interquartile range grew from about $3,569 to $16,577 in real terms. Over time, coefficients of variation (CV) indicate consistent \( \sigma \)-divergence across Pennsylvania in per capita earnings. The CV on per capita income indicate very weak if any actual convergence between 1980 (CV = 0.141) and 2015 (CV = 0.189), and the \( \sigma \)-divergence from 1990 to 2015 remained fairly stable.
Empirical Results from the Ordinary Least Squares

First, we estimated a non-spatial, classical OLS model to test for absolute convergence in real per capita earnings and real per capita income. The results are presented in Table 4. The OLS results reveal negative and statistically significant β coefficient, providing evidence of absolute convergence across counties in Pennsylvania for the per capita earnings. On the other hand, the results reveal negative and statistically significant β coefficient, providing evidence of absolute convergence across counties in Pennsylvania for the per capita earnings. For the remaining time periods, 2000-2010 and 2010-2015 reveal that the β coefficient is positive and not statistically significant at the 5% level. The final collection of model diagnostics consists of tests against spatial autocorrelation. A total of five test statistics are reported, as shown in Table 3. In the per capita real earnings, the Moran’s I statistic is highly significant, and this would suggest that there is a problem with spatial autocorrelation. However, for per capita real income, the decade of 1990-2000 would only exhibit a problem with spatial autocorrelation. While Moran’s I statistic has great power in detecting misspecifications in an estimated model, it does not suggest which alternative specification of the spatial model should be used. To figure out what alternative specification should be estimated, the various Lagrange Multiplier tests are estimated and examined. Each of these tests is discussed.

Empirical Results from the Spatial Error Model

The nature of spatial dependence was explored by the four additional LM tests, which suggest that the specification of the spatial error models captures the spatial patterns in the sample than the SAR model. In other words, this means that the spatial autocorrelation represents the nuisance parameter which needs to be accounted for. Table 5 summarizes the results of the absolute convergence using the spatial error model.

For the time period 1980-1990 for the real per capita earnings, the spatial autoregressive coefficient is estimated as 0.676, and is highly significant (p < 0.0001). As in the OLS case, the β coefficient is significant (p < 0.0001). The value of β coefficient is slightly more in absolute value relative to the OLS results. As for the time period 1990-2000 for the real per capita earnings, the spatial autoregressive coefficient is .778 which is statistically significant with a p value of p<0.0001. More striking is that the β coefficient is substantially larger than the OLS estimate of β in absolute terms, and it is statistically significant (p < 0.0001). As for the time period 2000-2010, for the real per capita earnings, the spatial autoregressive coefficient is .980 which is statistically significant with a p value of p<.0001. Like the 1990-2000, the β coefficient is substantially larger than the OLS estimate of β in absolute terms, and it is statistically significant (p < 0.0001).

In the time period 2010-2015, the β coefficient for the real per capita earnings remained nearly the same with the OLS estimate in absolute terms. Like its OLS estimate, it is statistically significant. In addition, the spatial autoregressive coefficient is .1023 which is not statistically significant because the associated p value exceeds the level of significance of .05. Finally, for the real per capita income, the only time period shown to have spatial dependencies as revealed from table 3 is 1990-2000. The estimated spatial error model showed that the β coefficient actually declined in absolute terms with the OLS estimate. The spatial autoregressive coefficient is .6662 which is statistically significant with a p value of p<.0001.

Empirical Results from the Spatial Error Model Another Variation

It is not surprising that there is evidence of absolute divergence in both per capita income and earnings across the counties in Pennsylvania. The state is marked by economic heterogeneity in both income and economic structure. At the larger scale, the counties containing Pittsburgh and Philadelphia are more urban and historically have had generally higher per capita incomes than the other counties in Pennsylvania. Income change over the entire period generally seems to have simply reinforced a pattern of higher incomes those counties. Absolute divergence, however, can mask an underlying process of conditional convergence in which regional incomes move toward steady states that balance their response to per capita income levels with other factors. Technology is unlikely to vary in a meaningful way across these counties, but other factors that may have an impact on change in per capita earnings and per capita income can be evaluated within models of conditional β-convergence. These factors include the following: (1) sectoral composition of county economies, (2) county population, (3) human capital, (4) environmental amenities, and (5) accessibility.

Sectoral composition of a region’s economy has been shown
to play a role in income convergence in several studies (Caselli and Coleman, 2001; Paci and Pigliaru, 1997). Percent of county earnings in farming, manufacturing, and tertiary activities, e.g. transportation; retailing; wholesaling; finance, insurance, and real estate; and services are used to define sectoral composition in the conditional β-convergence model. Typically, large manufacturing shares are expected to promote earnings and income growth, but that expectation is undermined by the general decline in manufacturing in the region during the study period. Relatively large shares of agriculture are expected to dampen earnings and income growth, while the importance of the service sector variable could make its contribution ambiguous. County population provides a measure of potential urban agglomeration economies that can result in higher wage levels (Adamson, Clark, and Partridge, 2004). Relatively higher levels of human capital may account for relatively higher wage levels while, conversely, relatively higher levels of amenities may provide a nonpecuniary offset (Adamson, Clark, and Partridge, 2004; Beeson and Eberts, 1989). Human capital is measured as the percent of a county’s population that has a bachelor’s degree while amenities are measured using the McGranahan (1999) index. Accessibility is measured as a binary (1, 0) variable that determines the presence or absence of a U.S. interstate highway link in the Pennsylvanian county. In fact, Boarnet and Haughwout (2000) found that interstate highway links yield significant economic growth effects that could have an impact on earnings and income on a region. Table 6 summarizes these results.

We explain the results from Table 6. First, we compared the R^2 from the spatial error model to the OLS models. The R^2 are higher than the OLS results. This is indicative that it’s a stronger model. Then, we looked at the Akaike info criterion and Schwarz criterion. We must make sure that these numbers went down in order to ensure that this test is more accurate than the OLS. When comparing the results from the spatial error model to the OLS regressions, these numbers went down suggesting that the use of the spatial error model is better. For the absolute convergence, the spatial error models are smaller than the OLS results. However, they are still statistically significant. A noticeable observation is that the sectoral parameters increased for the spatial error model in comparison to the OLS estimates, and these coefficients still had the correct signs. In addition, the spatial error models all of the manufacturing coefficients were statistically significant unlike the OLS estimates. In the time period, 1980-1990 for the per capita real earnings, the coefficient was not statistically significant. However, for all of the time periods for the per capita real income, none of the OLS coefficients were statistically significant.

Conclusions and Final Discussion

The evidence presented in this paper points to an increase in the convergence of per capita earnings from 1980-1990 to 1990-2000 then a slight decrease in convergence for the time periods of 2000-2010 and 2010-2015. Since the OLS performed rather well for the per capita income models, these convergence shows that there is a steady increase in the convergence among the counties in Pennsylvania. It is noteworthy that the effects of highways on the convergence of counties in Pennsylvania did not have an effect on the lagging areas in Pennsylvania. The standard strategy for increasing the growth of lagging regions might center on improving transportation access. Also the amenities index did not appear to have an impact on the convergence of the counties in Pennsylvania. Based on these results, a possible strategy would be to focus on the inherent advantages of the various regions within Pennsylvania and making them better known to people. While these counties is unable to control its level or quality of natural amenities, the policy-makers can take steps to develop and promote the advantages that each these counties may possess. As urban areas such as Philadelphia and Pittsburgh are often congested, access to open space and recreation increases the attractiveness of the counties that are perhaps less populated and could provide a different experience for people.

In a result that is not expected, education is important to the income and earnings growth of these counties in Pennsylvania. A plausible explanation is the fact that education levels have been steadily improving in Pennsylvania, and there has been a great deal of catch-up in these counties that were once far behind the rest of Pennsylvania in educational attainment. Some counties may still need to achieve more to reach equality with the other counties, but the evidence indicates that this is no longer a significant hindrance to the economic development of most regions in Pennsylvania.
# Table 1: A Summary of the Variables, Description, and Source

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per capita Earnings (from employment) and Per capita Income (earnings plus nonemployment income)</td>
<td>Income includes earnings from employment, as well as nonemployment sources such as transfer payments, and dividends, interest, and rent.</td>
<td>Bureau of Economic Analysis, Regional Economic Information System (REIS).&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Employment by Sectors: Tertiary, Manufacturing, and Agriculture</td>
<td>The BLS provides data on establishments, employees and payroll for the agriculture, manufacturing and service industries for Pennsylvania counties from 1980-2015, inclusive.</td>
<td>Employment data were obtained from the U.S. Census Bureau, County Business Patterns.</td>
</tr>
<tr>
<td>Amenities</td>
<td>Represents a measure of the physical characteristics of a county area that enhance the location as a place to live. The scale was constructed by combining six measures of climate, topography, and water area that reflect environmental qualities most people prefer. These measures are warm winter, winter sun, temperate summer, low summer humidity, topographic variation, and water area. These measures are available by county in Pennsylvania.</td>
<td>Economic Research Service, US Department of Agriculture&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Highway (Binary Variable)</td>
<td>A binary (1, 0) variable that marks the presence or absence of a U.S. interstate highway link in a county of Pennsylvania.</td>
<td>Highway Statistics Annual Report by Pennsylvania Department of Transportation&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>Population, by County</td>
<td>Measures the number of people living in the county.</td>
<td>Bureau of Census</td>
</tr>
<tr>
<td>Share of Adults with at least a Bachelor’s Degree</td>
<td>This is defined as the number of adults with at least a bachelor’s degree. This estimate is found by dividing the number of people in a county with at least bachelor’s degree divided by the number of adults residing in the county.</td>
<td>The number with at least a bachelor’s degree is obtained from the Quarterly Workforce Indicators (QWI) from the Census Bureau.</td>
</tr>
</tbody>
</table>

<sup>1</sup>Bureau of Economic Analysis (BEA) has the per capita personal income and per capita net earnings estimates available within their interactive tables located at [https://www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1#reqid=70&step=1&isuri=1](https://www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1#reqid=70&step=1&isuri=1). The data for each Pennsylvania county estimates are available under the section “Local Area Personal Income and Employment” from the table CA30 (Economic Profiles).


Table 2: Real Per Capita Earnings in Pennsylvania’s Counties: 1980, 1990, 2000, 2010, and 2015:
Summary Statistics

<table>
<thead>
<tr>
<th>Year</th>
<th>Minimum</th>
<th>Median</th>
<th>Mean</th>
<th>Maximum</th>
<th>Interquartile Range</th>
<th>Coefficient of Variation (CV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>1,752.567</td>
<td>2,380.220</td>
<td>2,509.842</td>
<td>3,973.647</td>
<td>2,411.319</td>
<td>0.179</td>
</tr>
<tr>
<td>1990</td>
<td>2,733.730</td>
<td>4,077.716</td>
<td>4,396.516</td>
<td>7,933.930</td>
<td>4,170.539</td>
<td>0.229</td>
</tr>
<tr>
<td>2000</td>
<td>3,824.225</td>
<td>6,294.746</td>
<td>6,792.280</td>
<td>13,880.430</td>
<td>6,373.766</td>
<td>0.257</td>
</tr>
<tr>
<td>2010</td>
<td>3,675.613</td>
<td>8,197.544</td>
<td>8,864.675</td>
<td>17,890.116</td>
<td>8,265.400</td>
<td>0.275</td>
</tr>
<tr>
<td>2015</td>
<td>4,152.629</td>
<td>9,849.282</td>
<td>10,595.992</td>
<td>21,183.874</td>
<td>10,026.286</td>
<td>0.256</td>
</tr>
</tbody>
</table>

Summary Statistics

<table>
<thead>
<tr>
<th>Year</th>
<th>Minimum</th>
<th>Median</th>
<th>Mean</th>
<th>Maximum</th>
<th>Interquartile Range</th>
<th>Coefficient of Variation (CV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>2,915.5463</td>
<td>3,532.670</td>
<td>3,654.780</td>
<td>5,604.328</td>
<td>3,569.08</td>
<td>0.141</td>
</tr>
<tr>
<td>1990</td>
<td>5,234.620</td>
<td>6,578.606</td>
<td>6,892.819</td>
<td>12,358.272</td>
<td>6,632.243</td>
<td>0.182</td>
</tr>
<tr>
<td>2000</td>
<td>8,173.248</td>
<td>9,929.460</td>
<td>10,534.315</td>
<td>19,903.058</td>
<td>9,954.381</td>
<td>0.208</td>
</tr>
<tr>
<td>2010</td>
<td>8,482.215</td>
<td>13,718.455</td>
<td>14,535.933</td>
<td>27,204.477</td>
<td>13,838.53</td>
<td>0.199</td>
</tr>
<tr>
<td>2015</td>
<td>10,139.217</td>
<td>16,496.323</td>
<td>17,335.316</td>
<td>29,885.565</td>
<td>16,577.73</td>
<td>0.189</td>
</tr>
</tbody>
</table>

Table 4: Classical OLS Model for Absolute Convergence for Real Per Capita Earnings and Real Per Capita Income (p values are given in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Real Per Capita Net Earnings</th>
<th>Real Per Capita Net Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.58867 (0.0065)</td>
<td>16.9692 (0.0004)</td>
</tr>
<tr>
<td>β</td>
<td>-0.4434 (0.0000)</td>
<td>-0.42534 (0.00176)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.825571</td>
<td>0.041162</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>67</td>
<td>67</td>
</tr>
</tbody>
</table>

Diagnostics for Spatial Dependence

| Moran’s I      | 5.3452 (0.0000)              | 5.0314 (0.0000)            |
| Lagrange Multiplier (lag) | 0.0030 (0.9565)     | 9.6469 (0.00190)          |
| Robust LM (lag) | 18.3926 (0.00002) | 21.7572 (0.00000)         |
| Lagrange Multiplier (error) | 16.9964 (0.00004) | 17.9279 (0.00002)         |

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Table 5: Spatial Error Model Specification for the Absolute Convergence for Real Per Capita Earnings and Real Per Capita Income (p values are given in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Real Per Capita Net Earnings</th>
<th>Real Per Capita Net Income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1980-1990</td>
<td>2000-2010</td>
</tr>
<tr>
<td>Intercept</td>
<td>-0.0672292 (0.86126)</td>
<td>-24.8138 (0.0000)</td>
</tr>
<tr>
<td></td>
<td>0.343781 (0.6430)</td>
<td>8.17436 (0.0000)</td>
</tr>
<tr>
<td>β</td>
<td>-0.52152 (0.0000)</td>
<td>-0.991 (0.0000)</td>
</tr>
<tr>
<td>λ (spatial lag in per capita earnings and per capita income)</td>
<td>0.676106 (0.0000)</td>
<td>0.789333 (0.0000)</td>
</tr>
<tr>
<td></td>
<td>0.980528 (0.0000)</td>
<td>0.102383 (0.39230)</td>
</tr>
<tr>
<td></td>
<td>0.102383 (0.39230)</td>
<td>0.666203 (0.0000)</td>
</tr>
<tr>
<td>R²</td>
<td>0.926182</td>
<td>0.778280</td>
</tr>
<tr>
<td></td>
<td>0.942622</td>
<td>0.263704</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>Likelihood Ratio Test</td>
<td>37.3551 (0.0000)</td>
<td>44.9187 (0.0000)</td>
</tr>
<tr>
<td></td>
<td>93.4086 (0.0000)</td>
<td>1.0373 (0.30845)</td>
</tr>
<tr>
<td></td>
<td>54.9793 (0.0000)</td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Spatial Error Model Specification for the Absolute Convergence for Real Per Capita Earnings and Real Per Capita Income Controlling for Regional Differences (p values are given in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Real Per Capita Net Earnings</th>
<th>Real Per Capita Net Income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1980-1990</td>
<td>2000-2010</td>
</tr>
<tr>
<td>Intercept</td>
<td>-0.228543 (0.5898)</td>
<td>-1.8897 (0.0042)</td>
</tr>
<tr>
<td></td>
<td>-2.80243 (0.0060)</td>
<td>-2.00006 (0.056)</td>
</tr>
<tr>
<td>β</td>
<td>-0.542084 (0.0000)</td>
<td>-0.6872 (0.0000)</td>
</tr>
<tr>
<td></td>
<td>-0.768473 (0.0000)</td>
<td>-0.69854 (0.0000)</td>
</tr>
<tr>
<td></td>
<td>-0.676473 (0.0000)</td>
<td>-0.21245 (0.00042)</td>
</tr>
<tr>
<td>Sectoral Parameters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tertiary</td>
<td>-0.00404 (0.1899)</td>
<td>-0.0131459 (0.1788)</td>
</tr>
<tr>
<td></td>
<td>-0.0131459 (0.1788)</td>
<td>-0.018134 (0.16988)</td>
</tr>
<tr>
<td></td>
<td>-0.018134 (0.16988)</td>
<td>-0.018200 (0.15567)</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>-0.0081268 (0.0321)</td>
<td>-0.0219589 (0.0388)</td>
</tr>
<tr>
<td></td>
<td>-0.0219589 (0.0388)</td>
<td>-0.02489 (0.03999)</td>
</tr>
<tr>
<td></td>
<td>-0.02489 (0.03999)</td>
<td>-0.025 (0.03000)</td>
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<td>Agriculture</td>
<td>-0.0653956 (0.3674)</td>
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<tr>
<td></td>
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<td>-0.08567 (0.55581)</td>
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<td>-0.08348 (0.57964)</td>
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<td>Control Parameters</td>
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<td>Amenities</td>
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<td>0.00900553 (0.0613)</td>
<td>0.00968 (0.0688)</td>
</tr>
<tr>
<td></td>
<td>0.00968 (0.0688)</td>
<td>0.00789 (0.0588)</td>
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<td>Highway</td>
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</tr>
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<td></td>
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<td>0.0082568 (0.35567)</td>
</tr>
<tr>
<td></td>
<td>0.0082568 (0.35567)</td>
<td>0.0076 (0.33345)</td>
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<tr>
<td></td>
<td>0.0076 (0.33345)</td>
<td>-0.0227981 (0.2544)</td>
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<td>Population</td>
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<td>0.5876</td>
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<td></td>
<td></td>
<td>1.1430</td>
</tr>
<tr>
<td></td>
<td>(0.5287)</td>
<td>(0.5577)</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------</td>
<td>----------</td>
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<tr>
<td>Human Capital</td>
<td>0.0765635</td>
<td>0.218258</td>
</tr>
<tr>
<td></td>
<td>(0.4771)</td>
<td>(0.2317)</td>
</tr>
<tr>
<td>( \lambda )</td>
<td>0.781553</td>
<td>0.901974</td>
</tr>
<tr>
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<td>(0.0000)</td>
<td>(0.0000)</td>
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<td>Likelihood Ratio Test</td>
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<td>41.5901</td>
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<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
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</table>

**REFERENCES**


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ECONOMIC FACTORS THAT AFFECT ADJUNCT FACULTY SALARIES

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ABSTRACT
This paper addresses economic factors that affect salaries paid by colleges to adjunct (part-time) faculty members. In terms of economic theory, market salaries are a function of supply and demand. People with PhDs in fields where demand is high may be able to find good paying full-time faculty positions. Their scarcity gives rise to substantial salaries. For colleges and universities that employ adjunct faculty, particularly those colleges and universities that expand their applicant pools to include non-PhDs, the supply of potential part-time faculty can be very large. It appears that a large number of potential part-time faculty members are willing to work for modest salaries. As a result, part-time faculty members tend to earn modest salaries.

INTRODUCTION
Articles that address the plight of adjunct (part-time) faculty (McKenna, 2015; Nolan, 2016; Sabga, 2013) tell stories about 35 and 40 year old PhDs who live in their parents' basements while earning low salaries as adjunct faculty members. Other stories entail adjunct faculty members with families to support who cannot afford health insurance and who feed their children using food stamps. A recurring theme of stories about adjunct faculty members is that many would prefer full-time faculty positions with good salaries and benefits. However, unable to find full-time positions, they instead teach part-time.

Although the more dramatic hard luck stories seem to entail adjunct faculty members with PhDs in English and history and other humanities, low salaries for adjunct faculty appears to be common across a wide range of disciplines. A survey conducted by the Coalition on the Academic Workforce, (Curtis and Thornton, 2013) showed that more than 10,000 part-time faculty respondents reported that the median salary for a 3 credit course was $2,700. Using the $2,700 figure, it could be inferred that if a person were to teach four courses per semester at several different universities, total earnings for a two semester academic year would be $21,600 ($2,700 X 4 X 2). Living on $21,600 per year could be a challenge.

To better understand the options available to adjunct faculty members, this paper addresses economic factors that affect adjunct faculty salaries. Much of the analysis entails consideration of determinants of the supply and demand for college faculty members.

Theoretically, an employer should be willing to pay an employee a wage rate up to the value of the goods and services generated by an employee. In some cases the value generated and the resulting employee compensation can be very high, such as prominent athletes and entertainers.

Forbes (DeSantis, 2016) reported that basketball player LeBron James had total earnings of $77.2
million, consisting of $23.2 million from salary and $54 million from endorsements. It can be inferred that team owners expected that additional ticket sales, broadcast fees and other revenues would justify his salary. Similarly, it can be inferred that James’ endorsement sponsors expected their revenues to increase by at least as much as the endorsement fees.

Forbes (forbes.com, 2016), reports that movie star Dwayne Johnson earned $64.5 million during 2016. It can be inferred that the producers of Johnson’s movies perceived that his appearances in their movies would generate additional revenues of at least $64.5 million.

Relating the economic concept of supply to the determination of compensation of athletes and entertainers, it can be posited that highly talented athletes and entertainers are very scarce. Substitutes with the same talents may not be available. Athletes and entertainers who know the value of their services may insist on high compensation.

ECONOMIC DETERMINANTS OF FACULTY SALARIES

The economic concepts that apply to compensation in general can be applied to faculty salaries. Regarding demand for college faculty, the upper limit for a faculty member’s salary could be the revenue generated by a class. For example, suppose that a particular university’s tuition rate were $1,000 per credit. If an adjunct faculty member were to teach a 3 credit class with enrollment of 40 students, the tuition generated would be $120,000 ($1,000 X 3 X 40). Theoretically, the college could pay a salary of up to $120,000 for that course.

In contrast to sports and movie superstars whose scarcity enables them to command high salaries, the supply of people qualified to teach college classes is much greater. The $2,700 per course average adjunct faculty salary, (addressed in the Introduction), suggests that there is a large supply of potential adjunct faculty members willing to work for modest salaries. Attempts to understand why adjunct faculty salaries are modest may entail addressing the question of why large numbers of qualified people seek adjunct faculty positions.

An oversupply of Ph.Ds in at least some fields may give rise to underemployed PhDs seeking adjunct faculty positions. Weissmann (2013) reported that in 2011, 19.4% of new PhDs had found academic jobs by graduation. Similarly, Iasevoli (2015) reported that one in five PhDs in science, engineering and health found faculty positions within 5 years of completing their degrees. Although in some fields, such as business, PhDs may face less difficulty finding faculty positions, those in fields of great oversupply may find that the only faculty positions available are part-time.

PhDs who are unable to find full-time faculty positions may seek part-time teaching positions in hopes of eventually finding full-time faculty positions. A PhD may view adjunct teaching as a “foot in the door” that may provide an advantage when a full-time opening arises. A PhD may consider adjunct teaching to be an opportunity to acquire teaching experience to enhance employability in general. An applicant for a full-time faculty position with a PhD and teaching experience may have an advantage over an applicant with a PhD and no teaching experience.

The fact that people dedicate years of their lives achieving PhDs in overcrowded fields may suggest they are motivated by more than money. A PhD whose goal in life is to be a college professor may view teaching multiple low paying adjunct assignments as a tolerable substitute for a full-time faculty position. That PhD may be willing to work year after year as an adjunct professor.

POTENTIAL SUPPLY OF NON-PHD FACULTY

If a college were to expand its faculty requirements to include non-PhDs, the supply of potential adjunct faculty could be very large. As an extreme example, consider the topic of unemployment rates and workforce participation. A Bureau of Labor Statistics News Release (2017) shows that for April 2017, the unemployment rate in the United States was 4.4%, calculated as:

\[
\text{Number of unemployed persons} = \frac{7,056,000}{100}\%
\]
Total civilian labor force  
160,213,000  

= 0.0440413 = 4.4%

The total civilian labor force is the number of civilian, noninstitutional persons, age 16 and older who are either employed or seeking work.

An unemployment rate of 4.4% might seem to suggest strong demand for workers. However, labor force participation figures may suggest that the real unemployment rate is higher. For April 2017 the labor force participation rate was 62.9%, calculated as:

Total civilian labor force  
Total civilian noninstitutional population  

= 160,213,000  
254,588,000  

= 0.6293 = 62.9%

The total civilian noninstitutional labor force includes persons 16 or older who are not in the labor force. The number of persons not in the labor force is the difference between total civilian noninstitutional population and the total civilian labor force, which is 94,375,000 (254,588,000 - 160,213,000). The nonparticipation rate can be calculated as 100% - 62.9% = 37.1%, or, alternately:

Persons not in the labor force  
Total civilian noninstitutional population  

= 94,375,000  
254,588,000  

= 0.3706969 = 37.1%

The persons not in the labor force figure suggests that there are 94,375,000 people who could potentially enter the workforce under appropriate conditions. Obviously, not all 94 million are qualified to teach college classes. But, some of them probably are qualified.

Some may be retired professors who would like to return to teaching on a part-time basis. Others may be college graduates who left the labor force to take care of children or aged parents and would like to re-enter the labor force as part-time college teachers.

The persons not in the labor force figures may also include persons who have not left the labor force but instead have been unemployed so long that they are excluded from the labor force figures. Those persons in particular may be willing to become low paid adjunct professors.

AN ILLUSTRATION OF THE SUPPLY OF ACCOUNTING FACULTY

As a more specific illustration of how supply of potential faculty applicants can affect salaries, consider the supply of accounting PhDs, and the supply of other accountants who could potentially teach accounting classes.

A number of articles have addressed a “shortage” of accounting PhDs. For example, Fogarty and Holder (2012) and Plumlee, et al, (2006) address a supply and demand imbalance between new accounting PhD graduates and accounting faculty openings. It is suggested that the number of doctorally qualified accounting faculty falls short of accounting faculty vacancies.

To estimate the potential supply of doctorally qualified accounting faculty, consider data from Prentice-Hall’s Accounting Faculty Directory (Hasselback, 2016). The accounting faculty directory includes a table that shows the number of accounting doctorates earned each year from 1997 through 2015, plus a cumulative total that includes several decades prior to 1997. The number of accounting doctorates earned between 1997 and 2015 ranged from 106 to 186. The cumulative total through 2015 (including pre-1997 graduates) was 8,303.

It might be inferred that because the cumulative total covers several decades, many of those accounting doctorate holders have retired or otherwise left the labor force. Of those actively employed as college professors, relatively few seek new employment. Accordingly, it can be inferred that the number of
accounting doctorate holders who seek employment in a typical year is small.

Suppose that a university were to seek to hire an accounting professor with an accounting doctorate from a prestigious university and a record of publication in prestigious journals. The scarcity of applicants would make relevant the revenue attributable to the professor. Revenue generated may go beyond tuition paid by the professor’s students. A highly regarded professor may enhance the prestige of a university. The result may be higher ranking and increased enrollment not just in that professor’s classes but for the university as a whole. The perceived value of that professor’s services would likely result in a very high salary.

Consider next colleges that choose to not compete for accounting doctorate holders. Those colleges would expand hiring criteria to include applicants who have other qualifications. For the sake of illustration, assume that certified public accountants (CPAs), including those without doctorate degrees, are qualified to teach accounting classes. The National Association of State Boards of Accountancy (Sheridan, 2016) estimates the number of CPAs in the United State to be 664,532. This figure suggests that for colleges that do not require an accounting doctorate degree, potential accounting teachers are plentiful. Many appear to be available to teach part-time.

If CPAs willing to teach part-time for modest salaries are representative of adjunct faculty in general, motivating factors for CPAs may provide some insight regarding motivation in other fields. Along the lines of the rationale of adjunct faculty who have PhDs in field where there is an oversupply of PhDs, CPAs (without PhDs) who aspire to become full-time accounting professors may view part-time teaching as a way to acquire experience that may lead to full-time faculty positions.

Some CPAs may view part-time teaching as a form of community service. Instead of, or perhaps in addition to volunteering their services to various charities, a CPA may teach a class or two. The modest salary received would be a bonus.

Along similar lines, some CPAs may teach part-time because they enjoy teaching. They may feel satisfaction in molding young minds and preparing the next generation of accountants.

These non-monetary motivations to teach part-time suggest that part-time teachers who need the money are competing with teachers who do not need the money. The fierce competition for part-time teaching positions may make the goal of a comfortable income impractical.

AN ILLUSTRATION OF UNIONIZED ADJUNCT FACULTY

To illustrate the potential effects of unionization on adjunct salaries, consider the state owned university system in Pennsylvania. At the 14 state owned universities in Pennsylvania, both full-time and part-time faculty members are represented by the Association of Pennsylvania State College and University Faculties (APSCUF). The Collective Bargaining Agreement (CBA) (APSCUF, 2016) includes a salary schedule for full-time faculty ranging from Instructor Step 1 to Full Professor Step 13. The CBA states that part-time faculty are paid one twenty-fourth (1/24) of the annual full-time faculty salary for a particular rank and step, for each credit (workload hour) taught. If a part-time faculty member were to teach a 3 credit class, the salary would be 3/24 (or 1/8) of a full-time faculty salary. For the Fall 2016 – Spring 2017 academic year, full-time salaries ranged from $47,891.29 for Instructor Step 1 to $115,325.51 for Full Professor Step 13. A part-time faculty member teaching a 3 credit class would be paid a minimum of 1/8 of the salary of an Instructor Step 1, calculated as $47,891.29 X 1/8 = $5,986.41, or approximately $6,000.

If a part-time faculty member were to teach a total of 8 classes per year at several universities at a salary of
$6,000 per class, the resulting annual earnings of $48,000 could provide a moderate standard of living. However, it seems unlikely that many faculty unions could negotiate a contract that provides part-time salaries comparable to the APSCUF CBA.

Higher salaries might also make finding part-time positions more difficult. Higher salaries would likely give rise to an increase in the supply of applicants. Qualified potential part-time faculty who would not be willing to work for a lower salary might be willing to work for a higher salary.

Higher salaries might give rise to less quantity demanded by colleges. Colleges might reduce the number of classes offered by increasing class sizes and/or dropping classes with low enrollment. A combination of fewer part-time openings and more applicants for the part-time positions would lead to more potential part-time faculty unable to find positions.

**CONCLUSIONS**

As stated in the introduction, a survey of adjunct (part-time) faculty (Curtis and Thornton, 2013) reported that the median salary for a 3 credit course was $2,700. At such a rate, to live comfortably as an adjunct professor would be a challenge.

In terms of economic theory, market salary rates are a function of supply and demand. People with PhDs in fields where demand is high, such as certain business disciplines, may be able to find good paying full-time faculty positions. Others, such as those with PhDs in overcrowded fields may not be able to find full-time faculty positions. Those who have a strong desire to become college teachers may be willing to work part-time. A large supply of applicants for part-time teaching positions leads to low salaries for part-time faculty.

For colleges and universities that hire non-PhDs to teach part-time, the supply of applicants with the basic qualification to teach college classes can be very large. Many applicants may be willing to work for low salaries for reasons other than money. Some may enjoy teaching. Some may view teaching as a form of charitable service. Some may have other personal reasons.

The general conclusion is that there is a large supply of potential adjunct faculty members who are willing to work for low salaries. The result is a market price for part-time faculty members that may not be sufficient to provide a high standard of living. As is the case of any free market, purchasers of goods and services pay the market price. In this case the purchasers are colleges and universities.

Actions that part-time faculty members may take could include seeking alternate employment. Considering that the minimum qualification to be a college teacher is a bachelor’s degree, it seems likely that many, if not most, part-time faculty members could find non-academic jobs that pay livable salaries.

For those who aspire to earn PhDs in overcrowded fields, more realistic long-range planning may be appropriate. They should realize that it is likely that not all PhD graduates will find full-time faculty positions. Aware of that possibility, they should make informed decisions regarding whether they really want to pursue PhD degrees.

Further research could entail a questionnaire survey of adjunct faculty members that would ask questions about their motivations and possible alternate choices they might have made years ago if they had known more about the market for adjunct faculty.

**REFERENCES**


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CHILDHOOD POVERTY IN PENNSYLVANIA

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1 S George St, Millersville, PA 17551

ABSTRACT:
This study observes family structure, demographic characteristics, economic characteristics, spatial characteristics, and social and cultural characteristics as determinants of child poverty in the Pennsylvania. It was concluded that family structure, male unemployment, and being a metro area were significant at the county level. The model was tested for omitted variable, serial correlation, heteroskedasticity, as well as multicollinearity and for the accuracy of the model as determined by the adjusted R squared value. OLS was determined to be valid to use and was used while conducting the regression.

INTRODUCTION:
Today, as the United States continues to recover from the Great Recession, families across the country are still dealing with the ramifications of the former economic downturn. As we continue to crawl out of this financial hole, some households are still chain to the bottom, living below the poverty line. As this paper is written, 14.5 percent of families in the United States live below the poverty line. This unfortunately means that the children of these households do not always receive basic necessities such as food and clothes. Why, in a country as prevalent as the United States is in the world economy, are more than 45 million unable to make ends meet? Why are 13.1 million children going hungry each day because they live in food insecure households? What is binding such a vast amount of Americans to the bottom rung of the country’s income distribution? The odds have been stacked against these disenfranchised children. Without a stable foundation to build their future on, these children are be left by the wayside and condemned to the relentless cycle of poverty.

This paper delves into those questions asked above. Determinants that drive poverty will be examined closely and tested for their significance in driving poverty. The independent variables believed to cause poverty are family structure, demographic characteristics, economic characteristics, spatial characteristics, and social/cultural factors. The hypothesis of this study is that together, these variables can be used to determine poverty (dependent variable) in the United States. More specifically, this paper looks more into poverty at a more micro level by analyzing these variables for counties in Pennsylvania.

LITERATURE REVIEW:
The study, Social and Cultural Determinants of Child Poverty in the United States, aimed to find the determinants of child poverty in the United States. What the authors, Sri Ranjith and Anil Rupasingha, further wanted to prove is that more government involvement in aiding the homes of disenfranchised children will help children step out of poverty later in life. The study suggests that policymakers must focus on, “attention to community social and cultural aspects for enhancing the welfare of children” (Ranjith and Rupasingha, 2012 page 139). They theorize that more involvement in social and cultural programs builds more interpersonal connections. From these connections, both individuals that comprise the relationship are better off as the more information is shared as well as more opportunities for each individual will arise. As opposed to those who are more isolated due to their lack of connections. These lack of connections may lead to lost opportunities that could have aided their financial situation.

The theoretical model that was used for this study was:

\[ Chp = a + bFS + cDM + dEC + eSP + fSC + \epsilon \]

As this study this about childhood poverty, the dependent variable is the percentage of childhood poverty per county. To determine the dependent variable Ranjith and Rupasingha based their model on the theory that takes into consideration the characteristics of the county that a child lives in as well as characteristic of the children themselves. These variables included the family structure of the child’s
home and demographic characteristics of the individual. In addition the independent variables included the economic and spatial characteristics of the household and social and cultural factors. These variable that were chosen give a small insight to the life of each household and the children that live in poverty.

The data that was used to for the dependent variable was cross-sectional data from 3,107 counties across the United States from 2007. The independent variables were based off of cross-sectional data from the same data set of 3,107 counties, but from 2000. When calculating the expected childhood poverty rate, the percentage of people under 18 in poverty was based on the data from 2007 (Runjith and Rupasingha, 2010, page 131). The independent variables were determined from breaking the theoretical model’s variables into more descriptive characteristics. The independent variables used for the expected model were: Female head of household, race (black and Hispanic), percentage of population over 25 that only has completed high school and has dropped out prior, unemployment rate, male unemployment rate, percentage people that work within the same county that they live, percentage of jobs that are in the (agricultural, forestry, fishing and hunting, and mining industries), percentage of jobs that are in manufacturing, percentage of jobs that are in (entertainment, food services), percentage of professional service jobs, urban versus rural, whether the county was in the South, social capital, and percentage of adherents to religion (Mainline Protestants, Evangelical Protestants, Catholics) (Ranjith and Rupasingha, 2012 page 128-130).

From this study the authors concluded that all variable from the theoretical model were significant. They were also able to determine that single parent homes where the mother was the head of the household had a strong positive correlation on childhood poverty. The most predominant however was whether a county was located in the South or not. They were able to prove that their variables were significant in determining childhood poverty and because of this I intend to use these results to apply to poverty in Pennsylvania.

Much like Social and Cultural Determinants of Child Poverty in the United States, the study, Spatial Inequality and Poverty among American Children, sought out to determine the causes and drivers of childhood poverty. What the paper ultimately proved was that the constantly evolving economic makeup of the United States was starting to grow unevenly. The culmination of their study was captured when they stated, “The uneven geographic distribution of child poverty clearly implies that children’s economic circumstances are tied directly to the economic fortunes of the communities in which they and their parents live.” (Friedman, Samantha, and Daniel T. Lichter, 1998, page 106).

To come to this conclusion, Friedman, Samantha, and Daniel T. Lichter, used a model based on variety of variables that assessed such matters as economic opportunities, spatial characteristics, educations levels, and family structure. To be more specific the independent variables used for their study included: portion of the population that is African American, portion of the population that is Hispanic, percentage of the county’s population that has a high school degree or lower, if a county was located in the South as well as if the county was a metro county, what the county’s main industries for employment are (Extractive, nondurable goods, miscellaneous service, professional services), the level of unemployment in the county, level of male unemployment in the county, and finally the percentage of single parent homes with a female head of household. All data used was county level data from 1990.

Their research yielded that, “All of the coefficients, except for the coefficient of miscellaneous services, are significant at the 0.01 level” (Friedman, Samantha, and Daniel T. Lichter, 1998, page 101). These variables are identical to those that were used in the model that I used for my study. Because this study had great success using these variables and that the model that my paper is based on used similar variables, I feel confident that I will also yield significant results.

**MODEL SPECIFICATIONS:**

For my study I intend to use the theoretical model from Social and Cultural Determinants of Child Poverty in the United States. The reason that I am using this model is because all of the variables in this study were found to be significant. Another reason for choosing the model from this study is because the expected model was based off of county level data which is what I will be using for my study about poverty in Pennsylvania.
Pennsylvania.

P = Poverty    FS = Family structure    DM = Demographic characteristics
EC = Economic characteristics    SP = Spatial characteristics    SC = Social and cultural factors

\[ P_i = \beta_0 + \beta_1 FS_i + \beta_2 DM_i + \beta_3 EC_i + \beta_4 SP_i + \beta_5 SC_i + \epsilon_i \]

The dependent variable of this study is the percentage of children per county that live in poverty. The model that I am using for my study entails 13 independent variables to determine the level of childhood poverty in each county. The first independent variable is percentage of female head of household. This variable looks at the family dynamic in each household (what family members live in the home). This variable more specifically looks at the female head of household (%FHH). This is believed to have a positive correlation with poverty. This variable is believed to be relevant because having only one parent dramatically decreases the potential earning power of the household. Not only that, but the wage gap between men and women only further hinders the earning potential of the household. For both reasons stated above, the variable is assigned a positive coefficient.

Next we will observe the percentage of a county’s population that is African American (%AA) and the same will be done for people of Hispanic decent (%Hisp). These variables look at the demographic characteristics about the individual that would be correlated to poverty. These characteristics are believed to make an individual more susceptible to living in poverty (positive correlation). This is because minorities are believed to be disadvantaged when looking for employment despite the addition of affirmative action.

This model also takes into account economic factors that affect the earning potential of a household. One way of determining earning potential is to look at the education level within the home. The variable used for this study is the percentage of 25 years old that have a high school degree or lower (%25HSD). This is supposed to have a positive correlation with poverty. This is because more education in associated with higher paying employment opportunities. Since this variable measures the portion of the adult population that only has up to a high school degree, the higher the value of this variable the less potential earning power there is within the county. The less potential earning power of the county the more likely the households within it are going to have to live below the poverty line.

Another way that I will examine the economic characteristics of the county will be through the level of unemployment in said county (%Unemp). This variable accounts for the fact that some households may be unable to find employment and is the reason that the household as a whole struggles to make ends meet. This variable has a positive correlation with poverty because households without a source of income will be forced into poverty.

Observing the previous variable in more detail, the model includes an independent variable that observes unemployment for males within a county (%Mune).

The purpose of having this variable in the model is, “Labor market participation may vary considerably across gender and children are less likely to be poor when the mother is successful in the labor market compared to that of the father (Chen and Corak 2008;Plotnick 1989)” (Ranjith and Rupasingha, 2012 page 129). Because of this the variable has a positive coefficient.

The final context in which I will evaluate the economic characteristics is by observing the makeup of the job market in each county. This will be done by looking at the percentage of total employment that is manufacturing (%Manu), percentage of total employment that is agricultural, forestry, fishing and hunting and mining (%Agric), as well as the percentage of total employment that are arts, entertainment, recreation, accommodation and food service, and other services (Except Public Administration) (%Rec).

These three variables are incorporated in both the
study conducted by Ranjith and Rupasingha, and in the study conducted by Friedman, Samantha and Daniel T. Lichter. Their reason for including these variables in their model was because certain industries are more susceptible to instability. When expanding on the use of different industry employment ratios, Friedman, Samantha, and Daniel T. Lichter said, “Tickamyer & Tickamyer (1988), on the other hand, reported that the percentage employed in agriculture and mining was associated with high unemployment and underemployment rate” (Friedman, Samantha, and Daniel T. Lichter, 1998, page 93). This may come into play as different industries pay different wages and have different levels of job security because of the nature of the work being done. Because of this, I will closely examine the effect that these industries may have on the county.

Another variable that has been studied by Ranjith and Rupasingha is the percentage of the labor force that works in their county of residence (%EICoR). This variable has negative correlation with child poverty because if a county is economically stable to support itself then childhood poverty is less likely to develop.

Now we look at the spatial characteristic of the model which is whether or not a county is a metro county (Metro). This variable will have a negative coefficient. This is due to a lack of higher paying jobs. These higher paying jobs can be found in more populated areas as opposed to more rural areas which have more agricultural jobs that are associated with lower wages. Not only that, but more resources and assets are often found within a metro area because of the high density of people and organizations.

The final insights into the lives of impoverished children are the social and cultural factors of their lives. To capture this, I used the social capital index (SocCap) to note the resources (civic, sports, political, business centers and voter turnout for presidential elections) available to the public in each county. I also took into account the percentage of the population that adheres to a religion (RelAdh). These variables take into consideration the level of interpersonal connections that the individuals have outside of the home. It is believed that the more people that a household has connections to, the less likely that they are to be below the poverty line. This is because the more connections that an individual/household has, the more likely opportunities are to arise. These opportunities can keep the household out poverty (such as job opportunities or handouts from religious organizations). These variable are to have negative coefficient because they are believed to increase the potential earning power of a household.

DATA DESCRIPTION:

The data I will be used for this project is cross-sectional data from the most recent year available (2010) at the county level. My data has come from a variety of sources. The vast majority of which was found searching through data from the Census Bureau. I was able to collect data for the following variables using this source: % of Childhood Poverty, Female Head of Household, % of Population that is African American, % of Population that is Hispanic, % Population 25 and older with High School Degree or Lower, % of Employment that is Agriculture, % of Employment that is Manufacturing, % of Employment that is Recreation. All data collected from this source come directly from the results of the 2010 Census and was available for each county in Pennsylvania.

Another source used for data in this paper was the Northeast Regional Center for Rural Development. Using this source I was able to find the social capital index for each county in Pennsylvania in 2010. This source provided an insight into the level of social capital available within each county. This includes civic, sports, political, and business organizations, tax-exempt not-for-profit organizations, voter turnout at presidential elections, and the response rate to the decennial census.

In order to find data concerning the percentage of religious adherents I turned to the American Religious Data Archive. Here I was able to find the percentage of adherents of a vast array of religions as well as the total percentage of the population that adhered to a religion. This study will only look at the total percentage of religious adherents for each county. Again, the data that was found was from 2010 and available for each county in Pennsylvania.

The final source used when collecting data was the United States Department of Agriculture. Thanks to the USDA I was able to collect data for the Metro
variable. This variable is the only variable uses data not from 2010 as it was not available. In place of 2010 data, I used the closest year possible which was 2013. Determining what counties were metro was based off the population density of the county and the density of bordering counties. Data was available for each county in Pennsylvania (67).

ECONOMETRIC ESTIMATION AND EVALUATION:

To test my model, I ran a regression of my equation using OLS and the estimated coefficients (Coef.), standard errors (Std. Err.), and p values (p). All are listed in Figure 1.

To test if the model has a good fit I will conduct a F-Test.

\[ H_0 = \text{All } \beta = 0 \]
\[ H_A = \text{At least one } \beta \neq 0 \]

After running the regression, STATA calculated the F-statistic for the model to be F(13, 53) = 8.32. Given the degrees of freedom used to calculate the F-statistic I now find the f critical value. Using the same degrees of freedom on the F-statistics table with .05 significance, the critical value is 1.92. Since 8.32 is greater than 1.92 we reject the null hypothesis and can conclude that the model has a good fit.

To test the significance of the variables used in the model, they will be judged at a 95 percent confidence level using the P-Method.

\[ H_0 = \beta = 0 \]
\[ H_A = \beta \neq 0 \]

For all variables with a P-value < .05 (level of significance), we reject the null hypothesis and the variable will be deemed significant. For all variables with a P-value>.05, we fail to reject the null hypothesis and subsequently determine that the variable is not significant. Referencing Figure 1 for the P-values, I observed that the only significant variables at a 95 percent confidence level is female head of household, male unemployment, and metro. If I were to expand the level of significance to .1, 2 additional variable would become significant. Those two variables being employment within the county of residence and religious adherence. For this study I will continue using the .05 level of significance.

Now that the significant variables have been determined, we can dive deeper into their meaning. Since the percentage of female head of household per county has a positive coefficient (1.459075), each additional percent of this variable will increase percentage of childhood poverty by 1.459075 percent. The same applies to male unemployment as its coefficient is 1.703574. As male unemployment increases by 1 percent, childhood poverty increases by 1.703574 percent. For my last significant variable, metro counties, the coefficient is negative (-.040455). Since this is a dummy variable, childhood poverty will decreases by .040455 percent when the variable is present. When the county is not a metro county this variable has no effect or a value of 0.

Now I will have to determine whether this model has missing variables. To determine this I will use the Ramsey’s Regression Specification Error Test.

\[ H_0 = \text{No omitted variables} \]
\[ H_A = \text{Omitted variables} \]

STATA calculated the F-statistic to be F(3, 50) = 1.09. Looking at my F-Stat Table and using the same degrees of freedom as STATA for the numerator and denominator I have determined the F-critical to be 2.76. Since the F-statistic< F-critical we fail to reject our null hypothesis and can say that there are no omitted variables.

Though there are not omitted variables, irrelevant variables are present. Looking at the adjusted $R^2$ which is .5904 which is close to .6 (the preferred adjusted $R^2$ for cross-sectional data). The problem is that $R^2$ is .6711. This relatively large gap in the adjusted $R^2$ and $R^2$ indicates there are irrelevant variable from the
model. As we have an ideal adjusted $R^2$, I will leave this issue alone as to not skew the model since the fit is sufficient.

The next step is to check for multicollinearity. To test for this I will look at the correlation between the independent variables. Any variable with $|R| > 0.8$ will be looked at more closely to determine if corrections are needed.

As we see in Figure 2, none of the variables are correlated $|R| > 0.8$. This assures that there is no multicollinearity. As extra assurance, I calculated the Variance Inflation Factor and the mean VIF is 1.54 with the highest VIF of any of the variables being 2.34. All of these values are <5 (any variable with a VIF > 5 might need correcting for multicollinearity).

Since I used cross-sectional data, it is likely that there is heteroscedasticity. I will look for this error in two ways. First by looking for a horn shape within the plot for the residuals (Figure 3). Secondly, I will be testing for this at .05 level of significance using the White Test.

To find the test statistic for this test, I will conduct a White Test on STATA.

$$H_0 = \text{No Heteroskedasticity}$$

$$H_A = \text{Pure Heteroskedasticity}$$

The test statistic given is 67. Compared to the critical value of the test, 90.531 (66 degrees of freedom at .05 significance), we see that the test statistic is less than the critical value of the test. This means that we fail to reject the null hypothesis. There is no heteroscedasticity, which is also confirmed by the visual test of observing the residual plot. There are no corrections that need to be made to the data.

Finally the model must be tested for serial correlation. This will be done by visually inspecting the residual plot (Figure 3) for patterns as well as running a Durbin-Watson Test.

$$H_0 = \rho \leq 0, \text{No positive serial correlation}$$

$$H_A = \rho > 0, \text{positive serial correlation}$$

As with all other tests conducted in this study, this test will be run at a level of significance of .05. The D-statistic determined by STATA is $D(14, 67) = 1.860476$. The critical range of this test is given by the D-statistics table using the same degrees of freedom that STATA used to calculate the D-statistic (13 was substituted for 14 in the numerator so that the constant wasn’t counted as one of the variable). The points of significance are 1.160 and 2.093. Since the D-stat falls in the critical range, the test for serial correlation is inconclusive. Since the results of inconclusive I will not make any corrections to the data.

CONCLUSION:

This study was able to conclude that having a single female parent as head of household and male unemployment levels increase child poverty whereas living in metro areas reduces child poverty. Since we cannot make every county in Pennsylvania a metro county, what I would recommend is an increase in outreach programs. A program that offers financial assistance to single parent homes and a program that aides the unemployed find employment would significantly reduce childhood poverty in each county. Despite having an inconclusive result for serial correlation, the model passed all of the other tests and was proved to have a good fit. The results follow solid logic. Single parent homes already would have a harder time making ends meet because of the lost potential earning power, not to mention the wage gap that women face. Also in older schools of thought, men are thought to be the breadwinners of the household and if they are unable to bring in an income because they are unemployed, it would make sense that male unemployment attributes to childhood poverty. Finally with a wide range of assets to offer in the form of organizations and people, metro areas offer more opportunities to earn income which helps combat childhood poverty.

No person, let alone a child, should have to struggle to feed and clothe themselves. We often hear about
poverty in other countries and it is easy to dismiss it as a problem that is out of our hands simply because we’re not there, but the problem is not just in distant countries on the horizon. It’s right here in the United States. Here in your very state. In your very county. People never seem to see the severity of a situation until it hits home, but this problem is in our homes. It affects our friends, our family, and our community. We can reduce the suffering of children from disenfranchised homes by proceeding to fund and hold outreach programs. These programs give the less fortunate the same opportunities that you and I take for granted all too often. The first step, finding the source of the problem, has been done. Now, we must act.

FIGURES AND TABLES:

Results of Regression

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<th>Std. Err.</th>
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### Independent Variable Correlation Coefficients

**Figure 2**

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<th>%Hisn</th>
<th>%25HS D</th>
<th>%Une</th>
<th>%Mune</th>
<th>%EICoR</th>
<th>%Agric</th>
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**2017 Conference Proceedings**

%ReligiousPop | -.0846382 | .0478329 | .083

Constant | .02133 | .046711 | .650
Metro | .3767 | -.1165 | .4273 | -.1449 | -.1491 | -.0388 | -.2227 | .4142 | .0892 | -.2412 | 1  
| RelAdh | .1841 | -.1547 | -.0511 | -.1891 | -.1901 | -.0993 | .3297 | -.1041 | .0680 | -.3751 | .1500 | .1903 | 1

Plotting of Residual

Figure 3

REFERENCES:


China’s One-Child Policy Has Created Irreversible Damage:  
A Comprehensive Look at a Life Changing Issue

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ABSTRACT
The term one child policy, describes an important, but for many, dangerous policy in China. The Chinese government claims that 400 million babies were not born because of the social policy enacted. What they do not say is how many of those unborn were forced abortions and sterilizations, infanticide, and unwanted baby girls. This problematic policy caused many issues such as a gender gap, social issues, and workforce problems. In 2013, China relaxed the policy allowing parents that were single children themselves, to apply to have a second child; however, only 1.5 million couples out of the eligible 11 million applied. Then, in 2015, China announced that they will be eliminating the child policy and allowing couples to have two children. It may be too late for this new policy to provide the positive change China is seeking. Throughout this essay, four aspects will be identified as to why the damage caused by implementing the one child policy in China has become irreversible.

Keywords: One Child Policy, Infanticide, Gender Gap, Bride Price, Workforce, 4-2-1 Phenomenon

Background
There have been several accounts of misinformation about Mao Zedong. King et. al delves deeper into these myths in the article Challenging myths about China’s one child policy and debunks many of the issues that have risen from these falsities (King Whyte, Feng, & Yong, 2015). Mao was recorded on several different accounts stating that he was proud of China’s large population size. He was never recorded promoting population growth, simply stating that normal population growth is a good thing and that China will continue to find a way to support its population. By 1957, Mao was recorded stating that birth control was more urgent (King Whyte et. Al, 2012). He in fact, is the one who deemed a ten-year program promoting birth control and birth planning as essential before hitting the 800 million population mark. The following year, the Great Leap Forward began and Mao became less concerned with population growth mainly because of the surplus in food supply. Once the famine from the Great Leap Forward occurred, Mao went back to stating that birth control was necessary and went as far as providing many provinces with free options. He later complained to an American journalist that too few in the rural providences were using the birth control options (King Whyte et. Al, 2015). Although not many records exist of his explicit birth control plans, China did create their own version of the birth control pill that they were distributing in order to curb population growth from 2.5% down to 1% in cities and 1.5% in rural areas, then subsequently down again as part of the five-year plan in 1975 to 1% in rural areas and .6% in cities by 1980 (King Whyte et. Al, 2015). This plan was titled “later, longer, and fewer” (Wan, xi, shao 晚、稀、少) meaning: get married later in life, wait longer between approved births, and have fewer children (King Whyte et. Al, 2015). This coercive plan did in fact reduce population growth during the 1970’s leading researchers to question why the one child policy was launched in 1980 and question why the policy has gathered so much credibility when research suggests the country’s population was already in decline (as shown in figure 1). Mao Zedong passed away in 1976 and under the new rule of Deng Xiaoping, the one child policy was introduced in 1979 and passed into law September of 1980.
Even before the policy change for 2016 to two children per couple, in 2013, China announced that any parent that was a single child themselves was allowed to apply for a second child. Walsh (2014) stated that “of the 11 million eligible citizens, only 1.5 million have applied to do so.” In fact, “a poll by China’s family-planning commission in 2008 found that just 19% of the people surveyed wanted more than one child” (Walsh, 2014). “Everybody wants just one” said Green Chrysanthemum in Mei Fong’s book titled One Child: The Story of China’s Most Radical Experiment (2016). This is a serious problem for China and with couples continuing to have only one child, this mindset will continue. These problems will be further reviewed in the following sections.

**GENDER GAP**

As stated previously, there are roughly thirty-two million more men than women in China. Men are expected to care for their parents and carry on the family line; whereas women are married off and become part of the husband’s family responsible only to them. This mindset plus the one child policy does not create much love for daughters. Scutti (2014) states that “survival depends on sons, and daughters are only a burden”.

“It's clear to me that having two x chromosomes is being processed in this culture as akin to having the most severe type of birth defect and you would be better off not carrying that pregnancy to term,” Valerie M. Hudson, a principal investigator of the WomanStats Project, told Newsweek. She argues that a long-standing devaluation of the lives of females coupled with the one child policy has helped to create an abnormal gender imbalance in China -- a dystopian nightmare manufactured by the state” (Scutti, 2014).

Because of this mindset, it is expected that the excess in men will only increase, leaving twelve to fifteen percent with no hopes of marriage in a society where a family is expected. These men have been termed “bare branches” which denotes that these unmarried men will be ending their family lines signified by bare branched family trees (Scutti, 2014; Walsh 2014). This not only leads to deep feelings of shame, but also creates other social and emotional issues such as aggression, depression, loneliness, and suicide threats.

As these mental health issues skyrocket through Chinese society, unmarried men have begun paying for sex. Scutti states that “more likely to engage in commercial and unprotected sex, these men are the drivers of a growing market for female trafficking” as well. In growing numbers, women from around the world (mainly in the surrounding countries such as Myanmar, Vietnam, Laos, Singapore, North Korea, Mongolia) are being trafficked into China and
Another issue that has resulted in the lack of women is the ever-rising bride price for women that are ‘available’ (Worrall, 2015). Whereas in the past, bride prices were anything from linens to animals, bride prices now are handled in cash and the price can be upwards of $30,000.

“According to sociologist Zhang Yi (张翼), who was interviewed by CCTV, rising bride prices have three major reasons. The first is China’s gender imbalance that has caused a surplus in men, making it statistically more difficult for them to find a wife. The second reason has to do with the population division in China – the majority of China’s single, young men live in the rural areas, whereas the majority of China’s single young women live in the bigger cities. It has caused a highly competitive marriage market, where the bride’s families can ask for a high price. The third reason is the growing trend of the so-called “bride price culture”, where many families now feel a low bride price means losing face - if one’s daughter or future wife is ‘too cheap’ it is generally seen as a bad thing, both by the bride’s side and the groom’s (Judah & Wendling, 2016).

As the bride price continues to rise, so do burglar brides; women who set high bride prices, get married, then disappear leaving the man broke, lonely, and humiliated. With men outnumbering women, the parents of these men are actually taking expensive steps in order to assure that they are able even to have the opportunity to find a woman. Parents are purchasing apartments in the cities, buying their sons cars, and shelling out a lot of money for the bride price. This has led to bai jin nu, or gold diggers. In a Yahoo conducted survey, Ma Nuo has gone on to become one of China’s most recognizable bai jin nu. Marry for love? Fat chance, said the material girl: “I would rather cry in a BMW than smile on the back of my boyfriend’s bicycle” (Pierson, 2010).

SOCIAL ISSUES

Currently in China, one out of five marriages end in divorce. Professionals called marriage doctors have been called in to help troubled marriages, but 2.87 million couples have still divorced (Banschick, 2014). Banschick states that there are five reasons for the rising divorce rate in China. The first reason is accessibility. It has simply become easier to get a divorce. The second reason is money. There are fake marriages and ‘setups’ by parents occurring which entail no love and typically end in divorce. Thirdly, mindset: the ideas and attitudes are changing and many people have been raised as the only child in their family which has led to spoiled behavior and uncompromising spouses. The fourth reason is the advancement of women. In the past, if women were divorced, they were shunned and became financially unstable and unwanted. Today, divorced women are seen as independent and able to take control of their lives (Banschick, 2014). And finally, infidelity. In Chinese society today, loyalty remains an important reason to stay together. It seems, however; that infidelity ties better with the number three reason which was mindset. If only children are being raised with spoiled behavior, then when one wants something, one will get it regardless of marital status.

This generation is fast becoming known as the “me” generation with men being called “little emperors” based off on their self-centered, immature, and excessive behavior. This generation has been found to be more risk averse, less trusting, and pessimistic (Worrall, 2015). Not having a sibling means no one to speak with about stressors. Chu, Junqing Khan, Hossain, Heiko, and Kraemer (2015) also research into the non-only children families stating that these children with siblings, though better off socially among themselves, have a difficult time in society because it is less common and more socially unacceptable to have a sibling. Only child families receive certain privileges that non-only child families do not receive which adds stress and less satisfaction to their lives. This exemplifies the “me” generation and that single child families are raising more selfish children that have only had time and money focused on them (Chu et. Al, 2015).

Hernandez and Qinnoy (2015) have found that “China’s one child generation is far different from the generations that have preceded it. It is unusually well educated, with more than eighty five percent of children born in the 1990s having attended high school. They generally have more intimate relationships with their parents, who doted on them for much of their lives but also imposed high expectations”. Yet another term being used is the “the loneliest generation”.

While performing interviews, Hernandez and Qinnoy found that the policy change in 2016 has reawakened feelings of regret and loneliness that this generation was not able to have any siblings. Many people are struggling to understand why they were forced to participate in one of the world’s largest social experiments. This generation is still left wondering how they will be able to perform the duties of several siblings by themselves, known in Chinese society as the “4-2-1 phenomenon” (Walsh, 2014). This refers to four grandparents, two parents, and only one child to care for them all. This added stress leaves couples wondering whether they want to take advantage of the two child policy. Only children look back to how lonely they were and want to have another, but with the 4-2-1 phenomenon and other financial burdens, most couple’s mentality is to continue with one child. As women become more educated, urbanized, and wealthy, they choose to have fewer children realizing that it is less
The one child policy has trained China into believing one child is the perfect number of children to have. Global aging has in fact become the larger problem and countries all over the world are “implementing policies meant to increase their birthrates” (Walsh, 2014). But according to Walsh (2014), the Chinese are going to soon find out that it has become more difficult to coerce women into having more children than it is to prevent them.

Yet another problem plaguing Chinese society are the “empty nests” of the one child parents. Feng et al. (2014) believe that the children have become the family focal point whereas it used to be the elderly. It has also been stated that parents spend less leisure time alone or with other adults and more with their children making a definite assumption that Chinese families are becoming more child centered (Feng et al., 2014). Because these one child families are putting all of their resources into their only child, when parents lose that child, parents are devastated and this had led to an increase of suicide rates (Fong, 2016).

WORKFORCE

Once the one child policy was passed, the workforce boomed because fewer parents were taking time off from work to have children (Walsh, 2014). However, now that the one child policy has come into fruition, there are not enough children coming up to take over the workforce. Walsh found that by “2050, 1 in 3 Chinese will be older than 60, a 430 million–strong cohort larger than the entire U.S. population” (Walsh, 2014). He suggests that China is facing a major aging crisis with fewer young people to take over the workforce. This problem cannot be curtailed by the two child policy. In fact, “the reform will slightly slow down China’s aging society, but it won’t reverse it,” said Peng Xizhe, a population professor at Fudan University (Denyer, 2015). This shortage of workers is a concern and there will rapidly be a large generation of elderly with only one child to care for their parents (Hernandez & Qinnoy, 2015).

ELDERLY

Elder care is supported by Chinese law and people can be imprisoned for up to five years for neglecting to take care of their elderly parents. A law was passed in 2013 that requires adult children to return home “frequently” to visit with their parents (Gustafson & Baofeng, 2014). In the past, elderly lived with their children and were taken care of by them. However, with the new 4-2-1 generation, this is increasingly more difficult and elderly have been living nearby, but not with their children since homes are not always an option. Elderly people in China are only placed in homes paid by the government if they face the ‘three noes’: no ability to work, no children, and no income (Gustafson & Baofeng, 2014). This is most important in rural elderly populations because as the population ages, fewer “services are available and they are less well-funded in rural China” (Gustafson & Baofeng, 2014). As an example, the gap continues to grow between urban and rural pensions due to unequal investments from the government (Gustafson & Baofeng, 2014). Through Gustafson’s research, he has found that there is also an increased need for more elderly facilities, because “as the elderly population grows, the traditional model of co-residence with grown children has been jeopardized by the strict national family planning policies, shrinking family size, increased mobility and the changing role of filial piety” (Gustafson & Baofeng, 2014). Of course, couples can always relate back to their grandparents and the stresses of caring for their elderly parents and state that that is yet another reason they do not want to have more than one child.

CONCLUSION

The one child policy has changed the mindset of the people in China and has created irreversible damage. Wang stated that the one child policy was “a textbook example of bad science combined with bad politics” that was morally questionable and primed a demographic time bomb by driving down fertility rates further (Denyer, 2015). The passing of the two child policy is thought to increase birth rates in China, however; the mentality of the Chinese people will take much longer to modify leaving the original policy irreversible regardless of those changes. These alterations will also not reverse workforce issues because of the rapidly increasing elderly population.

The one child policy mentally changed the population to only wanting one child. These children are doted on by their parents and given everything they want and more causing the ill effect of being spoiled which causes more social issues, such as: depression, aggression, feelings of loneliness and isolation, and increased divorce rates. The gender gap is an ever increasing one with there being roughly thirty-two million more men than women and in populations with a higher male to female ratio, societies can become unstable and lead to internal or external violence as per Scutti (2014). With only 1.5 million out of 11 million applying to have their second child, China’s lack of children will not be quickly solved by adding a two child policy. Change must occur now in order to influence future transformation. Applications for having a second child should be eliminated immediately in order to ease the process of change.
References


DIFFERENTIAL EFFECTS ON TIME ALLOCATION DECISION-MAKING REGARDING SLEEP FOR UNIVERSITY STUDENTS

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ABSTRACT

To better understand the incentives and economic motivations behind university students’ allocation of time and decision-making, a study was conducted using the United States Census Bureau’s 2003-2015 American Time Use Survey to analyze how full-time university students allocate their day between three primary activities: sleeping, attending school, and working. The results showed that students lose approximately thirteen minutes of sleep for every additional hour they choose to work and twelve minutes for every additional hour they spend in or preparing for class. This indicates that students could be unaware of the need for proper sleep hygiene to maintain cognitive recovery processes and its benefits to academic achievement.

INTRODUCTION

Underlying the vibrant American college life is a cult of sleep deprivation. According to Khazan (2014) from the Atlantic, sleep hygiene deteriorates when people begin to feel pressure at work, school, and other aspects of their life. As a university student, there is the expectation that sleep soon becomes a foregone luxury as the day is dedicated to one’s studies, work, and other activities. It is with this study that the prioritization of these activities in relation to sleep can be better understood.

Over seventy percent of college students have reported attaining inadequate sleep in 2014 (Hershner and Chervin, 2014). This can be caused by disruptions in natural circadian rhythm, irregular sleeping schedules, or sleeplessness exacerbated by stress or other distractions (Konnikova, 2015). Regardless of the cause, the end results are poor executive and emotional functioning, debilitated judgment-making abilities, depression, anxiety, and a string of physical effects, namely obesity and high blood pressure (Konnikova, 2015). Impaired cognitive functions can lead to lackluster performance in academic coursework and reduced overall productivity.

Interestingly, researchers have found that many believe that they can function optimally with only five to six hours of sleep and often do not take steps to “catch up” on sleep or adjust their schedules to prioritize sleep over other activities (Konnikova, 2015). It has been determined that an individual who sleeps six hours a night for twelve consecutive days performs at the same mental and physical level as someone who has been awake for twenty-four hours or someone with the blood alcohol level of 0.1 percent (Konnikova, 2015).

Dr. Klerman at Brigham and Women’s Hospital conducted a study where participants could create their own sleep schedule for two weeks (Konnikova, 2015). She found that her participants slept on average twelve and a half hours per night, displaying severe sleep deprivation (Konnikova, 2015). These same participants admitted their sleepiness but believed that they were still able to perform optimally. This led to the conclusion that sleep deprived individuals are unable to realize that they are impaired after a couple of days of sleep loss (Konnikova, 2015). University students, seeing the majority fail to get enough sleep each night, systematically undervalue sleep and unwittingly compromise their health, mental acuity, and academic career in the process.

Empirical studies regarding consumers’ time allocation choices about sleep are limited (Biddle and Hamermesh, 1990). Time spent sleeping can consume up to twenty-nine to thirty-eight percent of an average adult’s day (Olson, 2016), yet little is known of the economic incentives that potentially influence the fluctuating durations of sleep among the adult subpopulations.

With the average college student getting 6 to 6.9 hours of sleep per night (University of Georgia, 2016), many are experiencing chronic sleep deprivation and stand to suffer several consequences from their lack of sleep: depressed immune system, weight gain, lower academic and athletic performances and stress.
According to Strahota (2015), seventy percent of college students work while enrolled, forty percent of undergraduates and seventy-six percent of graduate students work at least thirty hours per week, twenty percent of full-time college students also work full-time and nineteen percent of working learners have children. Additionally, the 2016 National Survey of Student Engagement (NSSE) found that students spend approximately fifteen hours per week preparing for their courses in addition to attending classes.

As a student myself, endeavoring to better understand what activities other learners prioritize over sleep is of great interest and can help indicate key stressors and their magnitude. University students are under immense pressure to find some semblance of balance between school-related commitments, work, extracurricular activities, community service, and personal time. By identifying these stressors, steps can be taken to address proper sleep hygiene and improve performance in university students.

**LITERATURE REVIEW**

Gary Becker (1965) pioneered the argument against traditional theory’s established understanding that households produce units and maximize utility under budget constraints. Households have discretionary control over consumption and their productivity is determined through the combined inputs of goods and time based on cost minimization rules.

Instead, Becker (1965) postulated that time spent producing in households is directly influenced by perceptions of commodities such as sleep and income generating activities, and budget constraints. An increase in wages leads to an increase in the value of time, therefore shifting consumers’ preference to allocate more time to work rather than sleep. He focused on the impact of forgone earnings due to educational attainment, impact of non-working time, and time spent on educational activities. The reallocation of time involved a shift in goods; decisions involving income effect and substitution effect become interrelated (Becker, 1965). Scholars, like Biddle and Hamermesh (1990), have used Becker’s theory of time allocation to better understand economic influences that drive people’s choices.

Though Biddle and Hamermesh (1990) did not use Becker’s model to analyze the impact of educational achievement in their study, they still retained a critical component of the theory: the impact of non-working time and income. Deciding to measure the effect of economic factors on sleep variation, they developed a study that took survey responses regarding reported time spent conducting various activities from over 700 individuals to discover whether sleep is truly under a person’s control or influenced by uncontrollable economic variables (Biddle and Hamermesh, 1990). Biddle and Hamermesh (1990) claim that time allocation decisions are an implicit response to changing economic and demographic incentives, varying with the changing price of time and utility of sleep. This leads to the conclusion that time allocation decisions are not separate from labor supply; demand for sleep is a function of wages and income. Individuals with higher expected wages sleep less as sleep yields utility not income (Biddle and Hamermesh, 1990).

The model that will be used in this study, derived from Biddle and Hamermesh (1990), involves many of the same independent variables. A significant portion of these variables identifies socioeconomic characteristics as potential influencers of choice. Biddle and Hamermesh (1990) included variables such as marital status, age, years of schooling, health, having children under the age of three, gender, religion, and race. Sleep has been found to be highly diverse and subjective based on these variables (Biddle and Hamermesh, 1990). Biddle and Hamermesh argued that these variables could impact the quality and quantity of sleep an individual gets.

This argument is supported by several studies. Research has found that multiracial individuals report higher rates of sleep variability than all other racial groups; the racial groups that experience the least amount of sleep complaints are Asians and Hispanics; individuals with low educational attainment sleep less than their highly-educated counterparts; those who struggle to maintain sustainable employment or have lower incomes report higher rates of sleep complaints; women have been found to sleep less than men, especially if they have children (Biddle and Hamermesh, 1990; Grandner et. al., 2010).
Grandner et. al. (2010) found that individuals lacking sustainable employment and income experience more sleep loss than those who have stable occupations. Interestingly, Biddle and Hamermesh (1990) found that when income is held constant, people with higher predicted wages sleep less because these individuals are more likely to substitute the commodity-like sleep with income generating activities. This substitution effect largely impacts men whereas women do not see a significant change in the value of their time (Biddle and Hamermesh, 1990).

Researchers have expended an immense amount of time and energy documenting studies regarding student academic achievement, productivity, time allocation and other variables. Consistent and adequate sleep has been found to be highly correlated to improved mental health, higher GPAs, and higher productivity (Fredriksen et. Al., 2004; Grave, 2010; Taylor, Vatthauer, Bramoweth, and Ruggero, 2013). Grave (2010) concluded that students who spent more time attending courses and engaging in self-study sessions achieved higher grades than students who allocated less time or those activities. The more students study and engage in their studies, the better they perform. However, does academic achievement still correlate positively with studying when sleep is sacrificed in the process?

Taylor et. al. (2013) and Fredrikson et. al. (2004) concluded that students engaged in consistent sleep durations for their age group perform better academically than their peers. Taylor et. al. (2013) saw that university students with inconsistent sleep schedules and later bedtimes had lower GPAs and academic performance. Fredrikson et. al. (2004) summarized from her sample of middle school students that less sleep is correlated with lower self-esteem, depression and lower grades.

With a significant portion of university students employed, it is important to examine if work interferes with academic success. Pipkin (1982) saw that there was no significant effect of part-time work on academic success, noting that the relationship was “benign”. However, Biddle and Hamermesh (1990) found that there is a significant relationship between hours spent working and time spent sleeping. For each additional hour of work, there was a thirteen-minute reduction in time slept. They used a time allocation study to understand if there was a direct economic factor, such as wage, in a person’s decision to allocate time between leisure, work, and sleep. Biddle and Hamermesh (1990) concluded that there was a significant substitution effect on sleep, especially for men.

With both the need to dedicate time to academic activities and work, this study is attempting to identify if university students are more influenced by the wage effect or by the pressure to forego present earnings for future income by studying.

**METHODOLOGY**

By using collected data from the consolidated 2003-2015 Multi-Year American Time Use Survey (ATUS), sponsored by the Bureau of Labor Statistics and conducted by United States Census Bureau, a multivariate regression model is constructed to understand the effect of working and engaging in educational activities has on the dependent variable (Y), sleep, and to determine if either independent variable carries a higher priority. Several control and dummy variables will be considered for the regression model: age, employment status (unemployed as default), highest educational attainment (undergraduate as default), gender (female as default), number of children, and race (nonwhite as default). Time spent sleeping is measured in weighted average minutes spent per day per respondent. This includes time reported as spent sleeping and napping. Time spent in educational activities is measured in weighted average minutes spent per day per respondent. This includes time reported as class time, doing homework, research and travel. Time spent in work-related activities is measured in weighted average minutes per day per respondent. This includes all work-related travel and income generating occupations.
The average number of minutes spent per day per respondent for the above activities is calculated from an equation recommended in the American Time Use Survey and is expressed as

\[
\bar{T}_j = \frac{\sum f_{wgt_i} I_{ij} T_{ij}}{\sum f_{wgt_i} I_{ij}}
\]

where \( T_{ij} \) is the average number of hours spent per day in activity \( j \), \( f_{wgt_i} \) is the final weight of the respondent \( i \) (this is calculate by the Census), \( T_{ij} \) is the amount of time spent in activity \( j \) by respondent \( i \), and \( I_{ij} \) is an indicator that equals one if the participant engaged in the activity and zero if they did not. This weight is used to reduce bias in sampling and response rates for population subgroups and time; all components are provided by the American Time Use Survey in the data sets. The weight is specifically for data compiled with the multi-year data.

From the American Time Use Survey’s sample size of 3,375 respondents per month, only individuals indicted as a full-time university student are considered for this data set. Any recordings conducted on a holiday or indicating missing information are discarded to avoid contaminating the study. This provides the study with over 1,300 observations.

With the intent to determine if full-time university students in the United States lose more sleep due to work-related activities or educational activities, this study repurposed the regression model used by Biddle and Hamermesh (1990) to express

\[
T_{sleep} = \beta_0 + \beta_1 T_{work} + \beta_2 T_{education} + \alpha X + \epsilon
\]

where \( T_{sleep} \) is weighted average daily minutes spent sleeping, \( T_{work} \) is weighted average daily minutes spent working, \( T_{education} \) is weighted average daily minutes spent participating in educational activities and \( X \) is the vector of control and dummy variables, accounting for a total of eight independent variables.

**DATA SOURCE**

The data used for this research is obtained from the 2003-2015 Multi-Year American Time Use Survey (ATUS). The American Time Use Survey User’s Guide provides the following information in this section for 2003 to 2015. The survey interviews used Computer Assisted Telephone Interview Technology to conduct phone interviews with participants; interviews were conducted based on the participant’s assigned day of the week. The participants were required to report activities from the last twenty four-hour period and whom they were with during that time frame. Each activity was assigned a six-digit code to be classified in the ATUS system. These activities can range from paid work, religious studies, socializing, exercising, and relaxing. The ATUS recorded what participants stated as their primary activity for the listed time.

The results from the survey are available in the ATUS website in downloadable data packages. The participants in the study are randomly selected individuals. They are selected each month from the Current Population Survey (CPS) pool. These individuals are fifteen years or older and have completed eight prior interviews issued by the CPS. In the selection process, participants are stratified based on race/ethnicity, presence and age of children, and number of adults in the household.

The interview is conducted in both English and Spanish. The ATUS consists of five topics: household roster, time diary, summary questions, eldercare, and questions related to the CPS interviews. Eldercare questions were included in the survey to help collect data relevant to developing policies for the elderly population. Participants were not specifically instructed on how to record their daily activities before the interview. During the interview, the prompters inquired about the participant’s previous daily activities, who verbally answered to the best of their ability as the prompter recorded the answers electronically into a database.

The codes used for the time diary categorization are available in the ATUS dictionary. The ATUS data files include information about each participant’s demographic, time diary, call history, and responses to interview questions. The specific files that are used are the Respondent file (includes information regarding income and employment status), Roster file (includes age and sex of respondent), and Activity Summary file, (included final weighted summary of each participant’s time diary activities). The recorded times are in weighted minutes to help offset the effects of changing timeframes and different reporting schedules for the participants.
DESCRIPTIVE STATISTICS

The following tables outline the descriptive statistics for the following variables: total time spent sleeping, total time spent working, and total time spent in educational activities.

<table>
<thead>
<tr>
<th>Total Weighted Average Time Spent Sleeping</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>in Minutes per Day</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>486.44</td>
</tr>
<tr>
<td>Median</td>
<td>480.00</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>123.14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Weighted Average Time Spent Working</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>in Minutes per Day</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>124.99</td>
</tr>
<tr>
<td>Median</td>
<td>0.00</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>194.91</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Weighted Average Time Spent Educational Activities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>in Minutes per Day</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>227.96</td>
</tr>
<tr>
<td>Median</td>
<td>192.00</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>139.62</td>
</tr>
</tbody>
</table>

Figure 1 shows a frequency distribution for the dependent variable that is heavily skewed to the right. Many of the observations fall between 500 and 600 minutes. The peak range of time spent sleeping per day is 400 to 500 minutes. Figure 2 is heavily skewed to the left, indicating that most students surveyed are unemployed or were not working at the time of data collection. Figure 3 indicated that there is a left skew to the data with the peak time spent in class or other educational activities being between 200 to 300 minutes per day.

The average age of the surveyed students is twenty-seven years old. Most the participants were white, male, earning their bachelors or associates degree, and unemployed. Of the students surveyed, 227 worked part-time. The median weekly wage was $109.

RESULTS

In first conducting the OLS regression analysis, the results determined that changes in average time spent in educational activities is significant to changes in average time spent sleeping. This indicates that the primary independent variable is significant in the regression and follows an inverse relationship with allocated time for sleeping. These results are displayed in Table 1. A multiple regression was conducted with the other variables and produced the results in Table 2.

Of the variables, time spent working and time spent studying or in class are the most critical to the study. The regression found that both variables had a significant negative relationship with sleep and, interestingly, it is determined that students are more likely to sacrifice sleep for work-related activities. However, the difference in the amount of sleep lost for every additional minute of activity does not vary significantly between the two variables; students lose 12.96 minutes of sleep for every hour spent working and lose 11.52 minutes of sleep for every hour spent in class or studying. Regardless, this is evidence indicating that students prioritize work over their education as predicted by the substitution effect mitigating a student’s need to study, as Biddle and Hamermesh (1990) would suggest.

Weekly earnings were not included in this model due to the lack of diversity in wages. There was significant multicollinearity between time spent working and weekly earnings. Since most college students hold jobs that only pay minimum wage, reported earnings could have reduced variability. This lack of wage diversity could account for the regression’s inability to determine true economic significance of weekly earnings. Based on previous research and results from Biddle and Hamermesh’s (1990) study, there should be a significant substitute effect in an individual’s decision to allocate time. Income being a significant factor to one’s ability to sleep without interruptions or variability is also supported by medical studies (Grandner et. al., 2010). This study could not accurately determine if weekly earnings influenced time.
allocation decisions involving sleep for university students. Therefore, this variable was removed from the finalized data set.

Table 3 reports the findings of Biddle and Hamermesh’s 1990 study. As this regression model is derived from Biddle and Hamermesh’s 1990 study, it is important to note key differences in the regression models. This regression model excluded the following independent variables that were utilized in Biddle and Hamermesh’s model: years married, age squared, condition of health, and religious affiliation. These exclusions were due to lack of information available in the surveys to adequately define these variables. The 2003-2015 Multi-Year Time Use Survey did not collect information regarding, number of years married or religious affiliation. Additionally, individuals’ health statuses were not collected consecutively each survey year, only having available data for 2010 to 2013.

Biddle and Hamermesh (1990) found that an individual’s allocated time at work, gender, and religious affiliation were significant for all respondents. Number of years married, time spent at work were significant for women while work time and years of schooling were significant variable for men.

In attempt to explain deviations in results in this study to Biddle and Hamermesh’s 1990 study, a White test for heteroscedasticity was conducted and was followed by a robust standard deviation regression. The results are displayed in Table 4, Figure 4, and Table 5.

Table 4 and Figure 4 indicates that there is significant heteroscedasticity in the data. Therefore, a robust standard deviation regression is conducted. The results are displayed in Table 5.

Though the significance and coefficient of each variable did not change, the standard errors of the variables decreased, therefore reducing the impact of heteroscedasticity on the model and marginally adjusting the p-value for some variables.

Additionally, a regression was conducted to determine if the release of the smartphone in 2007 contributed to poor sleep hygiene. However, results showed that these dummy variables were insignificant. This can be the result of how the data was collected during the survey and can exemplify the individual bias and unknowing adjustments in reporting primary activities. Additionally, the data available prior to the release of the smartphone is limited to 2003 to 2006; therefore, reducing the effectiveness of trend analysis regarding this issue.

Overall, this study’s model produced models with an adjusted R² that was marginally higher than Biddle and Hamermesh’s 1990 study. The variance inflation factors for the regression model’s variables were below four and did not indicate any issues of multicollinearity.

**Conclusion**

The result of the study indicates that students, when having to make decisions regarding time allocation between working and classwork, are placing a higher priority on working than their education. Students lose twelve minutes of sleep for every additional hour they spend studying or in class in contrast to sacrificing thirteen minutes of sleep for every additional hour spent working. This rate of sleep loss is significant to the student population because sleep is integral to academic performance. The more sleep students lose to complete their academic or work obligations, the more likely they are underperforming in the classroom.

The impact time spent working has on sleep must not be overlooked. A thirteen-minute reduction in time spent sleeping for every additional hour spent working is substantial. The inherent consequences of sleep loss are numerous, though none so devastating for universities as lower overall academic performance.

Since sleep plays such a key role in a person’s ability to perform well and generates efficient products in the academic and economic ecosystem, an apparent sleepless generation would present a problem to such institutions. According to Hershner and Chervin (2014), students who obtained more sleep have higher GPAs than others (individuals who slept for six or less hours) with GPAs being 3.24 versus 2.74 on average, respectively.

Higher education institutions, especially universities relying on state subsidies, depend on their performance numbers (first-year retention rate, graduation rate, and placement rates) to maintain or grow their share of their state’s instructional subsidy pie. With state universities facing competition from private universities, two-year colleges, technical institutions, and community colleges, the amount of funding available from the state becomes smaller and smaller each year. By presenting numbers that result with favorable graduation and placement
rates of students, a university can improve its share of subsidies from the state.

Sadly, there are few published studies that provide evidence of successful intervention programs for improving sleep hygiene. Studies have found that adequate sleep knowledge does not necessarily smoothly translate into practice (Hershner and Chervin, 2014). Additionally, some sleep hygiene recommendations, such as a quiet environment and use of the bedroom only for sleep, may be challenging to provide in college dormitories. However, one educational campaign with a focus on sleep hygiene included a “Go to Bed” poster, a two-page “Snooze letter”, and other sleep educational material found that nine percent of students reported earlier bedtime, shorter sleep latency, longer sleep duration, and improved sleep quality (Hershner and Chervin, 2014). This intervention did not affect a large percentage of the student population; however, it was relatively inexpensive and did produce a measurable benefit.

Educational courses on sleep hygiene have produced meaningful results in improving sleep quality in students. Participants involved in a thirty-minute oral presentations and handouts on various aspects of sleep, showed improved sleep quality and sleep hygiene as fifty-five percent reported a change in their sleep hygiene as compared to forty-five percent of control students (Hershner and Chervin, 2014). However, these interventions are not practical at a university scale as only a limited number of student will be impacted by the course and the intervention may be costly and time consuming (Hershner and Chervin, 2014).

There can be a possibility of a viable intervention technique through changing class schedules and times. Later school start times have been noted to increase total sleep duration, attention, and academic performance, but this study has yet to be replicated with college students (Hershner and Chervin, 2014).

Overall, it is evident that students face significant economic influencers in their time allocation decision that cause them to choose other activities over sleep, an activity critical for optimal academic and work performance.

LIMITATIONS

This research is not without its limitations. The consequence of using multi-year data from the American Time Use Survey is having several variables such as condition of health and religious affiliation omitted from the regression equation. Future studies can look to expand the number of variables in the model that can improve this metric. Additionally, supplemental research can be done to distinguish how the coefficients change when the sample is divided into subgroups based on certain demographics. A trend analysis investigating the impact of smartphones, smart technology, social media, and other entertainment outlets on sleep would be enriching to this study.

The American Time Use Survey also described several limitations in their data collection. The survey admits to possible individual selective bias in its data sets as participants could have reported data that was incomplete, incorrect, or unknowingly adjusted. Additionally, the survey did not consider time used for multitasking and only recorded the primary activity for each time frame.
**FIGURES AND TABLES**

**Figure 1: Total Weighted Average Time Spent Sleeping in Minutes per Day**

**Figure 2: Total Weighted Average Time Spent Working in Minutes Per Day**

**Figure 3: Total Weighted Average Time Spent in Educational Activities in Minutes per Day**

---

**Table 1**

**OLS Regression Results**

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant</strong>*</td>
<td>513.359</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Total Time in Educational Activities</strong>*</td>
<td>-0.118</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Adjusted R-squared</strong></td>
<td>0.0172</td>
<td></td>
</tr>
</tbody>
</table>

---

**Table 2**

**Multiple Regression Results**

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant</strong>*</td>
<td>611.184</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Total Time in Work-Related Activities</strong>*</td>
<td>-0.214</td>
<td>0.000</td>
</tr>
</tbody>
</table>
Table 3  
Biddle and Hamermesh (1990) 1975-76 Time Use Parameter Results

<table>
<thead>
<tr>
<th></th>
<th>All Respondents</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>P-Value</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Work Time</td>
<td>-0.199</td>
<td>0.000</td>
<td>-0.219</td>
</tr>
<tr>
<td>Married</td>
<td>16.04</td>
<td>0.383</td>
<td>-43.15</td>
</tr>
<tr>
<td>Years Married</td>
<td>-2.59</td>
<td>0.213</td>
<td>2.43</td>
</tr>
<tr>
<td>Age</td>
<td>1.86</td>
<td>0.395</td>
<td>24.52</td>
</tr>
<tr>
<td>Age Squared</td>
<td>0.02</td>
<td>0.395</td>
<td>-0.26</td>
</tr>
<tr>
<td>Years of Schooling</td>
<td>-14.3</td>
<td>0.041</td>
<td>-18.28</td>
</tr>
<tr>
<td>Male</td>
<td>99.42</td>
<td>0.016</td>
<td></td>
</tr>
<tr>
<td>Excellent or Good Health</td>
<td>-94.16</td>
<td>0.112</td>
<td>-123.79</td>
</tr>
<tr>
<td>Children &lt; 3 Years Old Protestant</td>
<td>-35.42</td>
<td>0.327</td>
<td>39.03</td>
</tr>
<tr>
<td>Black</td>
<td>-69.17</td>
<td>0.276</td>
<td>-110.65</td>
</tr>
<tr>
<td>Adjusted R^2</td>
<td>0.141</td>
<td></td>
<td>0.176</td>
</tr>
</tbody>
</table>

Table 4  
White Test Results

H0: homoscedasticity
Against Ha: unrestricted heteroscedasticity

Chi2(40) = 72.34
Prob>chi2 = 0.0013

<table>
<thead>
<tr>
<th>Source</th>
<th>Chi2 (df)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heteroscedasticity</td>
<td>72.34 (40)</td>
<td>0.001</td>
</tr>
</tbody>
</table>
Skewness 6.40 (8) 0.602
Kurtosis 9.98 (1) 0.001
TOTAL 88.72 (49) 0.004

Cameron and Trivedi’s decomposition of IM Test

Figure 4

RVF Plot

Table 5
Robust Multiple Regression Results

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant***</td>
<td>611.184</td>
<td>0.000</td>
</tr>
<tr>
<td>Total Time in Work-Related Activities***</td>
<td>-0.214</td>
<td>0.000</td>
</tr>
<tr>
<td>Number of Children*</td>
<td>-5.325</td>
<td>0.065</td>
</tr>
<tr>
<td>Total Time in Educational Activities***</td>
<td>-0.192</td>
<td>0.000</td>
</tr>
<tr>
<td>Employed</td>
<td>2.251</td>
<td>0.779</td>
</tr>
<tr>
<td>Male</td>
<td>1.677</td>
<td>0.798</td>
</tr>
<tr>
<td>Age***</td>
<td>-1.560</td>
<td>0.000</td>
</tr>
<tr>
<td>White</td>
<td>-10.701</td>
<td>0.151</td>
</tr>
<tr>
<td>Graduate</td>
<td>-6.399</td>
<td>0.416</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.142</td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


