# TABLE OF CONTENTS

## Volume 1    Number 2    August 2010

**The Effects of Low Cost Airlines Growth in Italy**  
D. Campisi, R. Costa, P. Mancuso ........................................................................................................................................................................59

**The Poolean Consensus Model: The Strategic Scope of Monetary Policy**  
F. L. Sell, B. Sauer, M. Wiens ........................................................................................................................................................................68

**How to Reap the Induced Technological Bonus? A Mechanism and Illustrative Implementation**  
G. G. Das ........................................................................................................................................................................................................80

**An Inflation Targeting Regime in Egypt: A Feasible Option?**  
T. Ghalwash ..................................................................................................................................................................................................89

**Environmental Standards and Trade Volume**  
N. Mangee, B. Elmslie ..................................................................................................................................................................................................100

**A Modified Consumer Price Index**  
G. L. Yuan, X. R. Li ...................................................................................................................................................................................................112

**Research on the Relationship between Foreign Trade and the GDP Growth of East China**  
—Empirical Analysis Based on Causality  
Y. H. Li, Z. W. Chen, C. J. San ................................................................................................................................................................................................118

**Forecasting Model of Automobile Loan Based on Conditional Expectation**  
L. Sun, D. R. Tan, Y. Q. Nie ................................................................................................................................................................................................125
Modern Economy (ME)

Journal Information

SUBSCRIPTIONS


Subscription rates:
Print: $50 per issue.
To subscribe, please contact Journals Subscriptions Department, E-mail: service@scirp.org

SERVICES

Advertisements
Advertisement Sales Department, E-mail: service@scirp.org

Reprints (minimum quantity 100 copies)
E-mail: sub@scirp.org

COPYRIGHT

Copyright©2010 Scientific Research Publishing, Inc.

All Rights Reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, scanning or otherwise, except as described below, without the permission in writing of the Publisher.

Copying of articles is not permitted except for personal and internal use, to the extent permitted by national copyright law, or under the terms of a license issued by the national Reproduction Rights Organization.

Requests for permission for other kinds of copying, such as copying for general distribution, for advertising or promotional purposes, for creating new collective works or for resale, and other enquiries should be addressed to the Publisher.

Statements and opinions expressed in the articles and communications are those of the individual contributors and not the statements and opinion of Scientific Research Publishing, Inc. We assumes no responsibility or liability for any damage or injury to persons or property arising out of the use of any materials, instructions, methods or ideas contained herein. We expressly disclaim any implied warranties of merchantability or fitness for a particular purpose. If expert assistance is required, the services of a competent professional person should be sought.

PRODUCTION INFORMATION

For manuscripts that have been accepted for publication, please contact:
E-mail: me@scirp.org
The Effects of Low Cost Airlines Growth in Italy

Domenico Campisi, Roberta Costa, Paolo Mancuso

Department of Business Engineering, University of Rome Tor Vergata, Via del Politecnico, Rome, Italy
E-mail: costa@disp.uniroma2.it

Received May 19, 2010; revised June 28, 2010; accepted July 5, 2010

Abstract

In recent years, low cost carriers (LCCs) have been the fastest growing sector of the aviation industry. The routes served by these carriers were undersized in comparison with principal routes, but deregulation made possible an efficient access to many new markets. The new generation of regional and low cost carriers have enabled a better matching of capacity to demand on routes previously served solely by large airlines, experiencing an increasing role in spatial development. Regional airports impact on local economies directly as a catalyst for other on-site economic activities and indirectly as a regional economic multiplier. This paper analyses the relation between LCC passenger traffic, secondary airports utilization and regional economic development. We underline that increased service at Italian secondary airports could affect economic development in the surrounding regions, including increased tourism and the potential for cluster development.

Keywords: Low Cost Airlines, Regional Economic Development, Secondary Airports

1. Introduction

In the present difficult situation for European aviation, one sector is performing relatively well, the so-called low cost carriers (LCCs). While flag-carriers are experiencing a severe crisis, withdrawing from routes and cutting staff, the low cost sector is expanding at a steady rate. There is concrete evidence that the LCCs could even become dominant players on a significant number of intra-European short-haul and point-to-point routes. For this reason, the European industry and policy makers are questioning and investigating the extent to which the expansion of the LCCs will affect the traditional airline, characterized by hub-and-spoke networks. It is undeniable that airline deregulation has brought better service at lower prices to the majority of the population and that LCCs are the driving force behind the benefits of airline deregulation. It was frequently observed that when a new LCC enters a market, airfares drop [1].

In Europe, the experience of LCCs began in 1991 when the Irish carrier Ryanair transformed itself from a conventional regional airline into a carbon copy of the US low cost pioneer Southwest Airlines. At first, Ryanair focused on the large leisure market between Ireland and UK and in this phase the airline had a striking effect on services across the Irish Sea. After, Ryanair growth was the consequence of the strategic building of a network of intra-EU routes linking London’s third airport, Stansted, with over 50 under-utilized secondary airports located in a large number of countries. This strategy made Ryanair one of the largest LCC in Europe. The second case of success in the European LCCs was represented by EasyJet, established in 1995, after the acquisition of its rival Go, a British Airways offshoot. Several other LCCs have also been established as a reaction to these successful cases, including Buzz and Bmibaby in the UK, Virgin Express in Belgium, Transavia and Germanwings in Germany. LCCs have surely enabled a better matching of capacity to demand on routes previously served solely by large airline companies. Their appearance determined a rapid decreasing of airfares and determined the financial crisis of a large number of airline companies [2]. Moreover, these carriers have been experiencing an increasing role in spatial development [3]. Regional airports impact on local economies both directly as a catalyst for other on-site economic activities and indirectly as a regional economic multiplier [4]. This paper first look at the relation between LCC passenger traffic, secondary airports utilization and regional economic development, then it underlines how the introduction of LCC service to previously under-served secondary airports affect the economic development in the surrounding Italian regions, including increased tourism and the potential for cluster development. In recent years, theoretical and empirical studies have identified significant changes in the distinctive characteristics of clusters and their evolutionary stages. The development of cluster competitive-
ness is a function of different traits that from time to time have characterized their evolution [5]. We will try to identify in which cases the increased service at Italian secondary airports, that affected economic development in the surrounding regions, could possibly favour a cluster development.

2. The Market of Low Cost Carriers

In order to analyze the LCC structure and strategy and to investigate the real profitability and sustainability of the LCC business model, we adopted the Structure-Conduct-Performance (SCP) paradigm [6]. The SCP approach links elements of market structure to business conduct and performance in industrial economics. In this model, the market structure (Structure) is defined mainly by market concentration, number of firms and vertical integration. The behaviour of firms (Conduct), that could be collusive or competitive, depends strictly on pricing, cost structure of the firms, choice of technology, R & D, advertising, entry barriers, etc. Performance is mainly defined by the extent of the firm’s market power and it is measured by profitability, price level and efficiency.

The sample analyzed is formed by 15 LCCs (Table 1) and is representative of LCCs that serve routes to and from Italy. In our sample the competition is played between carriers in the European market, since they serve only intra-European routes on short and medium distances. The LCCs were chosen according to the STAT-FOR documents of Eurocontrol (European Organization for the Safety of Air Navigation) [7] and they represented in 2005 about the 70% of the European LCCs, corresponding to the 80% of the passenger traffic generated by LCCs in Italy.

**Table 1. LCC passenger traffic in 2005 (to and from Italy).**

<table>
<thead>
<tr>
<th>Low cost airlines</th>
<th># passengers</th>
<th>market share si</th>
</tr>
</thead>
<tbody>
<tr>
<td>Itali Airlines</td>
<td>113 075</td>
<td>0.18%</td>
</tr>
<tr>
<td>SkyEurope</td>
<td>171 000</td>
<td>0.28%</td>
</tr>
<tr>
<td>Lauda Air</td>
<td>386 177</td>
<td>0.63%</td>
</tr>
<tr>
<td>Blue Air</td>
<td>443 500</td>
<td>0.72%</td>
</tr>
<tr>
<td>Bmibaby</td>
<td>821 000</td>
<td>1.34%</td>
</tr>
<tr>
<td>Eurofly</td>
<td>1 108 291</td>
<td>1.81%</td>
</tr>
<tr>
<td>Volare Web</td>
<td>1 873 429</td>
<td>3.05%</td>
</tr>
<tr>
<td>Hapag Lloyd</td>
<td>1 950 000</td>
<td>3.18%</td>
</tr>
<tr>
<td>Germanwings</td>
<td>2 395 000</td>
<td>3.90%</td>
</tr>
<tr>
<td>Sterling Airlines</td>
<td>2 455 000</td>
<td>4.00%</td>
</tr>
<tr>
<td>Virgin Express</td>
<td>2 533 000</td>
<td>4.13%</td>
</tr>
<tr>
<td>Flybe</td>
<td>3 386 000</td>
<td>5.52%</td>
</tr>
<tr>
<td>Transavia</td>
<td>4 210 000</td>
<td>6.86%</td>
</tr>
<tr>
<td>EasyJet</td>
<td>18 153 000</td>
<td>29.58%</td>
</tr>
<tr>
<td>Ryanair</td>
<td>21 372 000</td>
<td>34.82%</td>
</tr>
<tr>
<td>Total</td>
<td>61 370 472</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: Eurocontrol, IATA, ICAO, LCC websites, 2006

As stated before, the Structure of a market is described by market concentration that is a function of the number of firms in a market and their respective market shares. We apply the Herfindahl-Hirschman Index (HHI) (1) to the LCC market shares (Table 1) in order to determine market concentration in the LCC market.

\[
HHI = \sum_{i} s_i^2 \geq 0.22 > \frac{1}{N} = \frac{1}{15} = 0.07
\]

All the data analysed are from Eurocontrol, IATA (International Air Transport Association) and ICAO (International Civil Aviation Organization) and they refer to the year 2005 [7-9].

From the analysis of the sample, we observe an evident disparity in the dimension of the LCCs and the presence of a great concentration in the LCC market. In fact, the market is constituted by a small number of large companies (Ryanair, Easyjet) with a combined market share exceeding 50% and a large number of small and medium companies characterized by a market share from 7% to less than 1%

Conduct represents the behaviour of firms in the market and it is highly influenced by the market demand. It is well-known that the market demand determines, in periods of economic uncertainty, the change of structure and intensity of competition in the airline sector. This is one of the many factors that caused the LCC success in the last decades. Under this aspect, we have to consider that the segmentation of the air travel demand, into business and leisure travellers, influences greatly airline pricing. Business travellers are less price sensitive, require more flexibility to change travel arrangements and are willing to pay much higher prices than leisure travellers. On the contrary, leisure travellers are usually considered to be price sensitive and, in their market segment, airlines can increase revenues by lowering prices [10]. As a consequence, many carriers have adopted a differential pricing: low-fares are targeted at leisure travellers to fill seats that would otherwise go empty. The pricing structure is preserved by applying constrains to low-fares making them unfeasible to business travellers (i.e. pre-booking periods) [11]. Concentrating their efforts on non-business travels LCCs have, in the last years, conquered a large part of the leisure market, especially on short routes.

From 1995 to 2006, LCCs registered a 45% growth of the weekly seats (Figure 1) and more important is the constant increase of ASKs [12], that is the number of seats available for passengers multiplied by the number of kilometres those seats are flown. LCC share of the overall European ASKs has grown about 640% since 1997 and LCCs are capturing a steadily growing share of the European market. It is important to point out that the growth of the LLC demand continued to go on after September 11th, whereas full cost air companies faced severe crisis. Besides, many organization as IATA and ICAO consider a great part of LCC market to be a newly
generated market.

As Conduct we intend also all the management peculiarity that are proper of LCCs. The business model of LCCs has a direct impact on their cost structure and consequently on the pricing strategies and revenues. In Table 2 are described the main aspects that distinguish low cost and full cost carriers, explaining the respective strategies of the two in their respect [13].

Table 2. The business model of low cost and full cost carrier.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Low Cost Carriers</th>
<th>Full Cost Carriers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brand</strong></td>
<td>One (low-fare) brand</td>
<td>Extensions: fare+service</td>
</tr>
<tr>
<td><strong>Fares</strong></td>
<td>Simplified fare structure</td>
<td>Complex fare structure</td>
</tr>
<tr>
<td><strong>Distribution</strong></td>
<td>Online and call centres</td>
<td>Online, direct, travel agent</td>
</tr>
<tr>
<td><strong>Airports</strong></td>
<td>Secondary (mostly)</td>
<td>Primary</td>
</tr>
<tr>
<td><strong>Connections</strong></td>
<td>Point-to-point</td>
<td>Interlining, hub and spokes</td>
</tr>
<tr>
<td><strong>Class segmentation</strong></td>
<td>One class (high density)</td>
<td>Two class</td>
</tr>
<tr>
<td><strong>Aircraft utilisation</strong></td>
<td>Very high</td>
<td>Medium to high</td>
</tr>
<tr>
<td><strong>Turnaround time</strong></td>
<td>25 min turnarounds</td>
<td>Low turnaround</td>
</tr>
<tr>
<td><strong>Product</strong></td>
<td>One product: low fare</td>
<td>Multiple integrated products</td>
</tr>
<tr>
<td><strong>Aircraft</strong></td>
<td>Single type: commonality</td>
<td>Multiple types: Scheduling complexities</td>
</tr>
<tr>
<td><strong>Seating</strong></td>
<td>Small pitch, no assignment</td>
<td>Generous pitch, offers seat assignment</td>
</tr>
<tr>
<td><strong>Customer service</strong></td>
<td>Generally under performs</td>
<td>Full service, reliability</td>
</tr>
<tr>
<td><strong>Operational activities</strong></td>
<td>Focus on core (flying)</td>
<td>Extensions: e.g., maintenance, cargo</td>
</tr>
</tbody>
</table>

Source: O’Connell and Williams, 2005
with respect to the cost per ASK. In Figure 2 is clearly depicted as this difference decreases with the length of the flight (sector length). The reducing cost advantage, occurring with the increasing sector length, is due mainly to a decreasing acceptance of lack of service by passengers and an increasing revenue need in LCCs. Focusing on a sector length of 1,500 Km, the ICAO estimated the LCC cost advantage as: 30% on total crew costs, 5% on landing and handling charges, 50% on passenger related costs, 70% on sales costs and 60% for other costs [14].

To measure Performance is to measure the results of a firm in terms of productivity and profitability. Since the LCC model derives competitive advantage from a greater aircraft productivity and a more efficient cost structure, the performance of LCCs in 2005 is analysed by means of profitability and efficiency indexes. We choose three profitability indexes: ROI (Return on Investment), ROS (Return on Sales), ROE (Return on Equity). While we consider the Load Factor of LCCs as the efficiency index. The analysis evidences the existence of a small number of large LCCs that gained a high profitability, while a great number of medium and small carriers faced economic and financial difficulties (Table 3). The bad performance of smaller LCCs is motivated by an inefficient management of their operating costs, that is a dangerous deficiency while adopting the LCC business model. Volare Web performed the worst ROS, because the operative costs are one and half greater than the revenues of this LCC. This result reflects the financial problem faced by Volare Web that conducted the company to a controlled administration in order to avoid bankrupt, followed by its acquisition by the Alitalia Group.

Figure 3 depicts the average value of each profitability index for: 1) large airline companies (more than 3 millions passenger traffic), and 2) small and medium airline companies (less than 3 millions passenger traffic). Volare Web was not considered because of the severe financial crisis. There is an evident gap between the two groups in all the profitability indexes, more so for the ROS index: that confirms the difficulty of smaller and medium LCCs to manage operating costs in accord to the LCC business model. The last performance index is a very important one in the LCC philosophy. The Load Factor is the percentage of seats filled with passengers: it indicates that an airplane is more efficiently utilized, lowering the operating costs and, as a result, the airfares. A good Load Factor assures the necessary utilization and productivity of critical LCC resources: personnel and aircrafts.

Figure 4 represents the Load Factors of the sample in 2005: the average value of this index is 75%. An half of the sample has a Load Factor better than the average value and from Figure 5 it is evident that there is a correlation between a good financial performance (ROS) and a high Load Factor: only those carriers that are operatively efficient have financial success in the long run.

Table 3. Low cost airlines: ROI, ROS, ROE (2005).

<table>
<thead>
<tr>
<th>Low cost carriers</th>
<th>ROI</th>
<th>ROE</th>
<th>ROS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Air</td>
<td>3.47%</td>
<td>0.00%</td>
<td>1.48%</td>
</tr>
<tr>
<td>Bmibaby</td>
<td>−1.64%</td>
<td>−10.00%</td>
<td>−1.05%</td>
</tr>
<tr>
<td>EasyJet</td>
<td>3.74%</td>
<td>4.43%</td>
<td>4.37%</td>
</tr>
<tr>
<td>Eurofly</td>
<td>−4.65%</td>
<td>−10.27%</td>
<td>−6.59%</td>
</tr>
<tr>
<td>Flybe</td>
<td>1.04%</td>
<td>3.14%</td>
<td>−5.28%</td>
</tr>
<tr>
<td>Germanwings</td>
<td>5.72%</td>
<td>18.51%</td>
<td>2.38%</td>
</tr>
<tr>
<td>Hapag Lloyd</td>
<td>9.09%</td>
<td>0.00%</td>
<td>3.61%</td>
</tr>
<tr>
<td>Itali Airlines</td>
<td>−0.47%</td>
<td>0.59%</td>
<td>−0.94%</td>
</tr>
<tr>
<td>Lauda Air</td>
<td>3.75%</td>
<td>5.16%</td>
<td>4.57%</td>
</tr>
<tr>
<td>Ryanair</td>
<td>10.68%</td>
<td>19.28%</td>
<td>31.28%</td>
</tr>
<tr>
<td>SkyEurope</td>
<td>−0.52%</td>
<td>−7.46%</td>
<td>−1.03%</td>
</tr>
<tr>
<td>Sterling Airlines</td>
<td>−7.27%</td>
<td>−3.45%</td>
<td>−10.99%</td>
</tr>
<tr>
<td>Transavia</td>
<td>3.20%</td>
<td>7.38%</td>
<td>4.10%</td>
</tr>
<tr>
<td>Virgin Express</td>
<td>−8.98%</td>
<td>n.d.</td>
<td>−7.73%</td>
</tr>
<tr>
<td>Volare Web</td>
<td>−4.50%</td>
<td>−37.02%</td>
<td>−66.81%</td>
</tr>
</tbody>
</table>
Positions of Ryanair and Volare Web are not a surprise as the first is a best practice of LCCs and the second had very serious financial problems.

3. Low Cost Carriers, Regional Airports and Geographic Clusters

Aviation policy makers are facing several issues connected with the growth of LCCs. Among them there is the necessity to mitigate the environmental effects of this expansion, especially at secondary airports, since a great part of LCCs tend to select routes between regional airports. As a consequence, these airports are confronted with a rapidly increasing traffic, that requires large capital expenditure for infrastructure investments. The positive aspect of decentralization from main routes is economic regional development. Regional and secondary airports impact on local economies directly as a catalyst for other on-site economic activities and indirectly as a regional economic multiplier. Moreover, congestion at the major hubs can be lessened by developing secondary hubs: alternative airports around the main urban environment. These are typically remote from the city centre, with plentiful capacity but little traditional scheduled air service. Advantages in terms of lack of congestion, and consequently of pollution, are set against disadvantages in terms of surface access. In Italian airports this phenomenon is clearly observable from Table 4: data on passenger traffic are reported for each Italian airport and it is clearly visible the rapid traffic growth of smaller and regional airports with respect to principal ones [15].

The consistent increase in passenger traffic in regional airports is due mainly to the diffusion and success of LCCs that, in choosing secondary airports as their bases, determined the economic and traffic growth of regional airports.

In order to analyse this phenomenon in the Italian scenario, we considered only those regional and secondary airports that are utilized by the LCCs of the sample and the number of routes they operate on (Table 5).
Some LCCs are not present in Table 5 (i.e. EasyJet) because they operate in primary airports.

The more promising type of regional economic development that could directly benefit from increasing passenger throughput at secondary airports is “cluster development”. While the idea of the “cluster”, first put forward by Michael Porter, has attracted some criticism, it is worth considering whether geographic proximity to a rapidly-growing airport could enhance the growth and knowledge spillovers of local industries [4]. Following this lead, we analyse traffic growth and accessibility (Table 6) of secondary airports served by the sample of LCCs under study.

### Table 4. Italian airports: passenger traffic growth.

<table>
<thead>
<tr>
<th>Airports</th>
<th>Passengers 2000</th>
<th>Passengers 2006</th>
<th>Increase from 2000 to 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alghero</td>
<td>664 330</td>
<td>1 079 843</td>
<td>62.55%</td>
</tr>
<tr>
<td>Ancona</td>
<td>433 729</td>
<td>485 929</td>
<td>12.04%</td>
</tr>
<tr>
<td>Bari</td>
<td>1 251 682</td>
<td>1 659 323</td>
<td>32.57%</td>
</tr>
<tr>
<td>Bergamo</td>
<td>1 241 138</td>
<td>4 356 143</td>
<td>250.98%</td>
</tr>
<tr>
<td>Bologna</td>
<td>3 524 789</td>
<td>3 690 953</td>
<td>4.71%</td>
</tr>
<tr>
<td>Bolzano</td>
<td>70 124</td>
<td>68 103</td>
<td>35.87%</td>
</tr>
<tr>
<td>Brescia</td>
<td>164 804</td>
<td>409 940</td>
<td>148.74%</td>
</tr>
<tr>
<td>Brindisi</td>
<td>614 140</td>
<td>794 378</td>
<td>29.35%</td>
</tr>
<tr>
<td>Cagliari</td>
<td>2 067 116</td>
<td>2 355 796</td>
<td>13.97%</td>
</tr>
<tr>
<td>Catania</td>
<td>3 970 754</td>
<td>5 192 697</td>
<td>30.77%</td>
</tr>
<tr>
<td>Crotone</td>
<td>53 275</td>
<td>85 221</td>
<td>59.96%</td>
</tr>
<tr>
<td>Cuneo</td>
<td>16 492</td>
<td>18 942</td>
<td>14.86%</td>
</tr>
<tr>
<td>Firenze</td>
<td>1 521 272</td>
<td>1 703 303</td>
<td>11.97%</td>
</tr>
<tr>
<td>Foggia</td>
<td>30 297</td>
<td>7 709</td>
<td>–74.56%</td>
</tr>
<tr>
<td>Forlì</td>
<td>45 933</td>
<td>565 341</td>
<td>1130.79%</td>
</tr>
<tr>
<td>Genova</td>
<td>1 063 146</td>
<td>1 013 288</td>
<td>–4.69%</td>
</tr>
<tr>
<td>Lamezia Terme</td>
<td>785 060</td>
<td>1 163 121</td>
<td>48.16%</td>
</tr>
<tr>
<td>Milano LIN</td>
<td>6 026 342</td>
<td>9 088 607</td>
<td>50.81%</td>
</tr>
<tr>
<td>Milano MXP</td>
<td>20 716 815</td>
<td>19 630 514</td>
<td>–5.24%</td>
</tr>
<tr>
<td>Napoli</td>
<td>4 136 308</td>
<td>4 588 695</td>
<td>10.93%</td>
</tr>
<tr>
<td>Olbia</td>
<td>1 336 618</td>
<td>1 671 218</td>
<td>25.03%</td>
</tr>
<tr>
<td>Palermo</td>
<td>3 231 267</td>
<td>3 831 876</td>
<td>18.59%</td>
</tr>
<tr>
<td>Parma</td>
<td>75 112</td>
<td>61 429</td>
<td>–18.22%</td>
</tr>
<tr>
<td>Perugia</td>
<td>52 802</td>
<td>54 815</td>
<td>3.81%</td>
</tr>
<tr>
<td>Pescara</td>
<td>114 024</td>
<td>350 477</td>
<td>207.37%</td>
</tr>
<tr>
<td>Pisa</td>
<td>1 246 807</td>
<td>2 334 843</td>
<td>87.27%</td>
</tr>
<tr>
<td>Reggio Calabria</td>
<td>538 048</td>
<td>398 089</td>
<td>–26.01%</td>
</tr>
<tr>
<td>Rimini</td>
<td>251 139</td>
<td>283 492</td>
<td>12.88%</td>
</tr>
<tr>
<td>Roma CIA</td>
<td>829 511</td>
<td>4 234 999</td>
<td>410.54%</td>
</tr>
<tr>
<td>Roma FCO</td>
<td>26 288 181</td>
<td>28 683 456</td>
<td>9.11%</td>
</tr>
<tr>
<td>Torino</td>
<td>2 814 850</td>
<td>3 148 807</td>
<td>11.86%</td>
</tr>
<tr>
<td>Treviso</td>
<td>281 442</td>
<td>1 300 298</td>
<td>362.01%</td>
</tr>
<tr>
<td>Trieste</td>
<td>574 665</td>
<td>615 759</td>
<td>7.15%</td>
</tr>
<tr>
<td>Venezia</td>
<td>4 135 608</td>
<td>5 825 499</td>
<td>40.86%</td>
</tr>
<tr>
<td>Verona</td>
<td>2 293 799</td>
<td>2 649 655</td>
<td>15.51%</td>
</tr>
</tbody>
</table>

Source: Assaeroporti, 2000-2006

### Table 5. Secondary Italian airports (2006).

<table>
<thead>
<tr>
<th>Secondary Airport</th>
<th>LCCs using the airport as base</th>
<th>Number of routes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alghero</td>
<td>Ryanair, Germanwing</td>
<td>8</td>
</tr>
<tr>
<td>Bergamo</td>
<td>Ryanair, Transavia, Blue Air,</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>SkyEurope Eurofly</td>
<td></td>
</tr>
<tr>
<td>Brescia</td>
<td>Eurofly</td>
<td>1</td>
</tr>
<tr>
<td>Brindisi</td>
<td>Volare Web</td>
<td>1</td>
</tr>
<tr>
<td>Ciampino</td>
<td>Ryanair, Hapag Lloyd, Sterling Airlines</td>
<td>27</td>
</tr>
<tr>
<td>Forlì</td>
<td>Ryanair</td>
<td>5</td>
</tr>
<tr>
<td>Lamezia</td>
<td>Ryanair, Hapag Lloyd, Germanwing, Volare Web</td>
<td>1</td>
</tr>
<tr>
<td>Olbia</td>
<td>Hapag Lloyd, Itali</td>
<td>6</td>
</tr>
<tr>
<td>Pisa</td>
<td>Ryanair, Easyjet, Transavia, Hapag Lloyd, Eurofly</td>
<td>35</td>
</tr>
<tr>
<td>Rimini</td>
<td>Hapag Lloyd, Eurofly</td>
<td>4</td>
</tr>
<tr>
<td>Treviso</td>
<td>Ryanair, Transavia, SkyEurope</td>
<td>13</td>
</tr>
<tr>
<td>Verona</td>
<td>Germanwing, Blue Air, Eurofly</td>
<td>8</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Secondary Airport</th>
<th>Primary airport</th>
<th>Accessibility (min)</th>
<th>Traffic increase from 2000 to 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Airplanes</td>
<td>Passengers</td>
</tr>
<tr>
<td>Alghero</td>
<td>Cagliari</td>
<td>196</td>
<td>12%</td>
</tr>
<tr>
<td>Bergamo</td>
<td>Milan LIN-MXP</td>
<td>7</td>
<td>26%</td>
</tr>
<tr>
<td>Brescia</td>
<td>Milan LIN-MXP</td>
<td>41</td>
<td>138%</td>
</tr>
<tr>
<td>Brindisi</td>
<td>Bari</td>
<td>109</td>
<td>1%</td>
</tr>
<tr>
<td>Rome CIA</td>
<td>Rome FCO</td>
<td>0</td>
<td>106%</td>
</tr>
<tr>
<td>Forlì</td>
<td>Bologna</td>
<td>40</td>
<td>262%</td>
</tr>
<tr>
<td>Lamezia</td>
<td>Reggio Calabria</td>
<td>98</td>
<td>57%</td>
</tr>
<tr>
<td>Olbia</td>
<td>Cagliari</td>
<td>225</td>
<td>33%</td>
</tr>
<tr>
<td>Pisa</td>
<td>Florence</td>
<td>49</td>
<td>36%</td>
</tr>
<tr>
<td>Rimini</td>
<td>Bologna</td>
<td>61</td>
<td>29%</td>
</tr>
<tr>
<td>Treviso</td>
<td>Venice</td>
<td>20</td>
<td>92%</td>
</tr>
<tr>
<td>Verona</td>
<td>Venice</td>
<td>63</td>
<td>6%</td>
</tr>
</tbody>
</table>

Observing Figure 6 it seems clear that LCCs success has a great deal to do with regional and secondary airports development. These airports gradually specialised in passengers transportation, leaving behind cargo transport (with the exception of Brescia, Brindisi and Treviso), according with the new alliances with LCCs.
In order to realise different patterns in the development of secondary airports, it is better, then, to focus only on passenger and airplane traffic (as airplane traffic we intend the number of airplanes that landed and departed from the airport). The airports of Treviso (secondary airport of Venice), Ciampino (secondary airport of Rome), Bergamo (secondary airports of Milan) and Forlì (secondary airport of Bologna) are the fastest growing in terms of passenger traffic, as result of being a secondary airport of big hubs such as Rome, Milan and secondarily Venice and Bologna.

In order to analyse the importance of geographical accessibility for cluster development (indicated by the traffic increase), we calculate “accessibility” for each secondary airport as the travel time in minutes between the primary and secondary airport (Table 6), as follows:

\[ T = \max \{0; t(C, S) - t(C, P)\} \]  

(2)

where \(t(C, P)\) is the travel time (by car) to the primary airport of a city from the centre of the city and \(t(C, S)\) is the travel time to the secondary airport from the same starting point. Travel time was calculated by means of the well known Michelin’s website.

For example, for the airport of Treviso, the accessibility results 20 minutes, where applying (2):
\[ t(C, P) = t(\text{Venice Centre, Venice airport}) = 54 \text{ min}, \]
\[ t(C, S) = t(\text{Venice Centre, Treviso airport}) = 1 \text{ h 14 min}. \]

For Bergamo airport (as for Brescia) we considered the average value of T estimated over the two principal airports of Milan, Linate and Malpensa.

The analysis of traffic and accessibility data shows four cluster of secondary and regional airports (Figure 7). The first cluster is formed by Bergamo, Ciampino and Treviso and has a high score in terms of passenger traffic growth and accessibility. This group of airports follows the same pattern of development, clearly due to the increasing traffic of LCCs and to the proximity of big cities and big hubs. The high degree of accessibility has allowed a huge transfer of passenger traffic from the main hub to the secondary airport, favouring surely “cluster development”. In fact, Ciampino is nearer to Rome than Fiumicino (the primary airport of Rome) and both Bergamo and Treviso are easily accessible.
Considering a lesser accessibility (20-50 min) and traffic growth, we can make up a second cluster that includes Pisa, Brescia and Forlì: for this group the regional economic development could directly benefit from increasing passenger throughput at secondary airports in terms of “cluster development”. In fact, even if the growth of the airport of Pisa and Brescia, regional airports in competition with the airports of Florence and Milan is less remarkable than the airports of the first group, it is noteworthy, in particular for Brescia if we consider cargo traffic. The huge growth of Forlì is explained by its past excessive underutilization (Table 4 and Table 6).

Another pattern of development characterizes Brindisi, Lamezia, Rimini, Verona (third cluster) and Olbia, Alghero (fourth cluster) that show a low growth both of airplane and passenger traffic: in this case development is due to domestic or leisure traffic and the absence of a near main hub has prevented effects of substitution in passenger traffic. Actually, for this group the regional economic development could directly affect occupation and be a catalyst for other on-site economic activities, but the absence of a near industrial environment will certainly not favour a “cluster development”.

4. Conclusions

Liberalization in Europe has opened up remarkable opportunities for the LCCs. Actually, passengers have benefited from the growth of the LCCs in terms of more competition, more destinations and a greater diversity of fares. If they maintain the 20% yearly growth that has been seen in the last decade, they will occupy around one third of the European market in a few years time.

Despite the success of the LCCs, however, there is not adequate evidence to conclude that they severely cannibalize the market of the full service carriers, as the great part of the LCC passengers, especially on the shorter routes, are newly generated traffic. Besides, on some major and congested European routes traffic is diverted from the network carriers to LCCs. However, it appears unlikely that the LCCs will enter long-haul markets to any significant extent, as the characteristics of these markets are strongly against the LCC business model. Simplicity and efficiency have been the keys to the success of the LCCs, but for how much more time is the LCC model going to be sustainable? Their continuous expansion expose them to direct competition at the secondary airports, while the traditional full cost carriers are responding more effectively to the LCC business model with lower fares. In fact, the full cost carriers are competing with LCCs on certain point-to-point routes, but they are responding by reducing aircraft size rather than by withdrawing from these routes.

Aviation policy makers are facing several issues connected with the growth of LCCs. Among them there is the necessity to mitigate the environmental effects of this expansion, especially at secondary airports, since a great part of LCCs tend to select routes between regional airports and, as a consequence, these airports are confronted with a rapidly increasing traffic, that requires large capital expenditure for infrastructure.

In this scenario, it is of the utmost importance to ensure high standards of safety, organizing the secure allocation of the increasingly scarce capacity of congested European airports.

The positive aspect of decentralization from main routes is the economic regional development. In fact, regional and secondary airports impact on local economies directly as a catalyst for other on-site economic activities and indirectly as a regional economic multiplier. Moreover, congestion at the major hubs can be lessened by developing secondary hubs: alternative airports around the main urban environment. These are typically remote from the city centre, with plentiful capacity but little traditional scheduled air service. Advantages in terms of lack of congestion and consequently of pollution are set against disadvantages in terms of surface access. While we can conclude that the growth of secondary airports will benefit the surrounding regions, we would need to make a more thorough analysis before being able to even try to quantify the effect of the airport growth on these regions. An interesting line of inquiry would be whether the economic development effects of LCC services differ in different economic settings. It would be interesting to compare the growth of secondary airports and the consequences for regional economic development between Italian regions, in order to understand how introducing LCC services to previously underserved airports affects the surrounding regions.

5. References

The Poolean Consensus Model: The Strategic Scope of Monetary Policy

Friedrich L. Sell¹, Beate Sauer², Marcus Wiens³

¹Economics and holds the Chair of Macroeconomics at the Department of Economics, Fakultät für Wirtschafts- und Organisationswissenschaften, Bundeswehr University Munich, Neubiberg, Germany
²Research Assistant at the Chair of Macroeconomics, Fakultät für Wirtschafts- und Organisationswissenschaften, Bundeswehr University Munich, Neubiberg, Germany
³Department of Economics, Fakultät für Wirtschafts- und Organisationswissenschaften, Bundeswehr University Munich, Neubiberg, Germany
E-mail: {friedrich.sell, beate.sauer, marcus.wiens}@unibw.de
Received June 2, 2010; revised July 8, 2010; accepted July 12, 2010

Abstract

Some years ago (before the outbreak of the financial crisis) most of the major central banks—in general—shifted to interest rate control. But does this fact render obsolete the IS-LM scheme, which is apparently tied to money supply control? And isn’t it necessary to find a solid basis for interest rate control instead of just following ad hoc policy functions? This paper is a sensible approach based on the important pioneering work of William Poole [1], which shows firstly that the static IS-LM framework can be further developed for the case of interest rate control and that secondly the current financial crisis and especially the policy reactions of central banks can be explained. Thirdly also the optimization behavior of central banks can be adequately represented in the dynamic version of our model framework. Especially in times of financial and economic crises (when central banks possibly switch their monetary policy instruments back to quantitative easing), it seems to be very helpful to be able to display both interest rate control and money supply control within one single model framework. Our analysis will show that retaining the LM curve is both practical and indispensable for didactic and analytical reasons.

Keywords: Monetary Policy, Economic and Financial Crisis, Quantitative Easing, New Keynesian Macroeconomics, Standard Macroeconomic Model, William Poole

1. Introduction

Some years ago (before the outbreak of the financial crisis) most of the major central banks—in general—shifted to interest rate control. But does this fact render obsolete the IS-LM scheme, which is apparently tied to money supply control? It seems that some economists think so and replace the LM curve with a policy function (“MP”, “TR”). We will show why this is not at all necessary. The Poolean model is able to present and compare both interest rate control and money supply control within one model framework. It is even possible to decide what policy is more advantageous if either money demand shocks or output demand shocks occur.

Furthermore, a lot of economists argue that the current financial crisis and especially the policy reactions of central banks cannot be explained with common macroeconomics. But is it really true, that neither a diagnosis, nor an analysis nor a therapy of the crisis is possible with standard macro-models? No, it is not! We will explain this fact with the Poolean model as well.

Therefore the rest of our paper is structured as follows: Section 2 presents details of the debate between the advocates of the “macroeconomic standard model” and “New Keynesian Macroeconomics” to emphasize the differences and to show why the LM curve still is important, even if central banks control the interest rate instead of the money supply. Therefore we blind out the current crisis. In Section 3 we present the model based on the important pioneering work of William Poole [1], which shows that not only the static IS-LM framework can be further developed for the case of interest rate control, but also the optimization behavior of the central banks can be adequately represented in the dynamic version of this model framework without abolishing the money market
equilibrium. This seems necessary because it can be assumed that central banks will shift back to interest rate control when the crisis is overcome. In Section 4 we develop a solid basis for central banks’ interest rate decisions instead of using ad-hoc interest rate rules. In this case, the following applies: Depending on the priority placed on output target and inflation target, the central banks will choose different interest rates. In this way, the interest rate control behavior of modern central banks can be microeconomically justified without having to assume a priori that a Taylor rule is followed. Especially with the monetary policy switch of major central banks it is essential to be able to use one model to explain both money supply control and interest rate control.

The paper ends with some conclusions in Section 5.

2. The Debate between the Advocates of the “Macroeconomic Standard Model” and “New Keynesian Macroeconomics”

Traditional—but also well-established—instruments of macroeconomic analysis, especially the IS-LM framework and the static AS-AD framework, have become a target of considerable criticism because almost all major central banks changed their monetary policy to interest rate control. In the meantime, some textbooks do not work with the LM curve any more, just the appendix is good enough to explain this money market equilibrium analysis. The LM curve as one of the basic instruments in modeling the money market fades out of macroeconomics education. But can it make sense to blind out explicit money market equilibria within monetary macroeconomics by assuming a priori that central banks follow Taylor rules and by merely applying policy functions (“MP”, “TR”), as advocates of “New Keynesian Macroeconomics” do?

In detail: Firstly, the advocates of “New Keynesian Macroeconomics” criticize the ambiguity of the axis label of the ordinate for the IS-LM scheme. For the goods market equilibrium, it should have to be the real interest rate, while for the money market equilibrium only the nominal interest rate is adequate. This dilemma could only be overcome by assuming, at the same time, constant prices and inflation expectations of zero in the short-run. Even if the latter was accepted, the former could only apply to the extremely special case of a horizontal AD function. Secondly, it is criticized that the mere static model framework is inadequate because, in reality, growth rates of prices (inflation rate) and output, but not the level of prices and output are taken into account.

The mentioned arguments sound good, but they are not really substantive. For example: If New Keynesians insist on the sluggishness of output prices (cf. Romer [2]) in the short-run, it is only reasonable to postulate sluggish inflation expectations within the conventional IS-LM scheme in connection with the static AS-AD analysis as well; thus, the Fisher interest parity continues to hold, even if changes in the output price level occur. Incidentally, the traditional static AS-AD analysis discusses one-off rises or reductions in the price level and not a process of continuing price increases, i.e. inflation. However, only the latter can also trigger positive inflation expectations and/or changes therein.

Even if all major central banks should have abandoned any money supply control (which is not the case at all in the current crisis), it would remain important from a theoretical point of view to regard the pursuit of a money supply control as a reference solution, especially if there are strong indications that it has advantages in comparison with an interest rate control under certain conditions (cf. Sell [3]). For this purpose, a theoretical framework is required which permits an undistorted comparison of both concepts. If a central bank controls its money supply, there is a money supply target $\bar{M}$ or a target growth rate $\bar{\Delta}M$, which can be reached with the interest rate as monetary policy instrument. Does a central bank follow an interest rate target $(T)$ however, it is able to realize it via its money supply. The IS-LM analysis and (as we found out later) also the (static) AS-AD analysis provide exactly this type of framework, as was already shown by William Poole [1] 38 years ago. An IS-LM analysis “re-located” of the explicit money market (equivalent to an IS-LM analysis without the LM curve) in favor of a monetary policy rule by the authors of the “New Keynesian Macroeconomics,” including Clarida et al. [4], Romer [5], Romer [2], Walsh [6] and others, however, is inappropriate for this purpose. Above all, it has apparently been “forgotten” that the explicit (rather than only an implicit) money market equilibrium is indispensable for blinding out—through Walras’ Law—the capital market. This is the only way to simultaneously consider four macroeconomic equilibria where only three of them are analytically explicitly and completely formulated.

But our article neither wants to take a position against modeling policy rules in macroeconomics education on principle (therefore, it will ignore the advantages specified by Romer [5]) nor does it want to discuss in depth the disadvantages of the “New Keynesian Macroeconomics” as Friedman [7] does. We want to emphasize primarily the comparative advantage of William Poole’s integrative approach.

The objection that William Poole was only interested in the rule of a constant nominal interest rate while Taylor’s and related rules are about regulations for changing the nominal interest rate to influence the real interest rate is not conclusive. Due to comparative statics within his model—and naturally even far more by a dynamization of the approach—the Poolean model can also be designed for a rule of the interest rate variation and/or for
change rates of the price level and of the output. Especially if the conviction prevails that modern central banks do not (or no longer) pursue any money supply control, but interest rate control (it really was the case until the start of the economic crisis in 2008 and most likely it will be the case again after the crisis), it appears outright bizarre to associate the European Central Bank’s (ECB) or US-Fed’s monetary policy with a Taylor rule as an ex-ante strategy in the new millennium. The ECB largely concentrates on stabilizing the price level while the Federal Reserve has already stepped in for the second time since 2001 to contain damage during and after a financial market crisis. Therefore a Poolean interest rate control seems to be appropriate in a twofold way: Not only does it retain the concept of the explicit money market equilibrium, it can also be oriented contractively or expansively depending on the requirements, irrespective of whether the acting central bank is committed exclusively to the aim of price level stability or also to the overall economic output and/or the aim of creating employment.

3. The Static Poolean Consensus Model in the Short-Run

Figure 1 shows a simple money market in which the “traditional” money supply control of central banks can be described: With a short-run (sluggish) output price level \( P_0 \), the central bank aims at the (nominal) money supply target \( \bar{M} \); for this purpose, interest rate level \( i \) is a suitable means. If fluctuations in the money demand —due to increases in income \( (Y) \) or shocks \( (u) \)—occur between \( L_0 \) and \( L_1 \) and/or \( L_2 \) then the central bank will continue to reach its target money supply by adapting the (hence endogenous) interest rate level to the new amount \( i_1 \) and/or \( i_2 \).

In Figure 2, we can describe the interest rate control conducted by central banks in accordance with Poole (1970): In order to achieve the desired interest rate \( i \), the central bank must—for a specific money demand \( L_0 \) —now provide money supply \( M_0 \). If fluctuations in the money demand occur between \( L_0 \) and \( L_1 \) and/or \( L_2 \) (for similar reasons as described above), then the central bank would have to adjust the money supply toward level \( \bar{M}_1 \) and/or \( \bar{M}_2 \). On the other hand, the central bank is still able to adapt its key interest rate to a changed environment and adopt a more expansive (contractive) policy. For a target interest rate of \( i_1 \) (\( i_2 \)) it must steer the money supply toward level \( M_1 \) (\( M_2 \)). Interest rate control and money supply control exhibit different comparative advantages: Interest rate control proves especially favorable if money demand shocks occur. These are not uncommon during the introduction of a currency union. That is why in 1999 the ECB gave priority to an interest rate control in contrast to the money supply control of the Deutsche Bundesbank. Already in the 1970s William Poole showed the comparative advantages of that policy compared to money supply control when money demand shocks occur.
As shown in Figure 3, the pursuit of interest rate control permits, as a general rule, to completely prevent potential output fluctuations (LM3 (i)), while the pursuit of money supply control cannot prevent shifts of the LM curve (LM1 and/or LM2); thus corresponding output fluctuations in interval Y1 – Y2 have to be accepted.

The comparative advantages show a completely different distribution when shocks to the output demand disturb the initial equilibrium: As demonstrated in Figure 4, the pursuit of money supply control reduces the potential output fluctuations to interval Y3 – Y4, while the orientation of the monetary policy towards interest rate control extends the interval to the new limits Y5 – Y6, which signify a much larger output fluctuation.
The current crisis is nothing other than an output demand shock where money supply control is more advantageous. All major central banks followed Poole’s recommendation and shifted away from interest rate control to quantitative easing. To avoid a so-called zero-interest-rate-policy, the US-Fed and the Bank of England changed their instruments when reaching the 0.25 and 0.5 percent threshold, respectively. Because of the blocked transmission channel (reduction of the key interest rate is not passed through to private economic agents by commercial banks/des not lead to lower interest rates on money markets), both central banks bought government securities and/or toxic assets to expand the monetary basis via money printing. This quantitative easing cannot be demonstrated without the LM curve. When the effects of the current financial crisis will be overcome, interest rate control is again conceivable as the adequate monetary policy instrument.

The effectiveness of monetary and fiscal policies can be examined in conjunction with the static AS-AD scheme (as it is described in Blanchard [8]) without abandoning the LM curve, where the central bank pursues—in the sense of Poole, but also in the sense of the “New Keynesian Macroeconomics”—interest rate control in an endogenous money supply environment.

We will take the following, strongly simplified structure as the basis model:

Let $Y$ be the output of the economy, $A_d$ the domestic autonomous absorption, $h$ the marginal propensity to invest and $r$ the real interest rate. Then the IS curve takes the common form

$$Y = \alpha(A_d - hr),$$

(1)

where $\alpha = \frac{1}{1 - c + ct}$, with $c$ being the marginal propensity to consume and $t$ being the rate of taxation.

The money market is represented by the LM curve

$$i = \frac{1}{J}(kY - M) + u,$$

(2)

with $i$ denoting the nominal interest rate, $k$ the transaction motive of the money demand, $j$ the speculation motive of the money demand, $M$ the real money supply, and $u$ is a shock term distributed with zero mean and variance $\sigma^2$.

The real money supply is defined as

$$M = \frac{M^*}{P},$$

(3)

where $M^*$ is the nominal money supply and $P$ stands for the price level.

The central bank’s nominal interest rate control can be written as:

$$i = i^*$$

(4)

The right-hand side of Equation (4) replaces the right-hand side of the LM curve, because the central bank compensates for fluctuations in the money demand as a consequence of income changes and/or under the influence of shocks in such a way that its interest rate concept materializes. As no distinction is made between the nominal and the real interest rates within the short-run ($i = r$), $i^*$ can directly be inserted in the IS curve (1):

$$Y = \alpha(A_d - hr^*)$$

(5)
Thus, the AD curve generated runs vertically and is therefore completely price inelastic. In the case of an increase (a reduction) in the interest rate, it shifts in a parallel manner to the left (right):

$$\frac{\partial Y}{\partial i} = -\alpha h < 0$$  \hspace{1cm} (6)

In conjunction with a very simple AS function (cf. Dornbusch/Fischer [9])

$$P = P_0 \left[1 + \gamma \left(Y - Y_{nat}\right)\right],$$  \hspace{1cm} (7)

with $\gamma$ as a weighting coefficient and $Y_{nat}$ as the natural output level, a compact AS-AD scheme can be obtained in the case of interest rate control, but without abandoning the money market equilibrium concept.

An expansive (contractive) monetary policy (Figure 5) determines a lower (higher) interest rate compared to the initial level $i_0$, which causes the entire LM curve to shift down (up) to the new interest rate level $i_1(i_2)$. In the aggregated supply and demand chart, the monetary policy results in an excess demand in the amount of $Y_1 - Y_0$ (excess supply in the amount of $Y_0 - Y_2$) for the initial price level $P_0$ because of the short-run sluggishness of prices. The subsequent price increase to $P_1$ (price reduction to $P_2$) lowers (raises) the value of the real money supply and/or the equally high real balance. As a consequence (in the medium-run), interest rates will rise to $i'_1$ (fall to $i'_2$), provided the central bank does not compensate for this effect. In both cases, the desired higher income/higher price level (lower income/reduced price level) will be achieved.

Figure 5. Expansive/contractive monetary policy in the case of interest rate control.
Finally, in Figure 6, the options of fiscal policy are discussed for the case of interest rate control. An expansive (contractive) fiscal policy creates (analogous with the above) an excess demand (excess supply) in the aggregated supply and demand chart for the initial price level $P_0$. The subsequent price increase (price reduction) lowers (raises) the value of the real money supply and/or the equally high real balance. As a consequence (in the medium-run), interest rates will also rise to $i_1$ (fall to $i_2$) and the LM curve will shift up (down) accordingly, again provided the central bank does not compensate for this effect. In both cases fiscal policy now achieves the desired higher income/higher price level (lower income/reduced price level).

By the way, it is possible to add the upward sloping Fleming-Mundell ZZ curve to the existing description and, hence, to shift to the open economy very easily (cf. Sell [3]). The use of Poole’s approach in an open economy case to explain and compare the different central bank policies is doable as well. Sell/Kermer [10] did a formal analysis of possible losses caused by either a cooperative or a non-cooperative strategy when designing interest rate control or money supply control in open economies.

4. A General Derivation of a Central Bank’s Optimal Interest Rate Policy

In the aftermath of the current financial crisis the central banks will probably switch back to interest rate control (see above). Therefore, in the meantime, it is very important to develop a decision logical and solid basis to explain interest rate control instead of using *ad hoc* interest rate rules like the Taylor rule. Such an optimization approach for central banks is described below.

---

**Figure 6. Expansive/contractive fiscal policy in the case of interest rate control.**
What is rarely noticed is that Poole [1] (pp. 204 ff.), in his much-noticed contribution, already worked successfully with the instrument of an overall economic welfare loss function. In this context, he minimized the expected value of the squared deviation between the current output and the target output (output gap) with regard to applying interest rates as a policy instrument and, alternatively, with regard to money supply control.

If the central bank chooses the nominal interest rate as the “operating target”, then it has direct influence on the real output given the equilibrium condition for the goods market. If, for the medium-run, the real interest rate in the IS curve \( r \) is replaced by the nominal interest rate and inflation expectations \( \pi' \) in accordance with the Fisher interest rate parity \( r = i - \pi' \), and the nominal interest rate is replaced by the interest rate target (see Equation (4)), the following is obtained:

\[
Y = \alpha_i \left( A_i + h\pi' - hi' \right) \tag{8}
\]

In the case of given autonomous absorption and given inflation expectations, an exogenous interest rate reduction (increase) leads to a rising (falling) real output. This real output level \( Y \) determines, in turn, the inflation rate, as can easily be seen from the dynamized AS function (cf. Dornbusch/Fischer [9]):

\[
\pi = \gamma \left( Y - Y^\text{nat} \right) + \pi' \tag{9}
\]

If income increases, inflation also rises c. p. (i.e. with an unchanged level of the natural output) within the same period.

If the central bank pursues interest rate control, it influences the output via the correlation of the IS curve (Equation (8)) and, in a second step, the level of inflation via the correlation of the AS curve. The transmission channels of monetary policy can be directly derived by inserting Equation (8), the medium-run IS curve, into (9), the dynamized AS curve:

\[
\pi(i) = \gamma_0 A_i + (1 + \gamma_0 h)\pi' - \gamma Y^\text{nat} - \gamma_0 hi \tag{10}
\]

The lower (higher) the interest rate is, the higher (lower) the inflation rate will be—for a given autonomous absorption, given inflation expectations, and a given natural output level. Accordingly, it is easier for the central bank to achieve a low inflation rate, the lower the inflation expectations are and the higher the natural output level is.

The central bank now minimizes a welfare loss function \( L \) by solving the following problem:

\[
\min_i L \quad \text{where}
\]

\[
L[\pi(i), Y(i)] = \theta \pi^2 + (1 - \theta) \left( Y - Y^\text{nat} - \Delta \right)^2, \tag{11}
\]

and \( \theta \) denotes a weighting coefficient, \( \Delta \) an externality.

The central bank will thus choose an interest rate to minimize the welfare losses due to inflation and output fluctuations. For simplification, the target inflation rate will be determined to be equal to zero. The output target envisaged by the central bank corresponds to the natural output \( Y^\text{nat} \) plus an externality \( \Delta \). The latter reflects the usual assumption of some frictions due to taxes, imperfect competition etc. The central bank then tries to overcome these inefficiencies by a higher output target. The specific interest rate \( i^* \) which minimizes the welfare losses (for an overview of optimizing approaches to gain policy rules cf. Walsh [11]) is given by:

\[
i^* = \frac{1}{h} A_i - \frac{1}{ah} Y^\text{nat} + \left[1 + \frac{\gamma_0}{\alpha h^2 \theta + \alpha h(1 - \theta)}\right] \pi' - \left[\frac{1 - \theta}{\alpha h^2 \theta + \alpha h(1 - \theta)}\right] \pi^* \tag{12}
\]

If we take Equations (12) and (10) together, we get the optimal inflation rate:

\[
\pi(i^*, \pi') = \frac{(1 - \theta)}{\gamma_0 \theta + (1 - \theta)} \left[ \pi' + \gamma \Delta \right] \tag{13}
\]

The most significant determinants of the inflation rate are inflation expectations and the externality. Both parameters have a positive impact on inflation.

Any optimal inflation level which satisfies Equation (13) is basically feasible. However, we should account for rational expectations as a standard consistency requirement of any model with forward looking behavior. In line with the well-known Lucas critics it is common practice to interpret the equilibrium under rational expectations as the long-run outcome of the economy and thus as a state where policy measures are ineffective since anticipation errors no longer occur. To find out the optimal inflation rate under rational expectations we simply add the condition \( \pi = \pi' \) to (13) and get:

\[
\pi(i^*) = \frac{(1 - \theta)}{\gamma_0 \theta} \Delta \tag{14}
\]

Figure 7 is an illustration of the rational expectation equilibria. The equilibria are all points where our optimal inflation function \( \pi(i^*, \pi') \) crosses the dashed bisecting line \( \pi = \pi' \).

The plot contains three different values for the weighting coefficient \( \theta \): The upper bound \( \theta = 1 \) (priority exclusively on fighting inflation), the lower bound \( \theta = 0 \) (priority exclusively on preventing output fluctuations), and an intermediate value for \( \theta \). As we can see, for \( \theta = 1 \) the inflation function becomes horizontal, which leads to the null inflation equilibrium. As the central bank has the highest possible preference for price stability, the audi-
ence is convinced enough to believe it ($\pi^* = \pi^e = 0$). With smaller $\theta$, both intercept and slope of the inflation function rise, which lead to higher inflation rates (and expected inflation rates respectively) in equilibrium. For $\theta = 0$ we get a somewhat extreme result: Both functions run in parallel, which means that they never intersect: The limit $\theta \to 0$ implies that inflation and expectations together build up to infinity: $\pi = \pi^e \to \infty$. In this case, the central bank completely ignores price stability and just concentrates on output stabilization. The audience takes this total neglect into account and expects an extreme inflation path.

If we take Equations (8) and (12) together, we get the optimal output level:

$$Y(i^*, \pi^e) = Y_{nat} + \frac{\Delta - (\Delta + \gamma \pi^e) \theta}{\gamma \theta + (1 - \theta)}$$  \hspace{1cm} (15)

The natural level $Y_{nat}$ represents the benchmark of output fluctuations. Further important parameters determining the optimal output level are again inflation expectations and the externality. However, each of the two influences output by a different sign: The impact of the externality on output is positive which should be quite clear since $\Delta$ is a positive externality and the central bank tries to adjust upwards (if $\theta < 1$). Higher inflation expectations however curtail the output level, since a rising $\pi^e$ comes with a higher interest rate.

To provide some benchmark solutions we now calculate the optimal interest rate $i^*$, the optimal inflation rate $\pi^e$ and the optimal output level $Y^*$ for the extreme constellations of the weighting factor upper bound $\theta = 1$ (priority exclusively on fighting inflation) and lower bound $\theta = 0$.

For $\theta = 0$, we obtain:

$$i^*_{\theta=0} = \frac{1}{h} A^e - \frac{1}{\alpha h} Y_{nat} + \left[1 + \frac{1}{\alpha h \gamma} \right] \pi^e$$  \hspace{1cm} (16)

For the output and the inflation rate, the values induced with this interest rate are:

$$Y(i^*_{\theta=0}) = Y_{nat} - \frac{1}{\gamma} \pi^e \quad \text{and} \quad \pi(i^*_{\theta=0}) = 0.$$  \hspace{1cm} (17)

We obtain these values by inserting Equation (13) into Equations (8) and (10) respectively for given inflation expectations. Accordingly, if the central bank places its priority exclusively on a lower inflation rate, then it will achieve an inflation rate amounting to zero. However, the resulting output is—as can be seen from (17)—below its natural level. For the opposite case $\theta = 0$, we obtain:

$$i^*_{\theta=1} = \frac{1}{h} A^e - \frac{1}{\alpha h} (Y_{nat} + \Delta) + \pi^e$$  \hspace{1cm} (18)

For the output and the inflation rate, the values induced with this interest rate are:

$$Y(i^*_{\theta=1}) = Y_{nat} - \Delta \quad \text{and} \quad \pi(i^*_{\theta=1}) = \Delta \gamma + \pi^e.$$  \hspace{1cm} (19)

Figure 7. Rational expectation equilibria.
A central bank which exclusively pursues the objective of preventing deviations from the natural output will reach this target in the short-run: The output then exceeds its natural state by the externality $\Delta$. The inflation rate is clearly positive: Inflation is partly composed of the central banks’ incentive to overcome the inefficiency ($\Delta$) on the one hand and of inflation expectations on the other hand ($\pi^*$). In this scenario, the short-run interest rate is lower (cf. with expression (16)), because a low interest rate is the means for extremely expansive monetary policy. Both benchmark solutions discussed so far are short-run. In the long-run, the strategy of the central bank will be adopted by the audience so that the optimal interest rate and the output must be in accordance with the inflation rate under rational expectations $\hat{\pi}$ (cf. Equation (14)). The corresponding output rate is clearly the natural output level $Y_{nat}$ (for all $\theta$), so in the long-run the central bank’s effort to compensate the externality and to push the output beyond the natural level will simply evaporate. The optimal interest rate is given by:

$$i^*(\hat{\pi}) = \frac{1}{h} A_s - \frac{1}{\alpha h} Y_{nat} + \hat{\pi}$$

with $\hat{\pi} = \frac{(1-\theta)}{\gamma \theta} \Delta$ (20)

Now the model is nearly complete and we add the last component. The derived values for the inflation rate and the output must at all time be compatible with the money market equilibrium (LM curve). This poses no problem, because the money supply will automatically adapt itself to changes in the interest rate (triggered by the central bank). In order to describe this constraint adequately, the dynamized version of the LM curve (Equation (2)) will be used (cf. Dornbusch/Fischer [9] and McCallum [12]):

$$m - \pi = k(Y_i - Y_{i-1}) - j(i_i - i_{i-1})$$

(21)

The rate of change in the nominal money supply $m$ (monetary expansion or contraction) will adapt itself in such a way that the change in the real money supply (left-hand side of Equation (20)) corresponds to the change in the real money demand (right-hand side of Equation (20)). If we take into account that, in the case of interest rate control, the variables $\pi$ and $Y$ result from Equations (8) and (10) respectively, and if we insert the optimal interest rate from Equation (12) into Equation (20), we obtain the change in the nominal money supply as a function of the weighting coefficient $\theta$. For the two extreme cases of exclusive priority placed on inflation containment ($\theta = 1$) and/or to the minimization of output fluctuations ($\theta = 0$), we obtain for $m$:

$$m_{\theta=1} = \left(\frac{j}{\alpha h} + k\right) Y_{nat} + ji_{i-1}$$

$$-\frac{j}{h} A_s - k Y_{i-1} - \left(\frac{j}{\alpha h} + \frac{k + j}{\gamma}\right) \pi^*$$

(23)

It can be seen from the last term of both equations that, in the case of an exclusive inflation target (Equation (21)), the higher the inflation expectations are, the lower the monetary expansion will be. In other words, the inflation expectations must be “broken” in this case. However, in the case of an exclusive output target (Equation (22)), the monetary expansion will rise in step with the inflation expectations. If the central bank does not pay any attention to the costs resulting from inflation, the inflation expectations will merely be “accommodated”. Figure 8 graphically represents the entire situation in a $(\pi, Y)$ chart. In the long-run the equilibrium is characterized by rational expectations. In this case the economy reaches its natural output level $Y_{nat}$ for all levels of (expected) inflation. The vertical line $\hat{\pi}(\theta)$ thus represents the long-run Phillips-Curve.

The set of curves represent indifference curves for various values of the loss function $L$. An arbitrary indifference curve with welfare loss $L$ and weighting coefficient $\theta$ can easily be determined by rearranging objective function (11) to $\pi$.

$$\pi(Y) = \sqrt{\frac{L}{\theta} - \frac{(1-\theta)}{\theta} (Y - Y_{nat} - \Delta)^2}$$

(24)

A low weighting coefficient ($\theta^h$) for the inflation target (e.g. $\theta = 0.2$) corresponds to the set of strongly concave indifference curves. Accordingly $\theta^h$ (e.g. $\theta = 0.8$) corresponds to weakly concave indifference curves. The strong concavity for a low priority on inflation can be explained by the fact that the central bank accepts a relatively high rise in the inflation rate in order to come somewhat closer to achieving target output $Y_{nat} + \Delta$. Consequently, for a high priority on inflation, the indifference curves are weakly concave, because in this case the central bank accepts relatively strong deviations from the target output in order to achieve a slight reduction in the inflation rate. The straight lines with negative slope represent the money market equilibrium condition: They describe all combinations of inflation rate and income which are consistent with a specific level of monetary expansion $m$. In this context, value $m_0 = 1$ corresponds to the constellation for $\theta = 1$ (see Equation (21) and point A in Figure 8) and, consequently, $m_0 = 0$ corresponds to the constellation for $\theta = 0$ (see Equation (22) and point B in Figure 8). We obtain the straight line for a specific weighting coefficient $\theta$ by inserting $m(\theta)$ together with $i^*$ into Equation (17) and by rearranging to $\pi$. In this way, being a function of the chosen weighting coefficient $\theta$,
Figure 8. Optimal monetary policy in the case of interest rate control.

all \((\pi, Y)\) combinations achievable by monetary policy can be described by the straight line with positive slope \(AB\). This line represents the (short-run) Phillips-Curve. A situation represented by Equation (17) \((\theta = 1)\) can be found at point A: The inflation rate is zero, but the output is lower than the natural output. The change in money supply occurs in a contractive manner. The intercept of the money market line \(m_0 = 1\) is below the inflation expectations; thus, a contractive monetary policy must “break” the inflation expectations in order to be able to achieve the desired zero inflation rate. The situation described by Equation (19) \((\theta = 0)\) exists at point B: Here the inflation rate is exactly at the level of the inflation expectations and, accordingly, also the achieved output is at its natural level. In this case, the intercept of the money market line \(m_0 = 0\) is above the inflation expectations. The output is higher than in the “natural state”: The money supply will adapt itself in such a way that, first, the money demand \(kY^{\pi' \gamma + (\gamma + k)\Delta}\) is satisfied and, second, inflation expectations \((\pi')\) are accommodated.

5. Conclusions

The IS-LM framework originating from Keynes’ disciples Alvin Hansen and John Hicks can—as has been demonstrated by this contribution—be appropriately extended to the case of interest rate control conducted by central banks without having to abandon the equilibrium concept of the IS-LM analysis, as has been vehemently maintained by advocates of “New Keynesian Macroeconomics” for years. Especially in times of financial and economic crises (when central banks possibly switch their monetary policy instruments back to quantitative easing), it seems to be very helpful to be able to display both interest rate control and money supply control within one single model framework. For a comprehensive—rather than simply partial—analysis of the macroeconomics of monetary policy it is objectionable to blind out the money market as such. Our analysis has shown that retaining the LM curve is both practical and indispensable for didactic and analytical reasons.

In addition, it is possible to design the dynamic version of the IS-LM framework in such a way that it is compatible with the optimization behavior of central banks in the case of interest rate control and that it provides very general determining reasons for choosing the key interest rate instead of following a policy rule.

Finally, it is easy to extend our framework to illustrate specific problems of optimal monetary policy, e.g. time inconsistency (cf. Kydland/Prescott [13]).

Our model confirms the impression that macroeconomic analysis should continue to work with a somewhat generalized and consistent framework—instead of putting aside the LM curve \(i.e.\) the explicit money market equilibrium as done in Graf Lambsdorff/Engelen [14].

6. References


How to Reap the Induced Technological Bonus?
A Mechanism and Illustrative Implementation

Gouranga G. Das*
Department of Economics, Hanyang University, Seoul, South Korea
E-mail: gouranga_das@hotmail.com, dasgouranga@gmail.com
Received June 17, 2010; revised July 19, 2010; accepted July 23, 2010

Abstract

Exogenous technical progress can have uneven impacts on productivity contingent on absorptive capacity, structural congruence and trade intensity. The paper illustrates the role of enabling behind-the-border factors for effective absorption and is pertinent for discussing issues like ‘Europe 2020’ or Lisbon strategy for inclusive growth. Drawing on our model, we illustrate that the capture-parameter is the propellant force for effective assimilation of foreign technology of recent vintage. The capture parameter is the outcome of endogenous decision-making process. The ‘productivity bonus’ mechanism leaves room for changing the results via skill-mix composition. However, it awaits implementation in a large-scale economy-wide modeling framework for further extension.

Keywords: Trade, Technology Spillover, Capture, Productivity, Congruence

1. Introduction

Of late, with the rise to dominance of new endogenous growth theory the role of international trade and foreign direct investment (henceforth, FDI) in facilitating trans-border technology flows and consequential rise in productivity can no way be underestimated. The role of international trade in transmission of technological benefits via traded intermediate inputs has been discussed at length in the literature—see Keller [1], Eaton and Kortum [2,3], Coe, Helpman and Hoffmaister [4,5]—to name a few. Participation in international trade provides a variety of benefits to developing countries through resource allocations according to comparative advantage, exploitation of economies of scale, increased capacity utilization and technology upgradation—to name a few. Upsurge in technology-intensive products is well-documented in the literature (Keller [1]; World Development Report [6], World Bank [7]; Connolly [8]; Coe et al. [4]; Guerrieri and Milana [9]; Hoekman and Javorcik [10]; Das [11-13]). In the literature of technology spillover, the importance of absorption capacity (AC) and structural similarity (SS) in appropriation of technological benefits has been discussed (Cohen and Levinthal [14,15]; Nelson and Pack [16]; Evenson and Westphal [17]; World Development Report [6]). According to the World Development Report (World Bank [6] (henceforth, WDR) trade facilitates technology flows. WDR (1999) has documented evidences of acquisition of the knowledge capital with particular emphasis on the role of AC for knowledge diffusion. In fact, WDR (1999) reports that

“even a follower country needs a labour force with a relatively high level of technical education, especially when technologies are changing rapidly” (see p. 42, ibid).

Also, for closing ‘knowledge gaps’ between the technology creator and the recipients it emphasized the crucial roles of (see p. 25):
1) “Acquiring and adapting global knowledge—and creating knowledge locally;”
2) “Investing in human capital to increase the ability to absorb and use knowledge;”
3) “Investing in technologies to facilitate both the acquisition and the absorption of knowledge.”

Development of AC is important for effective diffusion of technology as it encompasses the “ability to imitate new process of product innovations, [and] to exploit basic research.” (Cohen and Levinthal, [15]).

Nelson [18] defines AC as
“the ability to learn and implement the technologies
and associated practices of... ...developed countries.”

Nelson and Pack [16] argues that

“to learn to use new technologies and to function effectively in new sectors required the development of new sets of skills, new ways of organizing economic activity, and ... [becoming] competent in new markets” [and also]

“to be sure, adopting technologies of the advanced countries required, among other things, high rates of investment in physical and human capital...”

We offer a stylized model formalizing the nexus between embodied technology transfer, human capital and TFP Growth. AC is defined in terms of skill intensity of the labor force (Das [12]; Meijl and Tongeren [19]). SS of two sectors will be judged by the similarity of their capital intensities, for example, by physical capital per unit of effective labor. SS involves comparison of structural characteristics of a sector in the source of technological change and those in the destinations; the idea is that the technical knowledge in the advanced economies will be most ‘appropriate’ to the clients closest to them in terms of their primary factor intensities. Our overarching theory focuses on the sector-specificity of the capture parameter (CP) determined by AC, SS and trade intensity (TI). The model developed is specifically designed for illustrative simulation of a technology shock. Section 2 rationalizes. Section 3 models. Section 4 numerically illustrates. Section 5 concludes.

2. The Rationale

Most of the relevant papers in the new growth literature deal with non-convexities in production and dynamic gains from trade between trade partners. The integration of new growth theory and trade theory à la Grossman and Helpman [21] and other researchers (mentioned above) places the emphasis on induced endogenous technical change as an explainer for varying growth episodes in models assign a more prominent role to ‘technological change and scale economies. Typically, most of the models assign a more prominent role to ‘technological change’ as an explanator for varying growth episodes across nations.

Lucas [22,23], however, is a tour de force in this genre of growth models where the role of human capital—modelled via schooling and formal education as well as learning by doing and on-the-job-training—has been given due importance. Kosempel [24] also modeled such interaction. In fact, Lucas [23] argues

“By assigning so great a role to ‘technology’ as a source of growth, the theory is obliged to assign correspondingly minor roles to everything else, and so has very little ability to account for the wide diversity in growth rates that we observe”.

Lucas [22] argued that, although they started from almost entirely comparable bases, South Korea experienced a ‘growth miracle’ whilst the Philippines had an episode of ‘growth failure’ between 1960 and 1988; according to him,

“The main engine of growth is the access to human capital—of knowledge—and the main source of difference in living standards among nations is the difference in human capital. Physical capital accumulation plays an essential but decidedly subsidiary role”.

Using a “bottoms-up” approach, we focus not only on the firm’s attainment of a least-cost input combination, but also on technology transfer-induced endogenous changes in productivity. The vital elements in the latter are skilled labor intensity (measuring AC), physical capital intensity (proxying SS), and the trade intensity (TI, offering the opportunities for capturing a technological bonus). As shown below, for a sector “CP” is an amalgam of AC, SS and TI. In the context of European Union’s enlargement efforts to give accession to lower-tier countries, this issue is pertinent. SS encapsulates social capital and effects of physical capital amalgamated into one ‘catch-all’ factor for ease of expository convenience. According to Dasgupta [25], TFP binds both technology and socio-economic institutions. Sen [26] ascribes important role to lack of social and physical infrastructure. In a simple set up, the model purports to show the mechanism of three pillars for cooperation between high-tier and low-tier economies—a lesson useful from the EU’s enlargement perspective (not discussed for parsimony and different focus of current analysis).

A representative firm reaps the benefits of technological improvements embodied in imported inputs. It needs higher level skills to harness the benefits of technological improvements. At the macro level, given the overall human capital stock and structural congruence with the trading partners, the regions participate in trade and reap the technological bonus (TB) out of trade flows (see Cetin and Cincera [27]). Of course, at a given intensity of trade flows, a higher bonus may be achievable if the skill intensity of the work force is higher, which may partially motivate building up additional skills. At the level of a sector, the question is to find out the “optimal” level of skilled labour for a sector so as to make the best use of the “TB” obtainable from trade-mediated technology. Even though the firm chooses an optimal input mix, technical progress in the foreign source is an exogenous phenomenon. This induces a sectoral bias into technical change as skilled labour will have an advantage in extracting the “TB” from spillovers.

Based on the theoretical insights, we adopt a neo-classical growth framework. Let us consider an economy that produces a single homogeneous good “Y,” (output or GDP, synonymously) using composite (i.e., skilled and unskilled composite) labor (L), domestic capital or gross domestic capital formation, GDI, \(k^D\) and foreign capital of FDI (\(k^F\)) so that the aggregate Neoclassical well-behaved production function is written as:

---

*See for example, Das [14,20], Grossman and Helpman [21], Evenson and Westphal [18].*
where “$A_1 > 0$” is an index of technological progress (parameter) representing Total Factor Productivity (TFP) index or Hicks-neutral technical progress.

Also, aggregate composite capital stock, $K_t = K^D_t + K^T_t$.

Subscript “$t$” refers to unit of time. However, for simplicity we suppress the regional subscript for each country $j$.

Assuming linear homogeneity (constant returns to scale), this production function can be expressed in per worker (intensive form) terms as:

$$y_t = A_t f(k^D_t, k^T_t)$$

where lower case letters represent per worker values of the corresponding variables. Note that $y_t$ is the productivity per worker in period $t$.

Assuming log-linearity and taking a total differential of (1), we derive the following expression for growth-accounting relation as:

$$\frac{d}{d t} y_t = \frac{1}{y_t} \left( \frac{d}{d t} A_t + \beta \frac{d}{d t} f(k^D_t) + \gamma \frac{d}{d t} f(k^T_t) \right)$$

In (3), generically $x_t = \frac{dx}{dt} x$ is the time rate of change of variable $x$ or the growth rate.

The above expression shows that the growth-rate of per capita GDP depends on the growth rates of FDI and GDI intensity per worker and the rate of TFP growth. It is to be noted that the TFP changes, being influenced by shares of FDI and GDI in aggregate output, occur endogenously to escalate the growth in per capita GDP. Under perfect competition in product and factor markets, the coefficients are the corresponding output elasticities (equivalently, factor cost shares of foreign and domestic capital in per capita terms) of FDI and GDI per capita (in terms of growth rates).

The implication of this model is that since at higher level of capital stock, it will be subject to diminishing returns, the countries with lower level of productivity will experience a higher growth as a result of increased FDI. On the other hand, for the advanced countries the growth of productivity will be slower. Thus, this model suggests that the productivity differential across countries will be smaller owing to FDI-induced foreign capital inflows. The convergence of growth rates is in line with the catch-up hypothesis put forward for the newly emerging and rapidly industrializing economies of East and South-East Asia. This has important bearing for the EU’s integration effort with potential and candidate member states with lack of appropriate constellation of enabling factors (Shankar and Shah [28]). With sufficient human capital and skill formation, a country will have ample opportunity to break this diminishing returns and hence, will be able to reap spillover benefits via harnessing the technologically sophisticated capital goods or imported input embodying superior state-of-the-art. Thus, “$k$” in the above stylizations could be interpreted broadly to encompass human capital or knowledge-capital of superior quality. As Pack and Westphal [29] argued, “effort is required in using technological information and accumulating technological knowledge...to create new technology. This takes the form of investments in.....effective use of knowledge.”

In what follows, we just present an illustrative analytical model to show the role of human capital intensity to absorb sophisticated technology, assuming that physical capital intensity does not hinder the growth process.\footnote{This version of the paper is based on Das [30] with substantial alteration and improvement on the in-house version being incorporated based on feedbacks from Professor Man-Soo Joo.}

### 3. A Model of Productivity Bonus\footnote{Derived from Das [30].}

Newer technology embodied in traded goods demands its own types of skills. The profile of skills embodied in the workers interacts with other inputs and the available state of the art to determine the TFP. The underlying assumption is that workers differ in the appropriateness of their skills to achieve any given productivity level with a particular vintage of technology. Competition ensures that each labour type is paid according to its marginal product.

The incentive of reaping a technological bonus from embodied spillovers modifies the representative firm’s choice of an optimal occupational mix. Thus, the bonus hypothesis is: the representative firm, in the process of maximizing profit (or minimizing costs), takes into account the benefits of technological improvements embodied in imported intermediate inputs. Capturing these benefits requires an appropriate mix of skilled and unskilled labour, which is recognized by the representative firm in its production decisions. The benefits available, moreover, depend positively on the structural similarity of the source and the recipient (as measured by the ratio of capital to quality adjusted labour). Technological improvement is exogenous in this theory which is restricted to the propagation of technology. We assume that for a sector “Bonus Embodied Spillover of Technology (BEST)” is achieved in consonance with the representative firm’s static optimization exercise: firstly, three variables viz., sectoral skill intensity, structural congruence and trade intensity in production of the sector combine to produce a capture-parameter. This subsequently transforms the potential productivity improvement into an actual productivity bonus—BEST—accrued via the traded intermediates. Figure 1 shows the transmission mechanism behind the productivity bonus.

The production function is generically written as:
\[ Y = \text{function}(M_F, M_D, L_S, L_U) \]

where \( Y \): output,
\( M_F \): imported material input,
\( M_D \): domestic material input,
\( L_S \): skilled labour input and
\( L_U \): unskilled labour input.
\( M \): composite (aggregate) materials of \( M_F \) and \( M_D \).
\( V \): Value-added composite of primary factors.

Figure 1. Principal pathways underlying the mechanism of technological bonus capture by sector j in region s.
Assuming the production function Leontief (at the top level) in \( M \) and in value added measured in efficiency units, \( bV \):

\[
Y = \min \{M, bV\} \tag{5}
\]

where:

\[
M = M_F^\alpha M_D^{(1-\alpha)} \tag{6}
\]

\[
V = L_d^{(1-\beta)} L_U^{\beta} \tag{7}
\]

\[
b = f \times g \tag{8}
\]

\[
\ln f = h \left( \ln \left( \frac{M_F}{M_D} \right) \right) \tag{9}
\]

\[
\ln g = H \left( \ln \left( \frac{L_S}{L_U} \right) \right) \tag{10}
\]

\[
h, H > 0 \tag{11}
\]

\[
h', H' > 0 \tag{12}
\]

The function \( b \) in (8) allows for changes in TFP via two intensity ratios, the import intensity of material inputs and the skill intensity of labor, entering multiplicatively. The optimization problem facing the representative perfectly competitive firm is formalized as:

Maximize \( Y \) with respect to \( M_F, M_D, L_S, L_U, \) subject to:

\[
C = P_F M_F + P_D M_D + W_L L_S + W_U L_U \tag{13}
\]

where \( C \) is the cost of inputs, while \( P_F, P_D, W_S, \) and \( W_U \) are the prices of the inputs. Note that \( P_F, P_D, W_S, \) and \( W_U \) are all exogenous. \( C \) is a real anchor in this constant-returns-to-scale world and hence, is set exogenous.

Taking a monotonic logarithmic transformation, maximize \( Y \) subject to:

\[
\ln C = \ln \left\{ P_F M_F + P_D M_D + W_L L_S + W_U L_U \right\} \tag{15}
\]

Since (5) is non-analytic, we invoke the (Leontief) restriction (18) below; as a second constraint in the Lagrangean.

\[
\ln Y = \ln M = \ln b + \ln V \Rightarrow \tag{16}
\]

\[
\alpha \ln M_F + (1 - \alpha) \ln M_D \tag{17}
\]

\[
= \ln b + \beta \ln L_S + (1 - \beta) \ln L_U \Rightarrow \tag{18}
\]

\[
\alpha \ln M_F + (1 - \alpha) M_D \tag{19}
\]

\[
= h \left( \ln M_F - \ln M_D \right) + H \left( \ln L_S - \ln L_U \right) + \beta \ln L_S + (1 - \beta) \ln L_U \tag{20}
\]

Form the Lagrangean:

\[
L = \alpha \ln M_F + (1 - \alpha) \ln M_D \tag{21}
\]

\[
+ \Lambda \left\{ \alpha \ln M_F + (1 - \alpha) \ln M_D \right\} \tag{22}
\]

\[
- \left\{ h \left( \ln M_F - \ln M_D \right) + H \left( \ln L_S - \ln L_U \right) \right\} \tag{23}
\]

\[
+ \beta \ln L_S + (1 - \beta) \ln L_U \right\} \right\} \tag{24}
\]

\[
\frac{\partial L}{\partial \ln M_F} = \alpha + \alpha \Lambda - \Lambda h' - \Lambda P_F M_F / C = 0 \tag{25}
\]

\[
\frac{\partial L}{\partial \ln M_D} = (1 - \alpha) + \Lambda (1 - \alpha) + \Lambda h' - \Lambda P_D M_D / C = 0 \tag{26}
\]

\[
\frac{\partial L}{\partial \ln L_S} = - \Lambda H' - \Lambda - \Lambda W_L L_S / C = 0 \tag{27}
\]

\[
\frac{\partial L}{\partial \ln L_U} = \Lambda H' - \Lambda (1 - \beta) - \Lambda W_U L_U / C = 0 \tag{28}
\]

The left-hand sides of (26) through (29) add to unity, while the right-hand sides add to \( 1 / \lambda \); hence

\[
\lambda = 1. \tag{29}
\]

Using (30) in (24),

\[
\Lambda = -WL / C = -S_L = \text{the share of labour in cost} \tag{30}
\]

Denoting the cost shares of the four inputs by \( S_F, S_D, S_S, S_U \), from (30) and (26) through (29) we see:

\[
S_F = \alpha S_M + h' S_L \tag{31}
\]

\[
S_D = (1 - \alpha) S_M - h' S_L \tag{32}
\]

\[
S_S = (H' + \beta) S_L \tag{33}
\]

\[
S_U = (1 - H' - \beta) S_L \tag{34}
\]

The quantity component of the shares is determined [via (5)] by output. That is:

\[
S_L = W \times (bV) / C \tag{35}
\]

\[
= WY / C \tag{36}
\]

The value-added price index \( W \) is
Similarly for materials:

\[ S_M = M \times M / C \]

\[ = P_M Y / C \]

where composite material prices is given by:

\[ P_M = \frac{P_M M_F + P_D M_D}{M_F^{\alpha} M_D^{1-\alpha}} \]

4. Numerical Illustration

4.1. The Data and Parameter Setting

Our analytical model developed above indicates that several inferences could be drawn from patterns of changes in the system. Thus, we perform some numerical simulation to show the impact of a technology shock (TFP) on the productivity improvement. The problem is approached in a partial equilibrium setup to see what type of changes prevails in the model. We illustrate the mechanism on the basis of a hypothetical data set with admissible values—presented in Tables 1 and 2. We have assigned admissible values to the parameters of the model, \( \alpha \) and \( \beta \). Tables 1 and 2 present the specific initial settings or base-case scenario.

The base-case scenario in Tables 1 and 2 is a solution of the share Equations (32)-(35) above. The impact of TFP improvement on endogenous productivity enhancement is traced via changes in “b” in the wake of several perturbations as specified in the experiments.

### 4.2. TFP Simulation

We simulate the effect of 5 and 10 percent TFP shock. Following the perturbation, the changed initial configurations of the variables are given in Table 3.

The 10 percent Hicks-Neutral shock is represented by the 10 percent increase in “b” \((2.724/2.4764 = 1.10)\) between Tables 1 and 3. As this shock is factor-neutral by nature, it affects the ‘size’ of the composite value-added whilst the composition of value-added (measured in conventional units) remain unaltered. Thus, because of Hicks-Neutrality skill-unskilled labour ratio between Tables 1 and 3 \((4/8 = 0.5 = 3.739/7.478)\) remains unchanged.

With fixed cost and prices kept fixed at the original level, the TFP improvement translates into a fall in the value-added measured in conventional units—implying each productive factor inputs are required in less amount in physical terms. With cost being held fixed and given no change in the relative prices in the post-shock scenario, as \( V \) falls \( M \) has to increase to satisfy the constraint for fixed cost. Comparing the last column in these two tables, we infer that in quality-adjusted term, however, real value-added increases. This is because the level of productivity bonus \( i.e., \) value of “b” \( \) is augmented from 2.48 to 2.72. This, in turn, increases the effective value-added \( i.e., \) “bV”. Following the Leontief fixed-coefficient technology at the top-most level, the usage of composite material inputs goes up by the same magnitude as “bV”—see third column in Tables 2 and 3. Also, gross output \( [Y] \) increases by about 2.8 percent—see fourth column in Tables 1 and 3 \((15.439/15.014 = 1.028)\). Results for 5% shock could be explained analogously; however, as

<table>
<thead>
<tr>
<th>Table 1. Initial scenario for the representative firm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M_F</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2. Prices and Parameter setting for the representative firm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>W_S</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3. Post-shock scenario for the representative firm and the impacts of TFP shocks.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>10% shock</td>
</tr>
<tr>
<td>5% shock</td>
</tr>
</tbody>
</table>

The discussion and arguments draw partly on the in-house version of the article in Research Institute of Digital Economics, Hanyang University, Ansan. We need to report this to highlight the differences with other counterfactual simulations that we present below in details. However, this reproduction is for facilitating understanding of the theoretical insight via numerical example.
conjectured the lower TFP shock reduces the capture and the output compared to 10%-scenario. The sensitivity analysis with respect to TFP shock does not alter the direction of causality in the results. Keeping the skilled-unskilled factor intensities and the foreign-domestic intermediate input intensities unaltered, we see that the larger is the size of the TFP shock (i.e., 10% as compared to 5%), the larger is the accrual of productivity bonus (BEST). In other words, “b” augments from 2.60 to 2.72 in case of doubling the size of transmitted productivity shock. This motivates us to perform further scenario analysis to examine how variations in the intensities of factor usage in the presence of this TFP-augmentation (5%) could inflate the productivity bonus.

4.3. Design of Counterfactuals and Numerical Analysis

We keep the productivity shock at 5% (we call it TFP-base case) and consider the following scenarios:

1) “Ls” remains the same: in this case, we keep it unaltered as in Table 1, Column 6 (that is, it is not reduced as in Table 3, Column 7, TFP-base case). Thus, the constrained cost-minimization by the firm entails reduction in Su, increase in Ss (and hence, in g via Equation (10)). As “f” (via (9)) remains the same, bonus “b” increases to 2.60 (from 2.53) and Y goes up to 15.20 from initial base case value of 15.01 (see Table 4, row 2).

Inference I: increase in skill-intensity improves AC and leads to improvement of the productivity bonus despite TFP shock being fixed at 5% level. Skill-intensity is crucial for assimilating productivity benefits.

2) “Ls” is increased: to 10 so that skill intensity of the firm falls. Constrained cost-minimization in the presence of 5% TFP entails reduction of Ls and fall in material input usage (Mf and Md shrink) compared to both original base-case and TFP-base case (see row 3, Table 4). As expected, “g” and f fall (via Equations (9) and (10)), causing the bonus “b” to dissipate. This leads to fall in “bV” and “Y”.

Inference II: decrease in skill-intensity reduces AC and leads to dissipation of the productivity bonus despite the presence of TFP shock being fixed at 5% level. Also, decline in foreign intermediate input intensity leads to shrink in the productivity capture.

3) Foreign intermediate input (Mf) is increased: here traded intermediates is augmented whereas domestically sourced input (Md) input is decreased causing, via the representative firm’s constrained-cost minimization choices of factor inputs, share of materials to increase and share of value-added composite to fall (see row 4, Table 4). This led to increase in “f” substantially whereas “g” remained the same as in both the base-cases. It led to increase in the bonus capture (via (8)) and resultant increase in final output “Y” (row 4, Table 4).

Inference III: increase in imported intermediate inputs embodying sophisticated technology increases trade-mediated technology spillover and leads to rise in the productivity bonus even with fixed 5% TFP shock and same skill-intensity levels. Trade intensity is conducive for reaping productivity bonus.

4) “Ls” is increased, while keeping Lu unaltered: in this scenario, the representative firm’s optimization solution leads to increase in skill intensity (hence, in AC) whereas trade-intensity (f) remains almost the same. This led to increase in Ss, bonus (b) and hence, in output “Y” (see row 5, Table 4).

Inference IV: increase in skill-intensity enables to reap the productivity bonus via assimilation of imported intermediate inputs embodying sophisticated technology. This leads to rise in the level of final output even with fixed 5% TFP shock and trade intensity.

5) “Mf” is increased and “Md” is fixed at the original base-value: in this case, we see that “f” increases (as trade intensity goes up), but skill-intensity remains the same (g is unaltered). This leads to rise in the productivity spillover “b” causing output “Y” to grow (see row 6, Table 4).

Table 4. Post-shock scenarios for the representative firm under different scenarios with 5% TFP shock (TFP-base case).

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Mi</th>
<th>Mo</th>
<th>M</th>
<th>Y</th>
<th>V</th>
<th>Ls</th>
<th>Lu</th>
<th>b</th>
<th>f</th>
<th>g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1)</td>
<td>8.09</td>
<td>19.91</td>
<td>15.20</td>
<td>15.20</td>
<td>5.91</td>
<td>4</td>
<td>7.66</td>
<td>2.60</td>
<td>1.50</td>
<td>1.69</td>
</tr>
<tr>
<td>Scenario 2)</td>
<td>7.56</td>
<td>18.42</td>
<td>14.10</td>
<td>14.10</td>
<td>6.71</td>
<td>3.68</td>
<td>10</td>
<td>2.32</td>
<td>1.43</td>
<td>1.40</td>
</tr>
<tr>
<td>Scenario 3)</td>
<td>13.91</td>
<td>17.39</td>
<td>16.30</td>
<td>16.30</td>
<td>4.22</td>
<td>2.80</td>
<td>5.60</td>
<td>3.85</td>
<td>2.23</td>
<td>1.65</td>
</tr>
<tr>
<td>Scenario 4)</td>
<td>9.16</td>
<td>22.50</td>
<td>17.18</td>
<td>17.18</td>
<td>4.02</td>
<td>4.01</td>
<td>4</td>
<td>4.09</td>
<td>1.50</td>
<td>2.72</td>
</tr>
<tr>
<td>Scenario 5)</td>
<td>8.69</td>
<td>19.66</td>
<td>15.39</td>
<td>15.39</td>
<td>5.72</td>
<td>3.77</td>
<td>7.54</td>
<td>2.70</td>
<td>1.56</td>
<td>1.65</td>
</tr>
<tr>
<td>Scenario 6)</td>
<td>8.07</td>
<td>19.83</td>
<td>15.14</td>
<td>15.14</td>
<td>5.92</td>
<td>3.76</td>
<td>8</td>
<td>2.56</td>
<td>1.50</td>
<td>1.61</td>
</tr>
<tr>
<td>Original base-case</td>
<td>8</td>
<td>19.66</td>
<td>15.01</td>
<td>15.01</td>
<td>6.06</td>
<td>4</td>
<td>8</td>
<td>2.47</td>
<td>1.50</td>
<td>1.65</td>
</tr>
<tr>
<td>TFP-base case</td>
<td>8.12</td>
<td>19.95</td>
<td>15.23</td>
<td>15.23</td>
<td>5.86</td>
<td>3.86</td>
<td>7.73</td>
<td>2.60</td>
<td>1.50</td>
<td>1.65</td>
</tr>
</tbody>
</table>

Original base case scenario is the one without any TFP shock. TFP-base case is the one with only 5% TFP shock. Since 5% and 10% TFP shock generates the same direction of causality of results, only size or the magnitude of impacts differ, in the context of these series of counterfactuals this does not undermine our purpose. It is obvious that the higher doses of TFP coupled with those simulations would change the magnitude of accrual of bonus.

Copyright © 2010 SciRes.
Inference V: increase in trade-intensity enables to reap the productivity bonus embedded in the imported intermediate inputs containing sophisticated technology. This leads to rise in the level of final output even with fixed 5% TFP shock and similar skill-unskilled labor shares.

6) “Ls” decreases, but “Lu” remains at the original base-case value: in this counterfactual case, Ls decreases so that Ss falls and hence, skill intensity declines. As Mq and Mr do not alter much, following the firm’s constrained cost-minimization exercise, “f” remains unaltered while “g” is reduced. Thus, the bonus magnitude “b” shrinks compared to TFP-base case. But as there is initial 5% TFP improvement, this causes output “Y” to register marginally higher level than the original base-case value (compare row 7, Table 4 with row 8). This is lower than TFP-base case as there is a fall in “g” following decline of skill-unskilled ratio.

Inference VI: decrease in skill-intensity in the presence of unchanged trade-intensity causes less chance to reap the productivity bonus embedded in the imported intermediate inputs. In this case, rise in the level of final output is induced by 5% TFP shock despite declining skill composition and similar level of trade intensity.

All these inferences are instrumental in understanding the working of the theoretical model developed in this paper. The numerical illustration of the model confirms our conjecture that trade, indigenous skill-induced adoptive capabilities as well as technological sophistication are important forces for sustained growth and development. All these three channels facilitate learning of technologies of recent vintage. They mutually reinforce each other to translate into higher growth of output.

5. Conclusions

This paper presents and numerically implements a theoretical model of endogenous capture of technical change originating in the source of knowledge-creation (assumed exogenous). Numerical simulation confirms that: increases in the intensity of skilled labor in the input mix improves the absorptive capacity of the work force; the amount of technology captured increases with the import intensity of the material inputs while technological change is vehicled via foreign intermediates; increase in both types of intensities complements each other to augment the bonus capture; only technological change cannot deliver the potential benefits unless the input mixes are optimally chosen by the firm while making cost-minimization decision. We have explored their effects in harnessing the trade-induced technology flows. We show that capture-parameter is the propellant force for assimilation of transmitted technology. Further work along these lines will involve mounting the full scale simulations in a higher dimensional model and integrating a dynamic aspect of R&D-creation and its propagation. This work has important implications for technology policy and planning as well as for trade or regional integration, for example, in the context of European Union’s accession program under Europe 2020 aimed at social cohesion, competitiveness, skill formation, and R&D (Shankar and Shah [28]). Often, the necessity of political and social integration as precursor of successful monetary union is stressed. A systemic view is warranted for pursuing this objective. The model elicits heuristically that technology policy, trade policy and macroeconomic management needs a synergistic planning to achieve sustained growth. Trade, per se, is insufficient for achieving the growth dividends. Trade creates the opportunities for sustained development via industrialization and technology transfer; however, developing adequate socio-institutional framework, educational attainment and skill formations, inter alia, are necessary for seizing plethora of opportunities.

6. References


An Inflation Targeting Regime in Egypt: A Feasible Option?

Tarek Ghalwash
Department of Economics, Mansoura University, Mansoura, Egypt
E-mail: tarek.ghalwash@econ.umu.se
Received June 6, 2010; revised July 10, 2010; accepted July 15, 2010

Abstract

This paper addresses first whether scientific evidence—theoretical and empirical—exists to support the inflation targeting regime and, secondly whether inflation target is worthwhile for Egypt. The method in this paper builds on a literature review of the theoretical and empirical research in the field of economics. Our conclusion shows that there is incomplete evidence from a number of countries supporting the inflation targeting regime as an effective monetary policy framework for the achievement of macroeconomic stability. The paper concludes that the Central Bank of Egypt and the Egyptian economy is not yet ready for the implementation of an inflation targeting regime.

Keywords: Inflation Targeting, Monetary Regimes, Granger Causality Test

1. Introduction

The fact that the inflation problem has received increasing attention in recent years has led to an increased interest in the effects of different monetary policy regimes. By “effects” we partly mean what governments want to achieve (i.e., a price stability, output growth), but also the effects on the economy performance so that it can succeed in an increasingly competitive world market. In other words, the interest in price stability policy issues is not only related to the “benefit side” but also the “cost side.” It is well known that the main focus of monetary policy should be attaining low, stable inflation, since any deviating from this objective may have serious consequences in terms of growth stability and economic welfare [1].

There seems to be a wide consensus among economists that high and volatile inflationary rates distort relative prices, discourage savings and investment, hinder economic growth and development, and can induce social and political instability. In the quest to avoid this malaise, there are traditionally three aggregates that serve as an anchor for monetary policy management: a monetary aggregate, exchange rate, and inflation itself, which is called inflation targeting.

Recently, Inflation target has become the dominant monetary policy prescription for a number of developing and industrialized countries and has been widely talked about as an economic policy1. Many countries have adopted inflation targeting as a monetary policy with the hopes of effectively reducing inflation and increasing economic and price stability. Even though it is often claimed that inflation targeting has helped these countries achieve lower and more stable inflation along with more stable output, there is no conclusive evidence that inflation targeting directly caused the improved economic performance [3].

The adoption of an inflation targeting monetary framework that started in New Zealand in 1990, is currently popular among a number of emerging market countries such as Brazil, Chile, Colombia, The Czech Republic, Hungary, Israel, Korea, Mexico, Poland, South Africa, Thailand and Turkey. In the West African sub-region, Ghana has also adopted inflation-targeting monetary framework and other African countries are at various preparatory stages of adopting it.

The debate over the effectiveness of inflation targeting to reduce price levels has been overshadowed in recent year by the financial crisis originating in the sub-prime mortgage market and the run up in energy and food prices. It has focused on the view that inflation targeting places too much emphasis on inflation, potentially at the expense of other monetary policy goals. Some critics of inflation targeting see recent macroeconomic develop-

1Inflation targeting is a monetary regime that was first introduced in New Zealand in 1990 and as of 2006 had been adopted by more than twenty advanced and emerging economies (See Roger and Stone [2]).
ments as being the downfall of inflation targeting.\(^2\)

Economists have started debating the pros and cons for developed and developing countries to shift from the current regime to inflation targeting. In light of these debates, one can view the debate in, for example, Egypt with regard to the country’s desire to be at the forefront of switching to an inflation targeting regime especially in the Middle East area.\(^3\) On that front, the Central Bank of Egypt (CBE) announced in June 2005, its intention to “put in place a formal inflation targeting framework to anchor monetary policy once the fundamental prerequisites are met”.

To our knowledge, there are few earlier studies dealing with whether Egypt is ready for inflation targeting,\(^4\) as there are a number of requirements to be met for such a regime to be a sensible option as a monetary regime. Investigation is also needed as to whether the Egyptian Centre Bank (ECB) has considered the full implications of shifting to inflation targeting, in particular as to how this monetary regime will contribute to other objectives of the country, such as growth, employment creation and poverty reduction. Therefore, the main contribution of the present paper is to fill this gap in the debate.

This paper will not assess the pros and cons of inflation targeting as it has been extensively discussed in previous studies: See, for example, [6-9]. It has, however, been observed by [10] that the growing number of countries that target inflation and the perceived success of this monetary policy strategy serve as a stimulus for countries that engage in alternative regimes—such as monetary or exchange rate targeting. This consideration raises the question of how to evaluate whether a country is ready to join the group of inflation targeters now, later or even never.

This paper aims to give a systematic review of the inflation targeting regime. The fundamental question is whether scientific evidence—Theoretical and empirical—exists to support the inflation targeting regime. If inflation targeting can be supported, does it only apply within specific preconditions? Furthermore, a closer look at the case of Egypt is presented by reviewing recent evidence to assess whether it is ready to switch to inflation targeting. Thus, the main objective in this paper entails not only a full understanding of the theoretical basis underlying inflation targeting but also attempts to answer the question, is inflation targeting worthwhile in general, and especially for Egypt?

The method along of this paper builds on a literature review of the theoretical and empirical research in the field of economics. The rest of the paper is structured as follows: Section 2 provides a systematic assessment of what is meant by the inflation targeting policy and what are the important preconditions for applying it. One of the objectives of this section is to provide an overview of the current understanding in the literature with respect to the applicability and relevance of the inflation targeting regime. Section 3 discusses the empirical evidence on the effects of inflation targeting in developed and developing countries and some of the lessons for monetary policy that can be drawn from the experiences of inflation targeting of Central Banks. Section 4 discusses whether Egypt satisfies the preconditions for adopting inflation targeting. Section 5 concludes with a summary of current knowledge and to what extent this information can provide guidance to Egyptian policy-makers.

2. Monetary Policy Instruments, what does Inflation Targeting Mean?

2.1. Definition of Inflation Targeting

Economists and monetary policy makers have long believed that successful monetary policy should have a “nominal anchor”, a variable that the central bank could use to discipline their policy decisions and convince agents in the economy that the central bank was disciplined.\(^5\) Various nominal anchors have been used in countries: examples are monetary aggregates and the exchange rate. In recent times, many countries in the world have moved towards a system/framework for conducting monetary policy known in academic and policy circles as “Inflation Targeting”. As the name indicates, the nominal anchor is the inflation rate: the central bank is supposed to follow a monetary policy that is designed to achieve a stated objective with regard to the inflation rate.

A review of the literature reveals several interpretations of the definition of the inflation target. Inflation targeting is often defined as a framework for monetary policy, characterized by the public announcement of official quantitative targets (or target ranges) for the inflation rate, over one or more time horizons, and by explicit acknowledgment that low, stable inflation is the monetary policy’s primary long run goal (see [12,13] and [14]). According to [15], inflation targeting is not a method to reduce the current inflation but an anchor to monitor and control price stability in an economy after a thorough disinflation period.

With regards to literature discussions, [16] argues that the inflation targeting regime encompasses five main elements: 1) the announcement to the public of an explicit quantitative target or range for a period of time; 2) an institutional commitment to price stability as the primary goal of monetary policy, to which other goals are subordinated, meaning that a country is more likely to adopt

---

\(^2\)Joe Stiglitz, for example, has written that “Today, inflation targeting is being put to the test — and it will almost certainly fail”.

\(^3\)Israel and Turkey are already adopting inflation targeting as a monetary policy framework.

\(^4\)[4] and [5] examined whether Egypt is ready to adopt inflation target or not without examining whether this policy would be good for Egyptian economy as a whole.

---

Copyright © 2010 SciRes.
inflation target in the absence of fiscal and financial dominance; 3) the central bank should have powerful models to make inflation forecasts, which use some indicators and variables containing information on future inflation; 4) increased transparency of the monetary policy strategy through communication with the public and the markets about plans, objectives, and decisions of the monetary authorities; and 5) increased accountability of the central bank for attaining its inflation objectives. These defining features of inflation targeting require that the country’s monetary authorities have the technical and institutional capacity for modeling and forecasting domestic inflation and have some idea or prediction of the time it takes for the determinants of inflation to have their full effect on the inflation rate. The inflation target provides full transparency in the implementation of monetary policy that enables financial institutions in the market to foresee the future with less uncertainty and behave accordingly.

The conclusion that can perhaps be drawn from the previous discussion about the inflation targeting is that: the inflation targeting entails much more than a public announcement of numerical targets for inflation for the year ahead. This is important in the context of emerging and developing markets because many of them routinely reported numerical inflation targets or objectives as part of the government’s economic plan for the coming year, and yet their monetary-policy strategy should not be characterized as inflation targeting, as it requires all the elements mentioned above for it to be sustainable over the medium term. The main issue raised right now is how an inflation target model as a monetary policy regime works?

2.2. Inflation Target Model

The simple version of this model can be written as follows (see [17]):

\[ \pi_t = \pi^*_t + \alpha_1 E_t(\pi_{t+1} - \pi^*_{t+1}) + \alpha_2 (H_t - H^*_t) + \epsilon_t \]  \tag{1}

\[ H_t = E_t(H_{t+1}) - \sigma (\pi_t - \pi^*_t - E_t \pi_{t+1} + \epsilon_t) \]  \tag{2}

\[ r_t = r^*_t + \lambda_1 (\pi_t - \pi^*_t) + \lambda_2 (H_t - H^*_t) \]  \tag{3}

where \( \pi \) is inflation rate, \( \pi^*_t \) is the central bank’s inflation target, \( E_t \) is Expectation on time \( t \), \( (H_t - H^*_t) \) is output gap and \( r \) is interest rate and the symbol * refers to target or long-run variables (or ‘natural’ in the case of interest rate; \( H^* \) is the full-employment NAIRU level of output). The last term, \( \epsilon_t \), is an error term reflecting unobserved shock (random shock). The model contains three equations and three unknowns, namely, output, inflation and the interest rate. Firms are assumed to index their prices to their assessment of the central bank’s inflation target, and \( \pi^*_t \) is the public’s current estimate of the central bank’s target.

Equation (1) is a price equation or a simple forward-looking Phillips curve. The output gap explains the inflation gap. In this model, inflation is caused by the output gap and the latter is caused by interest rate policies (see Equation (2)). Equation (2) is the expectation IS curve. Interest rate deviations from the target explain the output gap. If the central bank sets the interest rate below the natural rate, firms will find it profitable to borrow from the banking system to finance their Investment plans. Thus output will grow and the output gap will decrease. Equation (3) is Taylor’s rule. It does not contain a random error because it is assumed that monetary policy operates without random errors. It is also assumed that \( \lambda_1 > 0 \) for stability of the equilibrium. If actual output gets close to the potential or if inflation rises above target, the central bank will increase nominal interest rates (and indirectly real interest rates).

To see how the model works, consider the central bank announcement to the public regarding the formal target inflation rate. This can align the public’s expectations of current and future target rates with the actual goals of the central bank. For example, reducing the public’s assessment of the current and future target inflation rates would allow average inflation to fall without any associated cost in terms of real economic activity. This implies that the monetary authorities can set any inflation target they desire without having any effect on the real equilibrium of the economy, i.e., the equilibrium level of real output is unaffected by a shock; only the equilibrium level of inflation changes. This also implies that, given the independence of the real economy from the inflation target, inflation targeting becomes an autonomous policy objective. Therefore, the stability of the system is guaranteed by the countercyclical role of the central bank in setting interest rates.

In the same manner, the inflation target regime can also allow the central bank to reduce both inflation and output volatility by anchoring the public’s beliefs about future inflation. If a positive inflation shock causes the public to, (incorrectly), adjust upwards their estimate of the central bank’s target, a larger decline in the output gap is necessary in order to limit the rise in actual inflation through rising of interest rates. Greater stability of inflation expectations should reduce the volatility of inflation and improve the short-run inflation—real activity
trade off faced by the central bank. This, in turn, means that the volatility of both inflation and real activity would be lower under inflation targeting. In addition, when monetary policy is based on an inflation target regime, the central bank inflation forecast plays a key role in this regime. Therefore, the corresponding interest rate path is necessary for the private sector to determine the central bank’s forecast of potential output because providing interest rate projection is very important for reducing uncertainty. According to the theoretical model, a feasible, and optimal, policy would set both inflation and the output gap equal to zero for all \( t \). In this case, an interest policy consistent with such equilibrium would ensure that \( r_t = r^* \) for all \( t \). Given zero inflation, it is clear that the output gap only depends on the current and expected future interest rate gaps. This means that the inflation target can reduce the public’s uncertainty about either the current target or future targets. This can be easily seen by rewriting the Phillips curve as

\[
\pi_t = \alpha_0 \pi^*_t + \alpha_1 \pi^*_t - \pi^*_t + \alpha_2 E_t (\pi_{t+1} - \pi^*_t) + \alpha_3 (H_t - H^*_t) + \mu_t
\]

(4)

Where:

\[
\mu_t = e_t - (\pi_t^* - \pi^*_t)
\]

(5)

The new random error term in the Equation (4), is now composed of the original random shock and errors in the public’s forecast of the central bank’s inflation target. Thus, reductions in forecast errors associated with the public’s assessment of the inflation target, like a reduction in the variance of the cost shock, allow both inflation (around target) and the output gap to become more stable. In this case, the interest rate projection would only provide the public with the central bank’s assessment of future demand shocks to which the policy rate will presumably be adjusted to offset.

Following the pervious analysis, it seems that the main argument in favor of inflation targeting is that an official announcement of an inflation target makes a central bank’s policy more credible, which helps to alleviate the dynamic inconsistency problem, and thus should lead to lower (expectations of) inflation and inflation variability\(^8\). Further, one can draw the conclusion that the transparency on how monetary policies operate under inflation targeting makes the formation of inflation expectations easier, thereby strengthening the ability of central banks to achieve inflation targets, and therefore, prompting other central banks to mimic this practice.

\(^{8}\)If credible, inflationary expectations are more accurate allowing businesses and consumers to better plan their production and spending.

\(^{9}\)This means that the central bank should not be required to attain low interest rates on public debt or to maintain a particular nominal exchange rate.

\(^{10}\)Usually, accountability is not established by explicit legislation, but through the transparency of monetary policy that inflation targeting creates.

2.3. Preconditions for Inflation Targeting Regime

The literature and experience of long-time inflation targeters have identified preconditions which have to be fulfilled in order to implement successful inflation targeting [18]. The first and probably the most important precondition for implementing the inflation targeting is that the central bank must be given complete independence to adjust freely its instruments of monetary policy toward the attainment of the objective of low inflation. Central bank needs to have the freedom to set its instruments of monetary policy in a way it believes that the objective will be achieved most adequately. Instrument independence mainly implies that the central bank is not constrained by the need to finance the government budget.\(^9\) In addition, there should not be any political pressure on the central bank to raise the rate of economic growth in such a way that is inconsistent with the achievement of the inflation target [19].

The second precondition for implementation of inflation targeting is the existence of efficient monetary policy instruments. According to this condition, monetary authorities have to be able to model inflation dynamics in the country and to forecast the inflation to a reasonable degree [20]. So, the monetary authorities should have access to policy instruments that are effective in influencing the macroeconomic variables. And also, there must be sufficiently developed money and capital markets to react quickly to the use of those instruments because the monetary policy’s tools to achieve an inflation target may weaken the positions of the banks and may lead to the undershooting of the inflation target.

The third, but not less important precondition for inflation targeting is closely connected to the credibility. Under the inflation target regime, the country should incorporate transparency and accountability into the central bank’s function. Both, accountability and transparency are dominantly determined by the quality of central banks communication to the public. It is very important for the central bank to inform the public about every circumstance connected to its policy, in order to make its goals and instruments clear and controllable. The public can use this information to form better expectations about future policy actions and keep track of the central bank’s performance. In addition, the increased accountability of inflation targeting enables the monetary authority to monitor and enhance the understanding of expectations. It also decreases the possibility of a time inconsistency trap, which leads to deviations from monetary authority’s long-term objective. Moreover, it provides a good benchmark that can easily be observed by the agents in the economy [21].\(^10\) A transparent monetary policy makes it more difficult for a central bank to deviate from set targets, since such behaviour would have serious and long-lasting impact effects on its credibility.
Central bank transparency should involve making inflation target explicit and public. This means that the central bank should have some form of published communication which not only announces the target but also describes the policy actions needed to reach and maintain the inflation target.

To conclude, the previous discussion has highlighted the importance of preconditions for successful inflation targeting.

3. Inflation Targeting in Emerging Countries: Empirical Evidence

The objective in this section is to review the empirical literature for developed and developing countries that is relevant to the objectives of this paper. An attempt will be made to present a systematic review, considering different aspects of inflation targeting regime, such as regulatory effects on 1) inflation rate, 2) real economy, and 3) expected inflation.

3.1. Evidence in Developed Countries

As mentioned above the academic debate around the inflation target regime started soon after New Zealand first instituted this monetary policy framework in early 1990. Since that time, 22 countries have formally adopted inflation targeting, and no country that has adopted it has abandoned it, although inflation targeting contribution to overall economic performance is still being debated.

There is an extensive empirical literature related to the connection between inflation targeting regime as a monetary policy and economic performance. The finding of empirical studies shows that inflation targeting countries have succeeded to reduce inflation and the volatility of inflation and to obtain inflation outcomes closer to target levels [22].

Reference [6] compares average inflation levels for seven inflation targeting countries with 7 countries excluding nontargeters countries. This contribution finds a much steeper decline in inflation in the case of the former group, concluding that inflation targeting is useful for countries facing lack of anti-inflation credibility. [23] interpret similar results as a process of ‘convergence’, in that on average inflation targeting countries converge to the inflation rates of the non-inflation targeting countries in the targeting period. [24] are able to conclude that inflation targeting countries have been able to meet their inflation targets and reduce inflation volatility11.

Closely related to the previous results, [25] employ cross-section difference-in-difference regressions to examine the treatment effects of inflation targeting in 20 OECD countries, seven of which adopt inflation targeting. They discover that after adopting inflation targeting, the economic performance of these countries improves. But, non-targeting countries also experience improvements around the same time. Thus, they argue that better economic performance reflects factors other than the monetary regime and conclude that inflation targeting does not produce a major effect. In other words, inflation targeting is irrelevant.

However, there are other studies that show a somewhat different result. [26] Provide a comparative analysis. They match three inflation-targeting countries (New Zealand, Canada, and the United Kingdom) with three nearby non-inflation-targeting countries (Australia, the United States, and Germany), finding little empirical evidence that an inflation-targeting regime performs better than a non-inflation-targeting regime. In addition, [27] states that “there is no evidence that inflation targeting has been detrimental to growth productivity, employment, or other measures of economic performance”, a view supported by [28] in his comparison of 5 industrial countries that have been targeting inflation for at least 10 years and 6 non-targeting targeting industrial countries.

Finally, [29] use matching methods to evaluate the treatment effects of adopting inflation targeting on seven industrial countries with fifteen non-inflation targeting industrial countries as the non-treatment group. They show no significant effects on inflation and its variability, arguing the window-dressing view of inflation targeting. [30] uses the same method and sample data as [29], finding that inflation targeting does not significantly affect output growth or its variability. [31], however, show that inflation targeting OECD countries suffer smaller output losses in terms of sacrifice ratio during the disinflationary period than non-targeting counterparts. [32], employing intervention analysis, find lower inflation rates, well-anchored and accurate inflation expectations for both targeting and non-targeting countries.

In summary, we can say that the empirical studies reviewed fail to produce convincing evidence that IT improves inflation rate and economic stability. In addition, as [23] argue, the environment of the 1990s was in general terms a stable economic environment, “a period friendly to price stability” and inflation was on a downward trend in many countries, especially developed countries.

3.2. Evidence in Developing Countries

Recently, more than a dozen developing countries have officially adopted inflation targeting. Thus, a complete evaluation of the effectiveness of inflation targeting requires further evidence from developing countries. But, in

---

11Comparing the pre-targeting period with the post-targeting period may not capture the impact of inflation targeting per se, but rather a re-orientation of monetary policy towards lowering inflation (which could be achieved with or without inflation targeting). Comparisons between inflation-targeting countries and non-targeting countries are weaker and, again, depend on the control group used.
In general, most developing countries—whether they targeted inflation or not—performed much better in terms of growth and inflation since 2000 than during the 1990s. The evidence also shows that those that adopted inflation targeting tended to see bigger improvements than others, both in terms of inflation and growth performance.

Reference [29] evaluates the effect of inflation targeting on inflation and inflation variability in thirteen developing countries that have adopted this policy by the end of 2004, using a variety of propensity score matching methods. They found that inflation targeting has quantitatively large and statistically significant effects on lowering both inflation and inflation variability in these countries. On average, the adoption of inflation targeting has led to a reduction in the level of inflation by nearly 3 percent. Following the methodology, [35] focus specifically on developing economies, excluding industrial economies from among their inflation targets and their non-inflation targets. They found that the effects of inflation targeting were statistically and economically significant.

On the other hand, [36] used panel data to assess the effect of inflation targeting in developing countries, and found no evidence that the inflation targeting regime improves performance of inflation and output growth in developing countries. That is, inflation targeting regimes do not lower the costs of disinflation. Finally, a group of scholars from Cambridge University conducted a painstaking research in the effect of inflation targeting, they concluded in these words: “We have attempted in this study to gauge empirical evidence for both developed and emerging countries that adopted the new monetary policy strategy that has come to be known as inflation targeting (IT). It may very well be the case that IT countries, developed and emerging, have been successful in taming and controlling inflation. But then there is also evidence that clearly suggests that non-IT central banks have also been successful in achieving and maintaining consistently low inflation rates”.

The previous empirical findings produce mixed evidence in economic performance for developing and developed countries, but it seems developing countries gain more from inflation targeting policy than do developed countries.

The main conclusion that we can draw from these discussions is that it may very well be the case that inflation targeting countries, developed and emerging, have been successful in taming and controlling inflation. But then there is also evidence that clearly suggests that non-inflation targeting central banks have also been successful in achieving and maintaining consistently low inflation rates. Our overall conclusion, then, is that the available evidence we have managed to gauge clearly suggests that a central bank does not need to pursue an inflation targeting strategy to achieve and maintain low inflation, particularly during the mature phase of stationary targeting. The main question that arises is, is inflation target worthwhile for Egypt’s Economy? To answer this question, we will try to assess, theoretically and empirically, if Egypt meets the preconditions for adopting an inflation target with some general comments on inflation targeting itself as a monetary policy.

4. Is Egypt Ready for Adopting Inflation Targeting?

In this section, we try to analyze the prerequisites and applicability of inflation targeting in Egypt to evaluate its feasibility. The main focus will be on the assessment of whether the preconditions of inflation targeting are satisfied in Egypt. In order to do that, we explore three basic elements that are the precondition for adopting the inflation target: 1) Independence status of the Central bank of Egypt (CBE); and 2) inflation forecasting capability in Egypt; and 3) existence of relationship between the monetary policy instruments and inflation.

4.1. Independence Status of the Central Bank of Egypt (CBE)

Related to the institutional conditions discussed in the precondition requirements for adopting inflation targeting, the independence of the central bank seems to be the first feature that should be implemented. This ambiguity arises from the fact that there are several kinds of independence: political and economic, de jure and de facto, constitutional and statutory, independence within and independence from the government, strategic (to formulate policy) and tactical (day-to-day operations), instrument independence but not goal independence, and independence of the executive, judiciary, and legislative. In this manner, we try to assess whether Egypt has satisfied the first preconditions for an IT regime in such a way that it makes the adoption of an IT regime in Egypt feasible to anchor individuals’ expectations around the potential inflation targets. In order to do that, we explore two basic elements that are related to the institution conditions: 1) Independence status of the CBE from the government; and 2) absence of fiscal dominance including no obligation for the CB to finance budget deficits.

4.1.1. Independence Status of the CBE from the Government

In Egypt, the central bank governor is appointed by de-
cree from the president of Egypt, for a renewable term of four years. The governor has two deputies appointed by decree and chosen on the proposal of the governor, for a renewable term of four years. The remaining nine members of the board of the CBE are also appointed by the president for a renewable four year\textsuperscript{16}. While all board members (Governor, deputies and nine experienced persons) are nominated by a decree from the President of the Republic, the remuneration and attendance allowances of the nine specialized members are determined by a decree of the Prime Minister, upon a proposal from the Governor\textsuperscript{17}. The board is the authority responsible for realizing the objectives of the CBE, by formulating and implementing monetary, credit, and banking policies. The board also determines the instruments required to achieve the objectives; particularly, the instruments of monetary policy to be followed, the structure of credit and discount rates, the regulatory and supervisory standards to guarantee the soundness of the financial position of banks, and the regulation of auctions and tenders.

Even though the explicit mention of monetary stability grants the CBE a degree of independence in implementing monetary policy vis-à-vis the government; law No. 93 of 2005, grants the CBE a higher degree of instrument independence, as it is free to set its discount rate and upper and lower limits for bank borrowing and lending rates and, in the absence of such limits, to make rules and directives to influence interest rate setting and credit expansion. However, the existence of government representatives as voting members on the Monetary policy committee and the fact that the governor are appointed by the decree of the president for a short term of four years, reflecting that the CBE still be seen as not fully independent according to law (de jure).

### 4.1.2. Absence of Fiscal Dominance Including no Obligation for the CBE to Finance Budget Deficits

As we mention before, to achieve effective inflation targeting, the central bank must not only have full legal autonomy but should be seen and act as one that has it and consequently be free from fiscal and political pressures that have the capacity to trigger objective that are in conflict with the inflation targeting goal. As it is with the redenomination so it is with large fiscal deficits. This has continued to undermine the autonomy of the central bank with respect to monetary management. No matter how fiscal deficits are financed, they always have deleterious inflationary consequences. But this is worse when it is financed by ways and means usually in response to the pressure from the government. Egypt’s fiscal disposition is largely characterized by a tradition of deficit budgeting financed mainly by means particularly during the last five years. Egypt’s budget deficit has been high and the level of public debt has been around 65 percent of GDP.

**Table 1** exhibits some macroeconomic indicators in Egypt.

As we can see from **Table 1**, both the inflation rate and the output growth rate in Egypt have increased. A high output growth rate, in addition to the revenue coming from the privatization process, have both contributed to a lower budget deficit in FY 2006 and 2007. Impressively, however, the inflation rate witnessed a rise in 2007 to 2009 when it turned out to be in a double digit during this period and this is a not good outcome for IT.

A fiscal profile of the government shows that the high ratio of both the budget deficit and the public debt for the period of 2003-2009 were in conjunction with the high contribution of both the banking system and the CBE to financing the budget deficit\textsuperscript{17}. Indeed, the structural budget deficit has been much higher than the transitory deficit, and fiscal discipline remains a problem. In Egypt, the rate of fiscal deficit has increased after 2005 and has been around 7% during the 2006-2008 period. Unless this trend is radically changed, which is socially and politically a real challenge, sooner or later, this fiscal gap will generate excessive pressures on monetary policy. The current fiscal deficit is also the outcome of the pressures on fiscal revenues due to trade liberalization, and most of all to the high degree of tax evasion, in addition to inefficiency of the public expenditure.

On another hand, the public debt is also growing and putting an extra burden on the budget through debt interest payment. On average, the level of public debt in Egypt exceeds 60%. Such a situation is emerging as a serious concern. Reducing this public debt ratio and in particular that of foreign currency dominated debt is therefore

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Selected Macroeconomic Indicators in Egypt 2003–2009.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2003</td>
</tr>
<tr>
<td>Real GDP Growth</td>
<td>3.2</td>
</tr>
<tr>
<td>CPI inflation (average)</td>
<td>3.7</td>
</tr>
<tr>
<td>Current account (% GDP)</td>
<td>2.4</td>
</tr>
<tr>
<td>Budget deficit (% GDP)</td>
<td>–9.5</td>
</tr>
<tr>
<td>Public debt (% of GDP)</td>
<td>60.4</td>
</tr>
</tbody>
</table>

Source: IMF and central bank of Egypt

\textsuperscript{15}One can only criticize the subordination of the board members’ remuneration to the head of the government because, in such circumstances, the autonomy of the members’ decisions becomes questionable.

\textsuperscript{16}The CBE has a board of directors under the chairmanship of the governor, with fourteen members (two deputy governors, the chairman of the Capital Market Authority, three members representing the ministries of finance, planning and foreign trade, and eight experts in monetary, financial, banking, legal, and economic affairs.

\textsuperscript{17}According to [5], the contribution of the banking system to budget deficit was, on average, 45% of the overall budget deficit for the period of 2003-2006, while the involvement of the CBE in financing the budget deficit was, on average, 58% of the banking system contribution during the same period of 2003-2007, excluding the year 2006.
necessary to reduce the vulnerabilities in a context of a more exchange rate flexibility. For the time being, in Egypt, despite the progress achieved in the ratio of public debt in 2007-2009 compared to the previous periods, the government still relies on seigniorage revenues in order to close the transitory gap between its revenue and its expenditure flows. It is true that the reliance on seigniorage revenues is often higher in developing countries due to low and unstable incomes and poor tax collection procedures but this is not consistent with inflation targeting, and is likely to hamper the central bank’s independence.

The conclusion one can draw from the previous facts is that the legal instrument independence granted to the CBE is sketchy and does not go beyond the de jure independence[18]. Consequently, the existence of government representatives as voting members on the MPC and the coercion of the CBE to extend finance to the government are two elements sufficient to undermine any meaning of the de facto independence of the CBE.

4.2. Inflation Forecasting Capability in Egypt

As mentioned above, the inflation forecast is central to any inflation-targeting regime and requires a well-developed technical infrastructure, including quality data, construction of an appropriate price index, and forecasting and modeling capabilities. A forward-looking inflation targeting framework is, in fact, “inflation forecast targeting” [40]. Indeed, inflation targeting is not applied mechanically and does not focus only on current inflation but on containing inflation as a medium-term goal. Central banks pay attention to indicators that can predict future inflation [41].

To what extent is this technical infrastructure currently available in Egypt? Regarding the quality of data, unreliability of data is one of the major problems facing econometric modeling and estimation in Egypt which incidentally is central to price-inflation forecasting for inflation targeting. Even with so many reforms and improvement of the data collection in Egypt[19], timely and reliable data availability remains an issue[20]. The absence of this desideratum means that we cannot meet the demands for full, timely, and accurate information on key variables such as GDP, financial and trade data etc. over required time periods. Since forecasting is at the heart of inflation targeting, such forecasts may not be as robust as should be expected by its advocates since data is necessary to implement them. Although the CBE generates its own data, in some cases, particularly in the past, there are significant divergences among the data series being published on the same subject by other organizations with data-generating responsibility. These could have a consequence of fundamental disparities in data generating and reporting procedures.

Moreover, the use of the consumer price index (CPI) in Egypt for evaluating the inflation behaviour may serve a useful tool, but it will be risky if the CBE is planning to use it for the purpose of inflation targeting. As in all developing countries, choosing such an index is problematic. The first reason is that foodstuffs, which make up a large part of the basket, have highly variable prices because of their sensitivity to weather conditions. This high variability translates into more volatile CPI inflation. Second, goods and services with subsidized prices have a substantial share of the basket. Large movements in regulated prices, which have a direct impact on the overall price level, may lead to poor control of inflation and damage the central bank’s credibility. In the Egyptian case, food & non-alcoholic beverages accounted for more than 50% of the old CPI basket, and still account for almost 40% of the current one. Within this category, bread, cooking oil and sugar benefit from consumption subsidies. Also subsidized are petroleum products (rent, power and fuel represent around 10% of the basket) pharmaceuticals (medical care represents 4%), water, electricity & gas (around 12%), (CAPMAS, 2005). Given this information, one can conclude that having a target limited to the CPI in Egypt is a serious problem, because it will underpin any meaning of expectations about future inflation: a key determinant of actual inflation. The effectiveness of monetary policy as a nominal anchor depends on what is targeted and how. One of the fundamental problems arising from this framework is therefore the absence of a valid price index.

4.3. Existence of Relationship between the Monetary Policy Instruments and Inflation

In this section, we examine one of the main preconditions for a successful adoption of inflation targeting framework as expounded in many empirical studies and gives a solid understanding of the relationship between monetary policy instruments and macroeconomic outcomes via the monetary transmission mechanism. In order to quantify the importance of monetary policy variables in determining changes in the consumer price index (CPI) in Egypt, this paper adopts the Granger causality tests in both bivariate and multivariate using the baseline VAR model form which is employed by [43] and, more recently, by [44]. The baseline VAR model representation

---

[19]One of the tough critiques of the CCMP came from the Morgan Stanley report about the government, specifically the prime minister, overriding both the CCMP and the MPC of the CBE [39].

[20]In 2005, Egypt subscribed to the IMF’s Special Data Dissemination System (SDDS), which requires prompt posting of various macroeconomic datasets, compiled in line with best International practice and comparable across countries.

[20][42] using the Data Quality Assessment Framework (DQAF) to assess the quality of data in Egypt. The most defects in the Egyptian data were found in the accuracy and reliability.
is given by:
\[ Y_t = A(L)Y_{t-1} + \beta(L)Z_t + \epsilon_t \]  
where \( Y_t \) is a k vector of endogenous variables, \( Z_t \) is a d vector of exogenous variables, and \( A \) and \( \beta \) are matrices of coefficients, and \( \epsilon_t \) is a vector of structural shocks with the variance covariance matrix \( \mathbb{E}(\epsilon_t \epsilon_t') = \rho \).

In the baseline model, the vector of endogenous variables consists of the gross domestic product (GDP), consumer price index (CPI), Broad money supply (M2), Government fiscal spending (FS), interest rate (R) and exchange rate (EX)\(^{21}\):

\[ Z_t = (\text{GDP}, \text{CPI}, M2, FS, R, EX), \]

In order to apply the Granger causality test in a VAR framework, the general mathematical representation of the test can be written as:

\[ y_t = \alpha_1 + \sum_{j=1}^{m} \beta_{1j} y_{t-j} + \sum_{j=1}^{m} \delta_{1j} z_{t-j} + \epsilon_{1t} \quad \text{(8)} \]

\[ z_t = \alpha_2 + \sum_{j=1}^{m} \beta_{2j} z_{t-j} + \sum_{j=1}^{m} \delta_{2j} z_{t-j} + \epsilon_{2t} \quad \text{(9)} \]

where \( \alpha_i \) are the constant terms, \( m \) is the lag order, and \( \epsilon_{it} \) are error terms and assumed to be serially uncorrelated with zero mean and finite covariance matrix. In order to test causality from \( z \) to \( y \), the null hypothesis \( (H_0) \) is expressed as \( \alpha_{ij} = 0 \) \((j = 1, 2, \ldots, m)\) and the alternative is at least one of \( \alpha_{ij} = 0 \) \((j = 1, 2, \ldots, m)\), is significantly different from zero. Similarly, \( (H_{02}) \) of testing the causality from \( y \) to \( z \) is \( \alpha_{2j} = 0 \) \((j = 1, 2, \ldots, m)\) against at least one of \( \alpha_{2j} \) is not zero.

The paper used annual data from 1998Q1 to 2009Q4 gathered from the International Monetary Fund’s International Financial Statistics, and Central Bank of Egypt. Table 2 presents the results of the bivariate and multivariate block Granger causality tests for CPI and GDP in Egypt.

As we can see in Table 2, the results suggest the causal link between the policy variables on consumer price index and gross domestic product. The joint probabilities for the multivariate tests suggest the rejection of the null hypothesis. The bivariate tests for Consumer price index (CPI) suggest that all the variables except interest rate and money supply cause significant variations in CPI. This means that the level of output, exchange rate and fiscal spending cause variations in the level of prices or the CPI\(^{22}\). The findings support that the fact that fiscal policy is also important for achieving price stability and economic growth. In addition, the bivariate tests show that money supply has a significant Granger-effect on output but not on prices. The empirical results suggest that Egypt’s exchange rate is quite significant with respect to GDP as with CPI. This is not surprising given the recent float of the Egyptian currency, and the subsequent positive effects on exports and the rate of growth of GDP. The results also show consumer price index, money supply, and government fiscal spending significantly drive GDP.

The previous results show that the interest rate and money supply as a monetary target regime are not sufficient in the Egyptian economy to send the right message to individuals to adjust their expectation about inflation. Meaning that, the mechanism of the inflation targeting model, as presented in Section 2, undermines the inflation target.

Another important point of concern is about the indirect effect between the money supply and inflation. It seems that the impact of money supply adjustments on inflation is not a one-time strike on inflation. Therefore when the monetary policy rate is adjusted in order to influence other rates, which invariably affects the spending decisions of economic actors, it neither affects the economy nor inflation in a manner that is readily predictable.

The transmission mechanism of monetary policy has long and variable lags because the economy takes time to adjust to changes in monetary conditions. Inflation targeting however does not seem to operate within this frame of reasoning which suggests that the actual inflation can be adjusted to hit the target inflation within a short period if a deviation is observed. This belief is just deceptive. What happens is merely the suppression of the truth about the prevailing conditions of inflation. According to the previous points, if we recognize the causes and uproot the inflation in Egyptian economy, then that problem is almost solved. It is expected that the focus of

\(^{21}\) All variables are in logs for all variables except interest rate where we have used the level.

\(^{22}\) This is expected since in a small open economy like Egypt, prices of traded goods return rapidly to world levels following an exchange rate appreciation.

---

Table 2. Granger Causality Tests: Baseline VAR, 1998–2009 1/.

<table>
<thead>
<tr>
<th>Effect on CPI</th>
<th>Chi-square probability</th>
<th>Effect on GDP</th>
<th>Chi-square probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>15.14</td>
<td>0.001*</td>
<td>CPI</td>
</tr>
<tr>
<td>ME</td>
<td>3.10</td>
<td>0.681</td>
<td>M2</td>
</tr>
<tr>
<td>FS</td>
<td>8.45</td>
<td>0.057**</td>
<td>FS</td>
</tr>
<tr>
<td>R</td>
<td>5.66</td>
<td>0.249</td>
<td>R</td>
</tr>
<tr>
<td>EX</td>
<td>12.84</td>
<td>0.003*</td>
<td>EX</td>
</tr>
<tr>
<td>Jointly</td>
<td>33.67</td>
<td>0.000*</td>
<td>Jointly</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations.

1/ The block Granger causality test for exclusion of a variable is based on a Wald test and follows a \( \chi^2 \) distribution; * and ** denote rejection of the exclusion at the 1 and 5 percent level.
monetary policy should be on the management of the primary source of inflation which in itself is unrestricted fiscal, monetary and credit expansion by the government using the instrumentality of the bank. What this means is that the central bank should first of all manage the money creation process from both the financing of government’s fiscal deficits as well as the growing penchant for loosening banks credit creation capacity. Once this is resolved within the context of the rule of law, the efficient justice system for the protection of private property rights, and eradication (or serious reduction) of public sector corruption, inflation will naturally drop to very low minimums and the economy will grow very strongly.

5. Concluding Remarks

This paper gave a systematic review of the Inflation targeting regime. The fundamental question was whether scientific evidence— theoretical and empirical—exists to support the inflation targeting regime. A closer look at the Egypt case was presented by reviewing recent evidence. The fundamental question was whether it is ready to switch to the inflation targeting regime. The paper concluded that: 1) There is insufficient evidence to show that an inflation targeting regime is effective as a monetary policy framework for the achievement of macroeconomic stability or price stability, and 2) the Central bank of Egypt and by extension, Egypt, is not yet ready for the implementation of the inflation targeting framework. This is because the stringent conditions required—based on the experiences of countries who have adopted it—are not yet met, and 3) more research should be conducted on main sources of inflation in the Egyptian economy in order to give a more informed picture to policy makers so they can adopt better policies according evidence.

6. References


Environmental Standards and Trade Volume

Nicholas Mangee*, Bruce Elmslie
University of New Hampshire, Department of Economics, Whittemore School of Business and Economics, Durham USA
E-mail: njf7@unh.edu, bte@cisunix.unh.edu
Received June 10, 2010; revised July 20, 2010; accepted July 24, 2010

Abstract

This paper presents a theoretical and empirical analysis of the effects of environmental regulation on bilateral trade volume. We use a gravity model of trade flows and find weak evidence that differences in regulation are a source of comparative advantage. We also find evidence against the race-to-the-bottom hypothesis in that increases in standards in both high and low standard countries increase bilateral trade volume. We use 1999 data on GDP, population, and environmental stringency for 39 countries.

Keywords: Environmental Standards, Trade Volume, Gravity Model, Comparative Advantage

1. Introduction

The link between environmental regulation and international trade has warranted considerable attention by economists, environmentalists and policy makers alike. A substantial amount of theoretical and empirical research has addressed the question of how environmental stringency affects international trade. Conventional trade theory suggests that country characteristics, such as land and capital define comparative advantage. Environmental quality, endowments, capacities and policies have also been considered as determinants of each country’s comparative advantage\(^1\).

This paper develops a model of comparative advantage based on differences in environmental regulation between countries. We then use a gravity model to test the hypothesis that as the differences in environmental regulation across countries increase, bilateral trade flows also increase as predicted by the theory. Differences in regulation are found to have a positive but weak effect on bilateral trade volume.

This result could also be consistent with a race-to-the-bottom in terms of environmental standards for low standard countries. Therefore, we develop a second test between overall standards and trade volume. We find strong evidence that increased standards by both countries promotes bilateral trade volume. Thus, even if trade volume is positively associated with differences in regulation, no incentive appears to exist for low standard countries to increase trade flows by lowering standards.

The existing literature has yet to demonstrate the effect of differentiated regulation on gross bilateral trade flows across a large set of countries. Previous studies have examined the effect that regulation has on the composition of trade regarding one country or a small set of countries. Other studies have demonstrated regulation in isolation, failing to examine the collective differences between stringency as a source of comparative advantage. Given the ubiquitous nature of comparative advantage in the theoretical determination of trade patterns between countries, it is surprising that many of the existing studies have eschewed this approach. This paper represents the first study of the effects of environmental regulation on trade volume that fully incorporates comparative advantages created by differentiated environmental regulation between trading partners.

Within the last three decades, two popular positions have emerged regarding the interaction of stringency and international trade in environmentally intensive goods rather than in overall trade volume. The first hypothesis suggests that, as a country imposes higher environmental regulations, the cost of production increases. This may result in a decrease in exports of pollution intensive goods and an increase in imports. Thus, higher stringency may lead to a decrease in comparative advantage in pollution intensive goods for a country \(^3\). Furthermore, to maintain international competitiveness, a country may purposefully set lax environmental standards. This potential global degradation in stringency is consistent with the race-to-the-bottom hypothesis. These theories hypothesize that in order to not lose the business...

\(^*\)We want to thank Robert Mohr, Michael Goldberg, Edinaldo Tebaldi, Torsten Schmidt and Sinthy Kounlasa for useful discussion and assistance.

\(^1\)For analysis on the environment and comparative advantage see Pethig [1] and Siebert [2].
of pollution intensive goods whose production may be shipped abroad, countries deliberately race-to-the-bottom in environmental regulations. Similarly, these costs incurred by increasing a firm’s total cost of production coupled with the “pollution haven hypothesis” suggest that pollution intensive production will migrate to regions of lax regulations [5,6]. With low environmental demand, developing countries may attempt to increase their share of the global market by setting lax regulations creating a comparative advantage in pollution intensive goods [7]. The empirical performance of these hypotheses has been poor [3,8,9]. Our results represent the first clear empirical case that comparative advantage is not associated with the development of pollution havens, because higher standards of low standard countries increases rather than decreases bilateral trade volume.

The contrasting hypothesis concerning the effect of environmental stringency on foreign trade is the Porter hypothesis [10,11]. This hypothesis predicts that an increase in environmental regulations will stimulate advancements in environmentally friendly technology. This tightening of standards will encourage firms to seek new technology for the long run and possibly differentiate their products by producing environmentally friendly ones. Porter, however, makes no distinction between high and low standard countries in terms of the relationship between inventiveness and trade volume. However, a loose interpretation of Porter is that countries should not fear that increased regulation will necessarily decrease trade volume. It may even increase trade volume as increased standards increase the incentive to innovate. The test that we develop supports this loose interpretation of Porter.

2. Empirical Framework and Literature Review

There is a vast literature on the relationship between standards and international trade. Typically, the methodological approach for determining the effect of regulation on trade involves a supply side model incorporating the determinants of international trade. The conventional supply side approach has followed a Heckscher-Ohlin-Samuelson (HOS) theoretical framework and often the Heckscher-Ohlin-Vanek (HOV) model in empirical work.

The HOS model predicts that a country will export the good that intensively uses its relatively abundant factor. The environment is incorporated in HOS as a factor of production predicting that a country with a greater environmental capacity for pollutants is relatively better endowed and will export pollution intensive goods. The HOV model allows for a direct empirical test by predicting the factor composition of trade for a country based on factor abundance. This model has been widely applied within the environmental trade literature as it allows for trade to be decomposed by pollution intensity and industry.

Tobey [9] uses a cross section HOV model to investigate whether increased domestic regulation during the 1960’s and 1970’s affected trade patterns in pollution intensive industries. Using 23 countries and 1975 data, he regresses trade in pollution intensive commodities across countries on resource endowment characteristics such as land area, literate workers, and capital. The results suggest that there is no significant effect of increased environmental stringency on net exports of pollution intensive goods. Tobey [9] does not investigate the role of regulatory differences specifically in explaining trade flows between countries.

Ratnayake [3] takes an inter industry trade approach consisting of 109 industries over a 13 year period (1980-1993) in New Zealand. Following the HOS/HOV models, New Zealand, as a developed capital abundant country is expected to possess a comparative advantage in the production of goods that intensively use capital in production. Ratnayake uses a revealed comparative advantage (RCA) index to determine if increased environmental standards lead to a decrease in competitiveness in the manufacturing sector. By comparing trade behavior of New Zealand’s to four other country groups (world, OECD, ASEAN, and DC’s) this study finds that, in spite of high environmental stringency in New Zealand, it’s exports in pollution intensive, or environmentally sensitive goods was not decreased.

Unlike Ratnayake, a number of other studies have shown an increase in environmental standards to have a negative impact on the exports of pollution intensive industries. Wilson and colleagues [14] takes a developing country perspective of stringency on trade by examining the export behavior of 24 countries (6 OECD and 18 non-OECD) between 1994 and 1998 for 5 pollution intensive industries. Utilizing the HOV model, this study finds that more stringent environmental standards result in lower exports of pollution intensive goods. Moreover, this study suggests that increased environmental standards have a significantly greater impact on exports of developing countries than developed ones.

It is well known that the HOV equation is inconsistent with trade data [15]. Given these weak general foundations, it is not surprising that the results of HOV models applied to the relationship between environmental standards and trade volume have been inconsistent at best. Alternative approaches, therefore, need to be considered.

Given the empirical problems with the HOV model, we utilize a gravity framework that incorporates differentiated environmental regulation as a source of bilateral trade volume. Such a model of international trade was first developed by Tinbergen [16] to model trade volume.
between two countries in terms of their GDP’s and the geographical distance between them. The gravity model, after being log linearized, takes the following form:

\[ \ln X_{ij} = \beta_0 + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 DIST_{ij} + \nu_{ij} \]  

(1)

Where:
\[ \ln \] denotes the natural logarithm;
\[ X_{ij} \] denotes gross bilateral trade flows between country \( i \) and \( j \);
\[ GDP_i, GDP_j \] denote the GDP of country \( i \) and \( j \) respectively;
\[ DIST_{ij} \] denotes the distance between country \( i \) and \( j \);
\[ \nu_{ij} \] denotes the error term.
\[ \beta_0, \beta_1, \beta_2, \beta_3 \] are parameters.

The expected relationship between these variables is as follows: since the dependent variable is gross bilateral trade volume, the signs of \( \beta_1 \) and \( \beta_2 \) are expected to be positive since larger countries trade more with each other. The parameter \( \beta_3 \) is expected to be negative due to transportation costs. However, the variable \( DIST_{ij} \) may represent any factor that impedes trade. Such factors that have been considered include language, historical, and cultural differences. These characteristics are expected to have a negative relationship with the volume of trade between two countries. In addition, a dummy variable controlling for a border effect is often included in empirical work and is normally found to be significant and positive for countries sharing a border. The gravity model is used in the present study because it incorporates gross bilateral trade volume between countries as the dependant variable and it allows for a large number of countries to be analyzed. Furthermore, in contrast to the HOS/HOV performance, the gravity model performs much better empirically. The gravity model has not yet been utilized as a theoretical tool revealing comparative advantage arising from differences in environmental regulation.

The empirical literature incorporating regulation into the gravity model include Jug and Mirza [18]; Grether and Melo [5]; Van Beers and Van Den Bergh [19]; and Harris and colleagues [20]. Some studies applying the gravity model decompose total trade into imports and exports and further into (non) pollution intensive imports and/or exports, in an attempt to capture the effect of increased stringency on total trade volume. Jug and Mirza [18] show that increases in environmental expenditures result in a decrease in net exports. These results are consistent with the pollution havens hypothesis and run counter to our so-called “loose” interpretation of the Porter hypothesis.

In testing the effects of increased stringency on bilateral exports, Van Beers and Van Den Bergh [19] find a strong negative relationship between total exports and total imports of 21 OECD countries. Part of this study gives evidence to support the pollution havens hypothesis while the negative effect of standards on a developed country’s imports presents a surprising result. This result may suggest the presence of import barriers when regulation is increased within a country. Another study that decomposes bilateral trade volume into imports and exports is Grether and Melo [5]. They test total imports against pollution intensive imports as well as non-resource based (footloose) imports against resource based (non-footloose) imports. This study finds support for the pollution haven hypothesis for the footloose industries due to the increase in imports for developed countries when firms are allowed to migrate across countries.

The gravity studies have shown no robust conclusive evidence of the effect of regulation on trade flows [18]. The lack of consensus within this literature may stem from the lack of a comprehensive measure of the environment or regulatory stringency. Measures of stringency should incorporate various indicators of a country’s standards, enforcement and policy implementation. Most data sets used in previous studies are either not comprehensive or they cover a small sample of countries. The present study utilizes a recent 2001 comprehensive measure of environmental stringency over a large sample of countries. In addition to the data problem, the literature to date has been limited by the Solomon-like choice between theory and empirics. Researchers choosing the general HOS-HOV approach are able to base their study on a solid theoretical foundation, but must pay in terms of weak empirical support. The well-known empirical shortcomings of the HOV model with regard to the factor content of trade in factors such as capital and various qualities of labor also plague environmental endowment measures. On the other hand, researchers choosing the gravity approach are able to tap into a solid empirical framework but must pay in terms of theoretical underpinnings. As a result, this literature has developed on an ad hoc basis.

We argue that such a choice is not necessary. We augment the work of Helpman and Krugman [21] and Helpman [22] on the theoretical foundation of a gravity equation to make theoretical predictions regarding the effect of differential standards on trade volume. In so doing, we are able to develop an empirical gravity model with the strong theoretical underpinnings of an HOS approach.

3. Theory

The relationship between environmental standards and
bilateral trade volume can be developed in a straightforward manner using a $2 \times 2 \times 2$ factor proportions model. However, as a basis for empirical work using a gravity equation, the factor proportions model has little to contribute. In this section we first develop the factor proportions model using the environment as one factor of production. Then we extend the analysis to allow for one sector to produce differentiated products within a monopolistically competitive setting. This approach allows for the gravity model and comparative advantage based on differential environmental standards to jointly determine trade volume.

3.1. The Factor Proportions Model

Consider a $2 \times 2 \times 2$ economy producing goods manufacture (M) and food (F) with factors labor (L) and the environment (E). The manufactured good is E intensive. Consumers in each country maximize identical homothetic utility functions. Foreign variables will be designated by $\ast$.

Figure 1 shows the relevant factor-price equalization set for such an economy. O is the Home origin.

The world output of M and F are given by $OA(O \ast A')$ and $OA'(O \ast A)$ respectively.

First, allow the relative endowments to be equal between countries so that the endowment point falls on the diagonal such as at point C. Home production and consumption of the manufactured good and food are at $OC_M$ and $OC_F$ respectively. Thus with equal relative endowments, autarky prevails.

Next allow the relative endowment to move along line segment $B'B$ from C to G. Relative consumption remains at C, but production of M increases for Home to $OQ_M$, while foreign production of M decreases from $C_MA$ to $Q_MA$. Similarly for food, Home production falls to $OQ_F$ while Foreign production increases to $A'Q_F$. Home exports $Q_MC_M$ and imports $C_FQ_F$.

However, the move need not be along a given relative GDP line. Under factor-proportions theory trade volume ($VT$) is a function of relative endowment differences. Thus country size is not an independent determinant of trade volume. As shown in another form by Helpman and Krugman [21], assuming Home is E abundant:

$$VT = \lambda_E E + \lambda_L L$$

where $\lambda_E > 0$ and $\lambda_L < 0$ above the diagonal $OO^\ast$. Therefore isolate lines within the factor-price equalization set $OA'O' \ast$ are linear with slopes $OO^\ast$ and with $VT$ increasing monotonically from zero along $OO^\ast$ to a maximum when relative endowments are at $A(A')$. This can be expressed as Proposition 1.

![Figure 1. Factor-price equalization set for economy.](image-url)
Proposition 1
Trade volume within the factor-price equalization set is maximized when relative endowment differences are maximized.

Within the factor-price equalization set the world endowment of E and L are fixed at OE and OL respectively. Utilizing such a framework the effect of differential environmental standards takes on a very particular interpretation. Beginning with the endowment at C, a move from C involves a switching of either or both factors between countries. For example, a move from C to H implies that Foreign gives CH of its environmental endowment to Home.

While such an exercise is useful to see how environmental policy can influence comparative advantage, it is not a realistic interpretation of operating standards. A more realistic interpretation of an increase in environmental standards is the decreasing of a country’s effective environmental endowment while holding the other country’s endowment fixed. Using this interpretation necessarily involves moving from one factor-price equalization set to another. However, the analysis is surprisingly simple.

Consider the original endowment point at C. This point is on the VT = 0 isotrade line. If the foreign country adopts environmental standards that decrease its endowment, the world endowment of environment is decreased from OE to OE’. The new origin for Foreign is O’. The new diagonal is shown as OO’. Now C is above the new OO’ VT = 0 isotrade line. Thus, the change in standards for Foreign away from those of Home increases trade volume. Given linear isotrade lines this is a general result and can be expressed as Proposition 2.

Proposition 2
Within the factor proportions model, a change in environmental regulation that increases relative endowment differences between countries increases trade volume.

b) Monopolistic Competition
Proposition 2 generates an empirically testable link between relative regulatory environmental differences and trade volume. However, it is inconsistent with an empirical model that includes country size as an independent determinant of trade volume. Therefore, we move to a monopolistically competitive setting that links relative standards and trade volume within a gravity framework.

Allow M to be monopolistically competitive where each variety m is equally priced, equally produced and earns zero profit. OA is now interpreted as many varieties of M. If n is the number of firms in industry M, m = M/n.

Returning to Figure 1, allow the initial endowment to be at G. Given that m = m*, Home is a net exporter of manufacturing goods. The value of Home exports is Foreign’s share of world GDP (s*) times the value of Home production of M, s* p_H^m. Let the Home production of varieties be given by M_H = mn. Given that trade must be balanced in the absence of international borrowing overall trade volume is:

\[ VT = 2s* p_H^m n = 2s* p_H M_H \] (3)

Assume each country is of equal size in terms of world GDP. The situation is depicted in Figure 2 where OC = O’C and the endowment point is G.

Using the standard log differentiation of 3 generates:

\[ \hat{VT} = \hat{s} + \hat{M_H} \] (4)

Given that GDP + GDP* = world GDP which is constant:

\[ \hat{s} = \hat{GD}P* = \frac{-\hat{s}}{s} \hat{GD}P \] (5)

Along OZ, \( GD = \hat{M_H} \) so \( \hat{VT} = \frac{-\hat{s}}{s} \hat{GD}P + \hat{GD}P \),
or

\[ \hat{VT} = \left(1 - \frac{s}{s*}\right) \hat{GD}P \] (6)

Using Equation (6), at G, \( \frac{s}{s*} = 1 \) implying that \( \hat{VT} = 0 \). Moving from O to G along OZ, s* > s implying that \( \hat{VT} > 0 \). Moving from G to Z, s > s*, thus \( \hat{VT} < 0 \). Trade volume increases from O to G and decreases from G to Z leading to Proposition 3.

Proposition 3
Trade volume is maximized when countries are of equal size (gravity equation).

Now, allow the endowment point to move from C along BB* to G’ so that holding relative size constant, Home is getting more E abundant. Along BB’ \( \hat{s} = 0 \), thus:

\[ \hat{VT} = \hat{M_H} \] (7)

From C to G’, \( \hat{M_H} > O \), trade volume is increasing resulting in Proposition 4.

Proposition 4
Within a factor-price equalization set, given country size is constant, trade volume increases as endowments become less similar.

Taking Propositions 3 and 4 together trade volume is maximized at G’. Holding country size constant, as environmental regulations effectively makes the relative
endowments less similar between countries, bilateral trade volume increases. However, interpreting an increase in regulation as decreasing the effective size of the environmental endowment has a negative effect on GDP. Given the non linearity of isotrade lines within the monopolistic competitive framework [21], no general proposition can be stated beyond Proposition 4.

Our empirical framework is developed using Proposition 4. In that framework we regress bilateral trade volume against, size, distance and environmental standards. The coefficient on environmental standards is interpreted holding relative size constant, thus moving along $BB'$ toward $G'$ is a change in relative environmental standards. From Propositions 2 and 4, the models based on the factor proportions model of interindustry trade predict that increases in the differences in stringency of environmental standards between countries increases bilateral trade volume.

4. The Environmental Index

The environmental index utilized in this study comes from the Global Competitiveness Report 2001-2002 [23].

The Environmental Regulatory Regime Index (ERRI) captures the effects of several variables in constructing one absolute ranking for 71 countries to measure environmental stringency\(^5\). This number of countries far exceeds other indices such as Walter and Ugelow [24] and Dasgupta and colleagues [25] which include 23 and 31 countries respectively. The absolute ranking in the ERI for each country ranges from -1.743 for Paraguay to 2.303 for Finland. The statistical methodology follows bilateral regressions and collects all significant variables to construct the ERI.

For the purposes of the present paper, the variables that directly influence the ERI are presented in detail below. For an explanation of the dependent variables and other indirect explanatory variables within the index see the Appendix. The ERI is divided into two groups of independent variables. The first group is comprised of six categories: 1) stringency and environmental pollution standards, 2) sophistication of regulatory structure, 3) quality of the environmental information available, 4) extent of subsidization of natural resources, 5) strictness of government, and 6) quality of environmental institutions [23].

The six indicators of environmental stringency listed above give a very inclusive measure for regulation. Insight into a country’s regulatory regime can be collected from these indicators because a variety of data collection processes are utilized in their construction.\(^6\) The data

\(^5\)For a list of all 71 countries see Etsy and Porter [23].

\(^6\)Data sources include the Global Competitiveness Report (GCR), Environmental Sensitivity Index (ESI), World Bank, and the World Economic Forum [23,26].
sources are mentioned below with a detailed description of the stringency indicator. The variables mentioned below represent the best available and comprise one of the most extensive, inclusive and accurate measurements of a country’s environmental stringency.

The stringency and pollution standards category uses the Global Competitiveness Report (GCR) survey to measure air, water, toxic waste, and chemical regulation for a country. It is expected that this regulatory measure has an inverse relationship with all three dependent variables defined in the Appendix. Higher regulation results in lower urban particulates, lower SO2 concentrations and greater energy efficiency.

The sophistication of regulatory structure category measures the characteristics of the regime. This concerns the clarity in which the regulations are defined, the progressive nature of the regime, the structure of the regime to promote competitiveness, and the relationship between business and government. This category is also expected to have an inverse relationship with the environmental performance (dependent) variables.

The category regarding the quality of environmental information available rests on data from the World Economic Forum and the Environmental Sustainability Index (ESI). This measures the extent to which environmental and economic data are available for policy making and regulatory enforcement. This study relies on four proxy variables for this measure: 1) the extent to which data is collected, 2) the extent to which sustainable development data is available coupled with plans supporting environmental policy, 3) structure assessing environmental decisions, and 4) the extent to which a country has plans for environmental action. Again, there should be a negative relationship between this category and the dependent variables.

The extent of the subsidization of natural resources category recovers data from the GCR survey. This captures the extent to which a country subsidizes energy and natural resources. However, there is expected to be a positive relationship between the natural resource subsidies and the three environmental performance variables.

The strictness of enforcement category measures two factors within a country. The enforcement of environmental regulations are measured coupled with the extent to which a country follows through with international agreements regarding environmental policy. There should be an inverse relationship between this measure and the dependent variables as countries that have high environmental enforcement should expect to have lower level of pollution concentration and higher energy efficiency.

The final category involves the quality of environmental institutions of a country. This measure captures the effect that nongovernmental organizations (NGOs) have on enforcing the environmental decisions and actions of the government. This may include environmental organizations that further research to aid government endeavors or even institutions that become substitutes for the governmental sector. These NGOs may increase a country’s ability to control for pollution by increasing awareness and information on environmental issues. Data is gathered from the ESI and this measure is expected to have a negative relationship with the dependent variables.

5. Empirical Analysis and Data

The data on bilateral trade volume was recovered from the World Bank for 1999. The aggregate of bilateral trade volume from country i to country j was collected by summing the total exports from i to j with the imports from j to i. Since, duplicate pairings within the data set would cause statistical problems the country that is alphabetically first was considered i and no duplicate pairings were included. Table 1 expresses the pairings of bilateral trade volume and ERRI Index value for each country.

The data for the remaining variables was collected as follows. The real 1999 GDP data is in billions of 2000 U.S. dollars while the per capita 1999 data was in 2000 U.S. dollars and found at the World Bank development indicators. The distance measure is in kilometers.\(^7\) This model is measured across 39 countries for the year 1999.\(^8\)

The gravity model augmented to include differences in environmental regulation is given in Equation (8). Equations (9) to (11) represent logical extensions of the model that are explained in more detail below. Each country’s ERRI number is represented as \(R\). The well-known effect of sharing a border is represented with a dummy variable \(\delta\) with a value of 1 representing countries i and j sharing a border.

\[
\ln X_{ij} = \theta_0 + \theta_1 \ln GDP_i + \theta_2 \ln GDP_j + \theta_3 \ln \text{DIST}_{ij} + \theta_4 \ln R_i - R_j + \theta_5 \delta_{ij}
\]

\[
\ln X_{ij} = \theta_0 + \theta_1 \ln GDP_i + \theta_2 \ln GDP_j + \theta_3 \ln \text{DIST}_{ij} + \theta_4 \ln R_i - R_j
\]

\[
+ \theta_5 \left[ \ln \left| R_i - R_j \right| + \delta_{ij} \right] + \theta_6 \ln \left| \ln \frac{R_i}{R_j} \right|^2 + \theta_7 R_i - R_j
\]
Table 1. Pairings of bilateral trade volume and ERRI index across countries.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>23.98</td>
<td>-0.732</td>
</tr>
<tr>
<td>Australia</td>
<td>69.11</td>
<td>1.083</td>
</tr>
<tr>
<td>Austria</td>
<td>49.67</td>
<td>1.641</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>3.30</td>
<td>-0.584</td>
</tr>
<tr>
<td>Bolivia</td>
<td>2.22</td>
<td>-0.743</td>
</tr>
<tr>
<td>Canada</td>
<td>370.96</td>
<td>1.297</td>
</tr>
<tr>
<td>Chile</td>
<td>17.77</td>
<td>0.177</td>
</tr>
<tr>
<td>China</td>
<td>220.04</td>
<td>-0.348</td>
</tr>
<tr>
<td>Colombia</td>
<td>11.88</td>
<td>-0.416</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>7.63</td>
<td>-0.078</td>
</tr>
<tr>
<td>Denmark</td>
<td>52.82</td>
<td>1.384</td>
</tr>
<tr>
<td>Ecuador</td>
<td>3.29</td>
<td>-1.616</td>
</tr>
<tr>
<td>Egypt</td>
<td>1.51</td>
<td>-0.224</td>
</tr>
<tr>
<td>Finland</td>
<td>45.11</td>
<td>2.303</td>
</tr>
<tr>
<td>France</td>
<td>312.75</td>
<td>1.464</td>
</tr>
<tr>
<td>Greece</td>
<td>21.68</td>
<td>-0.619</td>
</tr>
<tr>
<td>Hungary</td>
<td>12.45</td>
<td>0.283</td>
</tr>
<tr>
<td>Indonesia</td>
<td>46.19</td>
<td>-0.758</td>
</tr>
<tr>
<td>India</td>
<td>34.47</td>
<td>-0.759</td>
</tr>
<tr>
<td>Ireland</td>
<td>82.67</td>
<td>0.546</td>
</tr>
<tr>
<td>Italy</td>
<td>228.14</td>
<td>0.498</td>
</tr>
<tr>
<td>Jordan</td>
<td>2.23</td>
<td>0.002</td>
</tr>
<tr>
<td>Japan</td>
<td>473.60</td>
<td>1.057</td>
</tr>
<tr>
<td>Korea</td>
<td>168.83</td>
<td>-0.121</td>
</tr>
<tr>
<td>Mexico</td>
<td>240.43</td>
<td>-0.602</td>
</tr>
<tr>
<td>Malaysia</td>
<td>85.43</td>
<td>-0.127</td>
</tr>
<tr>
<td>Netherlands</td>
<td>177.71</td>
<td>1.747</td>
</tr>
<tr>
<td>Norway</td>
<td>34.67</td>
<td>1.045</td>
</tr>
<tr>
<td>New Zealand</td>
<td>18.47</td>
<td>1.299</td>
</tr>
<tr>
<td>Peru</td>
<td>6.74</td>
<td>-0.722</td>
</tr>
<tr>
<td>Philippines</td>
<td>31.96</td>
<td>-1.014</td>
</tr>
<tr>
<td>Poland</td>
<td>24.08</td>
<td>0.005</td>
</tr>
<tr>
<td>Portugal</td>
<td>38.48</td>
<td>-0.028</td>
</tr>
<tr>
<td>Spain</td>
<td>158.27</td>
<td>0.437</td>
</tr>
<tr>
<td>Sweden</td>
<td>75.25</td>
<td>1.772</td>
</tr>
<tr>
<td>Thailand</td>
<td>54.68</td>
<td>-0.389</td>
</tr>
<tr>
<td>UK</td>
<td>345.73</td>
<td>1.185</td>
</tr>
<tr>
<td>United States</td>
<td>815.80</td>
<td>1.184</td>
</tr>
<tr>
<td>Venezuela</td>
<td>17.79</td>
<td>-1.079</td>
</tr>
</tbody>
</table>

*Bilateral trade volume based on sample of 39 countries

\[
\ln X_{ij} = \theta_0 + \theta_1 \ln GDP_i + \theta_2 \ln GDP_j + \theta_3 \delta_{ij} + \theta_4 \ln \text{DIST}_{ij} + \theta_5 \min (R_i - R_j) + \theta_6 \max (R_i, R_j) + \theta_7
\]

(11)

The results from Equations (8) through (11) are presented in Table 2. Equation (8) represents the log linearized gravity model with a regulatory distance variable, \( \left| R_i - R_j \right| \), included as the absolute value of environmental differences. The absolute value is used to express the effective differences without regard to sign. Gravity theory suggests that the larger the masses the greater the force. The significance of both \( GDP_i \) and \( GDP_j \) is no surprise as larger countries trade more with each other. As we further expect, there is a significant positive border effect captured by \( \delta_{ij} \) and a significant negative distance effect captured by \( \text{DIST}_{ij} \). These four measures appear strongly significant across the four equations above. The regulatory distance, \( \left| R_i - R_j \right| \), displays a positive but weak effect on bilateral trade volume.

Equation (9) includes a quadratic regulatory distance term, \( \left| R_i - R_j \right|^2 \), measuring any diminishing affect of differences in standards. We would expect that this measurement be negative. The natural logarithm is dropped in this regression to avoid perfect multicollinearity among the exogenous variables. The absolute distance is still weakly positive but the point estimate is indicating a much stronger effect. The quadratic measure expresses a very weak negative relationship.

Equations (10) and (11) add the log of the minimum and maximum regulations per country. The results from Equations (8) and (9) can be interpreted as giving weak support to the pollution havens hypothesis and the race-to-the-bottom for low standard countries since a decrease in standards for the low standard country increases trade volume. To better control for this effect, we add the high and low value of standards. A negative value on \( \theta_7 \), which is the coefficient for the low standard country, would indicate that a decrease in standards of the low standard country increases trade volume. Both regressions produce positive and generally significant effects of increased standards on trade volume for each country. When the regulatory distance measure is dropped, Equation (11) shows a positive and significant relationship between an increase in the standards of the higher regulated country and trade volume. Both equations yield results refuting the race-to-the-bottom hypothesis. No country has an incentive to lower environmental standards in order to increase bilateral trade volume given that the coefficient for the low standards country is positive and significant at the 10% level in both equations.10

9The original ERRI values ran from −1.743 to 2.303. In order to take the natural log of the max and min we added 2 to each value insuring that all values are positive.

10We also ran regressions without taking the natural log of \( R_{\text{max}} \) and \( R_{\text{min}} \). The results were consistent though less significant.
Table 2. Results from OLS regression of the natural log of bilateral trade volume between country i and j on explanatory variables in column one.

<table>
<thead>
<tr>
<th></th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln GDPi</td>
<td>1.061***</td>
<td>1.059***</td>
<td>1.025***</td>
<td>1.024***</td>
</tr>
<tr>
<td></td>
<td>(35.75)</td>
<td>(35.57)</td>
<td>(32.52)</td>
<td>(32.46)</td>
</tr>
<tr>
<td>ln GDPj</td>
<td>0.941***</td>
<td>0.939***</td>
<td>0.909***</td>
<td>0.911***</td>
</tr>
<tr>
<td></td>
<td>(31.41)</td>
<td>(31.29)</td>
<td>(28.99)</td>
<td>(28.90)</td>
</tr>
<tr>
<td>δij</td>
<td>1.268***</td>
<td>1.268***</td>
<td>1.344***</td>
<td>1.346***</td>
</tr>
<tr>
<td></td>
<td>(4.20)</td>
<td>(4.20)</td>
<td>(4.47)</td>
<td>(4.48)</td>
</tr>
<tr>
<td>ln DISTij</td>
<td>-0.897***</td>
<td>-0.897***</td>
<td>-0.848***</td>
<td>-0.852***</td>
</tr>
<tr>
<td></td>
<td>(-16.35)</td>
<td>(-16.29)</td>
<td>(-14.98)</td>
<td>(-14.98)</td>
</tr>
<tr>
<td></td>
<td>0.217</td>
<td>0.217</td>
<td>0.287</td>
<td>0.287</td>
</tr>
<tr>
<td></td>
<td>(1.15)</td>
<td>(1.15)</td>
<td>(1.11)</td>
<td>(1.11)</td>
</tr>
<tr>
<td>ln</td>
<td>0.038</td>
<td>0.034</td>
<td>0.038</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>(0.96)</td>
<td>(0.53)</td>
<td>(0.96)</td>
<td>(0.53)</td>
</tr>
<tr>
<td>ln</td>
<td>-0.059</td>
<td>-0.059</td>
<td>-0.041</td>
<td>-0.041</td>
</tr>
<tr>
<td></td>
<td>(-0.88)</td>
<td>(-0.88)</td>
<td>(-0.88)</td>
<td>(-0.88)</td>
</tr>
<tr>
<td>ln min</td>
<td>0.269*</td>
<td>0.269*</td>
<td>0.235</td>
<td>0.235</td>
</tr>
<tr>
<td></td>
<td>(1.68)</td>
<td>(1.68)</td>
<td>(0.94)</td>
<td>(0.94)</td>
</tr>
<tr>
<td>ln max</td>
<td>-0.076</td>
<td>-0.076</td>
<td>-0.076</td>
<td>-0.076</td>
</tr>
<tr>
<td></td>
<td>(-0.16)</td>
<td>(-0.16)</td>
<td>(-0.16)</td>
<td>(-0.16)</td>
</tr>
</tbody>
</table>

*,**,*** denotes significance levels of 90%, 95%, and 99% respectively. Test statistics are in parentheses.

Where: ln denotes the natural logarithm; Xij denotes gross bilateral trade flows between country i and j; GDPi, GDPj denote the GDP of country i and j respectively; DISTij denotes the distance between country i and j; δij denote the environmental regulation index of country i and j respectively; δij denotes a dummy variable equal to 1 if country i and j share a border, 0 otherwise;  ý denote the error terms.

To control for country size, per capita GDP is substituted into Equations (8), (9), (10), and (11) to generate Equations (12) through (15). A useful economic interpretation of the gravity model is that size is a measure of the purchasing power of each country. Therefore an alternative measure of size is income per capita. Countries closer in terms of per capita income will be expected to trade more.

\[
\ln X_{ij} = \theta_0 + \theta_1 \ln \left( \frac{GDP_i}{N_i} \right) + \theta_2 \ln \left( \frac{GDP_j}{N_j} \right) + \theta_3 \ln \left( \frac{GDP_i}{N_j} \right) + \theta_4 \ln \left( \frac{GDP_j}{N_i} \right) + \theta_5 \ln \left( \frac{GDP_i}{N_i} \right) + \theta_6 \ln \left( \frac{GDP_j}{N_j} \right)
\]

The results from Equations 12 through 15 are presented in Table 3. Surprisingly, Equation (12) shows a negative but insignificant relationship between regulatory differences and trade volume. In controlling for diminishing returns by including the quadratic term, Equation (13) shows a positive marginally significant effect. As found in the previous results, Equations (14) and (15) present strong evidence against the race-to-the-bottom hypothesis. Holding income per capita, distance, borders, and regulatory differences constant, increased standards of the low standard country increases trade volume. The point estimates indicate that a 1% increase in the standards of the low standard country results in an increase of trade volume of 0.8% and 0.9%. Using the ERRI these results indicate that, for example, countries with index values of 2 and 1.5 trade more with each other than countries with index values with 1 and 0.5 even after controlling for the effect of income per capita.
Table 3. Results from OLS regression of the natural log of bilateral trade volume between country i and j on explanatory variables in column one.

<table>
<thead>
<tr>
<th></th>
<th>(12)</th>
<th>(13)</th>
<th>(14)</th>
<th>(15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\ln \left( \frac{GDP_i}{N_i} \right)$</td>
<td>0.742***</td>
<td>0.737***</td>
<td>0.572***</td>
<td>0.601***</td>
</tr>
<tr>
<td></td>
<td>(11.58)</td>
<td>(11.49)</td>
<td>(6.59)</td>
<td>(6.64)</td>
</tr>
<tr>
<td>$\ln \left( \frac{GDP_j}{N_j} \right)$</td>
<td>0.65***</td>
<td>0.641***</td>
<td>0.483***</td>
<td>0.516***</td>
</tr>
<tr>
<td></td>
<td>(9.88)</td>
<td>(9.74)</td>
<td>(5.52)</td>
<td>(5.55)</td>
</tr>
<tr>
<td>$\delta_D$</td>
<td>1.139**</td>
<td>1.151**</td>
<td>1.284**</td>
<td>1.29**</td>
</tr>
<tr>
<td></td>
<td>(2.14)</td>
<td>(2.17)</td>
<td>(2.43)</td>
<td>(2.45)</td>
</tr>
<tr>
<td>$\ln \text{DIST}_{ij}$</td>
<td>-0.677***</td>
<td>-0.663***</td>
<td>-0.626***</td>
<td>-0.629***</td>
</tr>
<tr>
<td></td>
<td>(-6.81)</td>
<td>(-6.65)</td>
<td>(-6.28)</td>
<td>(-6.33)</td>
</tr>
<tr>
<td>$\left</td>
<td>R_i - R_j \right</td>
<td>$</td>
<td>0.461</td>
<td>0.947**</td>
</tr>
<tr>
<td></td>
<td>(1.38)</td>
<td>(2.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\ln \left</td>
<td>R_i - R_j \right</td>
<td>$</td>
<td>-0.071</td>
<td>0.057</td>
</tr>
<tr>
<td></td>
<td>(-1.00)</td>
<td>(0.49)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\left</td>
<td>R_i - R_j \right</td>
<td>$</td>
<td>-0.217*</td>
<td>-0.185</td>
</tr>
<tr>
<td></td>
<td>(-1.84)</td>
<td>(-1.59)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\ln \min \left( R_i, R_j \right)$</td>
<td>0.931***</td>
<td>1.38***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.25)</td>
<td>(2.74)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\ln \max \left( R_i, R_j \right)$</td>
<td>0.109</td>
<td>-0.874</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>(-0.88)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**R**$^2$ = 0.332  **R**$^2$ = 0.335  **R**$^2$ = 0.338  **R**$^2$ = 0.347  
# of obs. = 741  # of obs. = 741  # of obs. = 741  # of obs. = 741

*,**,*** denotes significance levels of 90%, 95%, and 99% respectively. Test statistics are in parentheses.

6. Conclusions

This paper makes four contributions. First, we develop a theoretical model of the relationship between environmental standards and bilateral trade volume within a factor proportions framework. We further extend this model to consider monopolistic competition that generates a gravity equation. This allows us to produce an empirical equation of the relationship between standards and trade volume with strong theoretical foundations.

Second, we utilize a new more comprehensive index of environmental stringency in our empirical analysis of the stringency-trade volume relationship than has been utilized in previous studies. This index represents a comprehensive measure of overall environmental stringency by country and allows for a relatively large sample of countries. We conduct our empirical analysis over 39 developed and less developed countries.

Third, we fully utilize the concept of comparative advantage in a gravity equation framework to address the question of the relationship between environmental standards and bilateral trade volume. We find that differences in environmental standards have a weak but positive effect on trade volume. At the very least, our results indicate that differential standards between countries do not hinder trade volume. A country that is considering a unilateral move to increase standards will not appear to pay in terms of decreased trade volume.

Finally, we develop a test of whether low standard countries have an incentive to decrease standards in order to increase trade volume. Controlling for environmental differences, and measures of country size (GDP and GDP per capita) we find that trade volume increases as the standards of the low standard country increase. Countries higher on the ERRI trade more with each other than similarly differenced countries lower on the index. This evidence refutes the race-to-the-bottom and pollution havens hypotheses of trade, because neither high nor lower standard countries increase trade volume by reducing standards. All of our evidence runs in the opposite direction.

7. References


Appendix

There are three dependent variables used in the ERRI. They are 1) the level of urban particulate matter, 2) average SO$_2$ concentration which is normalized by urban population, 3) energy efficiency. Particulate matter is collected from the World Bank and the World Health organization (WHO). This measures the concentration of air-born dust and is therefore a measure of air quality. A higher particulate concentration corresponds to a higher pollution level. Similarly, the SO$_2$ concentration also measures the quality of air and serves as a gauge for levels of pollution. The energy efficiency measure utilizes U.S. Department of Energy data and captures the aggregate amount of energy consumption per unit of GDP for each country. The higher the level of energy efficiency the lower the amount of energy consumed per unit of GDP and therefore the more efficient a country’s energy consumption.

The ERRI is divided into two groups of independent variables. The first group is comprised of six categories: 1) stringency and environmental pollution standards, 2) sophistication of regulatory structure, 3) quality of the environmental information available, 4) extent of subsidization of natural resources, 5) strictness of government, and 6) quality of environmental institutions [23]. The second group of independent variables is concerned with a country’s economic and legal context. This group can be further divided into two categories: 1) administrative infrastructure which includes but is not limited to measures of civil/political rights, private property protection, corruption, and judiciary independence and 2) a country’s technical capacity measuring scientific and technological advancement. A number of proxies are used in this category such as the number of scientists and engineers, intellectual property protection, strength of scientific community, government commitment to technological research and advancements, and the adoption of foreign technologies.
A Modified Consumer Price Index*

Gonglin Yuan, Xiangrong Li

College of Mathematics and Information Science, Guangxi University, Nanning, China
E-mail: glyuan@gxu.edu.cn

Received June 2, 2010; revised July 3, 2010; accepted July 8, 2010

Abstract

It is well known that the Consumer Price Index (CPI), as a Laspeyres-type index, attempts to measure the average change in the prices paid by urban consumers for a fixed market of goods and services, and new samples for most item categories are routinely introduced over time to keep the CPI sample representative of consumer spending patterns. The CPI normally overstates the true rate of increase of the cost of living. In this paper, our main objective is to propose a new measurement in the CPI which combines with the Gross Domestic Product (GDP). This new method will make the bias effectively decreased.

Keywords: Consumer Price Index, Gross Domestic Product, Fixed Market Basket

1. Introduction

The CPI is defined by

\[ CPI = \frac{\sum P_b Q_b}{\sum P_{t-1} Q_b} \]  

where \( P_t \) is the price of an item in period \( t \), \( P_{t-1} \) is the price in a base period \( b \), and \( Q_b \) is an index of the quantity of an item in a base period \( b \). The CPI can provide an approximation to a cost-of-living index (CLI), measuring the average change in the prices paid by urban consumers for a fixed market basket of goods and services has many limitations when interpreted relative to a true CLI. For example, consumers shift spending patterns in response to changes in relative prices, items and outlets available in the original or base period disappear, and new items and outlets enter the marketplace. To alleviate some of these problems, the CPI uses a modified Laspeyres approach, which allows for product substitution and introduction of new samples of outlets and items [1].

It is important to have an assessment of the magnitude of the bias in the CPI. First, the CPI is the most widely followed measure of inflation. Users of all types, including members of the general public, policy makers, and participants in financial markets, should have the best information available concerning the size of the bias. Second, knowledge about the sources and magnitude of the bias could be important in guiding efforts to improve the index. Among other things, this type of knowledge is essential for judging the likely costs and benefits of investing additional resources in the index. Third, the CPI has a substantial effect on the Federal budget. This link between the CPI and the Federal budget has generated considerable political interest in the magnitude of the bias in the CPI.

Furthermore, price evaluations may be biased by perceptions of price unfairness [2], low purchase frequency and steep price changes of particular goods [3]. Although Kemp [4] to some extent dealt with general costs, the cognitive processes described typically comprise individual reactions to price changes of isolated goods and services, not to reactions of the general public to prices changes across consumption categories. At the aggregate level, the divergence between perceived and actual price changes cannot be fully explained from cognitive process. Economic data usually capture price changes by using price indices, which essentially reflect changes in aggregated prices, \( i.e. \), weighted averages of a large number of price changes in different item categories. Hence, inflation perceptions may deviate from price indices due to differences between perception processes and statistical procedures in constructing the price indices.

Kemp [4] mentions the possibility that experience with purchases, \( i.e. \), for frequently purchased items such as stamps, butter and telephone bills, tends to strengthen these effects. Experience may add to the availability bias [5], possibly resulting in greater weight of high-frequency purchases in perceived inflation judgments. Kemp [6] found almost correctly perceived inflation for the previous year but again under-estimated perceived inflation for the previous 15 years. Brachinger [7] assumes as-

---

*This work is supported by China NSF grants 10761001 and the Scientific Research, Foundation of Guangxi University (Grant No. X081082).
symmetric inflation perceptions for prices increases versus price decreases. Due to the asymmetric value function in the prospect theory (Tversky & Kahneman, 1991), price increases should influence perceptions more than price decreases. Hence, items associated with large price increases should influence general perceived inflation more heavily than items associated with minor prices increases or price decreases. This expectation may be qualified by distinguishing between absolute and relative price changes. In contrast, a one cent increase of gasoline prices may be evaluated as quite low (see [8]). Hoffmann, Leifer, and Lorenz [9] seem to favor the role of relative price changes in consumer price perception.

The GDP was introduced as a monetary measure of wartime production capacity during the World War II. Today, it is widely used by policymakers, economists, and the media as the primary scorecard of a nation’s economic health and welfare. However, GDP has some unavoidable deficiencies as a measure of economic performance (see [10-12]), and is incapable of measuring peoples’ well-being. The major problem is that GDP makes no distinction between economic transactions that add to welfare and those that diminish it [13]. It includes all expenditures, assuming that every monetary transaction adds to peoples’ welfare. Real GDP is often used as a proxy of a country’s real income, even though official statisticians warn against such a practice [14]. Thus, Prescott [15], who singles out Switzerland for its poor economic performance over the past three decades, focuses exclusively on real GDP. Yet, unlike a technological progress, the beneficial effect of an improvement in the terms of trade is not captured by real GDP, which focuses on production per se. In fact, if real GDP is measured by Laspeyres quantity index, as it is still the case in most countries, an improvement in the terms of trade will actually lead to a fall in real GDP [16]. Based on the nominal GDP (NGDP) and real GDP (RGDP), an index GDP deflator (GDPD) is defined by

$$\text{GDPD} = \frac{\text{NGDP}}{\text{RGDP}}$$  \hspace{1cm} (2)

which reflects the changes of all items in economics. Usually the GDPD tends to underestimate the inflation for consumer price [17].

Motivated by the above observations, we propose a new index which combines the CPI and the GDP to test inflation. This index will make the bias decreased effectively in the CPI. In the next section, motivation and method are stated. The data results are reported in Section 3. One conclusion is stated in the last section.

2. Motivation and Method

Many proposals have been forwarded to alleviate the bias caused by the rotation of new item and outlet samples in the CPI. In the interim, there are three ways that have been systematically investigated in which the current bias in the CPI sample rotation process may be alleviated [18]:

1) using geometric means to calculate basic item-area price relatives; 2) setting base period prices using pre-link month “initiation” prices; 3) pricing both the old and new samples for a period of time before introducing the new sample into the CPI.

It is well known that the CPI is one of the most important indexes of the inflation. Normally the CPI overestimates the inflation [17]. Many authors study this problem to decrease the CPI (see [18,19] etc.). From the definition of CPI (1), it is easy to see that the CPI only refers to the consumer items but other items. When we consider the CPI of some items, other items are omitted. In fact, this CPI will be influenced by other items. Then a reasonable idea is to consider the items’ percent of the total property, i.e., the GDP should be considered. Moreover, the authors [18,20-23] use geometric means to calculate basic item-area price relatives in CPI and get better results. Motivated by their ideas and the above discussions, we present the modified CPI formula as follows

$$\text{MCPI} = \frac{\sum P_{Ob}Q_{Ob}}{\sqrt[\text{NGDP}]{\sum P_{Ob}Q_{Ob}}},$$  \hspace{1cm} (3)

where \( \text{GDP}_b \) is the GDP in period \( t \), \( \text{GDP}_b \) is the GDP in a base period \( b \), and \( N_t \) is the number of all items, respectively. In practice, it is not difficult to compute (or estimate) the quantities \( N_t \). By (3), we have

$$\text{MCPI} = \frac{\sum P_{Ob}Q_{Ob}}{\sqrt[\text{NGDP}]{\sum P_{Ob}Q_{Ob}}} = \sqrt[\text{NGDP}]{\frac{\text{GDP}_b}{\text{CPI}}}.$$  \hspace{1cm} (4)

In this paper we will use the index MCPI in (4) instead of CPI in (1). In the next section, we report the practical data to compare the given Formula (4) with the normal CPI Formula (1).

3. Data Results

Since reform and open policy, China has one of the highest rates of economic growth in the world, especially for GDP. In this section, we report the detail data to test our given method including GDP, CPI, all items of CPI since the year 1990 in China. We list them as the following tables.

The data of the Table 1-2 is from National Bureau of Statistics of China (2008) or can be found at the Home-page:
Table 1. The data of GDP, Per Capita GDP, CPI, Urban Household CPI, and Rural Household CPI.

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP (100 million Yuan)</th>
<th>Per Capita GDP (Yuan)</th>
<th>CPI (preceding year = 100)</th>
<th>Urban Household CPI</th>
<th>Rural Household CPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>18667.8223761059</td>
<td>1644</td>
<td>103.1</td>
<td>101.3</td>
<td>104.5</td>
</tr>
<tr>
<td>1991</td>
<td>21781.4994107882</td>
<td>1892.8</td>
<td>103.4</td>
<td>105.1</td>
<td>102.3</td>
</tr>
<tr>
<td>1992</td>
<td>26923.4764511214</td>
<td>2311.1</td>
<td>106.4</td>
<td>108.6</td>
<td>104.7</td>
</tr>
<tr>
<td>1993</td>
<td>35333.9247145462</td>
<td>2998.4</td>
<td>114.7</td>
<td>116.1</td>
<td>113.7</td>
</tr>
<tr>
<td>1994</td>
<td>48197.8564447092</td>
<td>4044</td>
<td>124.1</td>
<td>125</td>
<td>123.4</td>
</tr>
<tr>
<td>1995</td>
<td>60793.7292113314</td>
<td>5045.7</td>
<td>117.1</td>
<td>116.8</td>
<td>117.5</td>
</tr>
<tr>
<td>1996</td>
<td>71176.5916539871</td>
<td>5845.9</td>
<td>108.3</td>
<td>108.8</td>
<td>107.9</td>
</tr>
<tr>
<td>1997</td>
<td>78973.0349964914</td>
<td>6420.2</td>
<td>102.8</td>
<td>103.1</td>
<td>102.5</td>
</tr>
<tr>
<td>1998</td>
<td>84402.279768922</td>
<td>6796</td>
<td>99.2</td>
<td>99.4</td>
<td>99</td>
</tr>
<tr>
<td>1999</td>
<td>89677.0547509045</td>
<td>7158.5</td>
<td>98.6</td>
<td>98.7</td>
<td>98.5</td>
</tr>
<tr>
<td>2000</td>
<td>99214.5543084772</td>
<td>7857.7</td>
<td>100.4</td>
<td>100.8</td>
<td>98.5</td>
</tr>
<tr>
<td>2001</td>
<td>109655.170558159</td>
<td>8621.7</td>
<td>100.7</td>
<td>100.7</td>
<td>100.8</td>
</tr>
<tr>
<td>2002</td>
<td>120332.6892742425</td>
<td>9398.1</td>
<td>99.2</td>
<td>99</td>
<td>99.6</td>
</tr>
<tr>
<td>2003</td>
<td>135822.756149557</td>
<td>10542</td>
<td>101.2</td>
<td>100.9</td>
<td>101.6</td>
</tr>
<tr>
<td>2004</td>
<td>159878.33791739</td>
<td>12335.6</td>
<td>103.9</td>
<td>103.3</td>
<td>104.8</td>
</tr>
<tr>
<td>2005</td>
<td>183217.4</td>
<td>14053</td>
<td>101.8</td>
<td>101.6</td>
<td>102.2</td>
</tr>
<tr>
<td>2006</td>
<td>211923.5</td>
<td>16165</td>
<td>101.5</td>
<td>101.5</td>
<td>101.5</td>
</tr>
<tr>
<td>2007</td>
<td>249529.9</td>
<td>18934</td>
<td>104.8</td>
<td>104.5</td>
<td>105.4</td>
</tr>
</tbody>
</table>

Table 2. Consumer Price Indices by Category (2007) (preceding year = 100).

<table>
<thead>
<tr>
<th>Item</th>
<th>National Indices</th>
<th>Item</th>
<th>National Indices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer Price Index</td>
<td>104.8</td>
<td>Health Care and Personal Articles</td>
<td>102.1</td>
</tr>
<tr>
<td>Food</td>
<td>112.3</td>
<td>Health Care</td>
<td>102.1</td>
</tr>
<tr>
<td>Grain</td>
<td>106.3</td>
<td>Medical Instrument and Articles</td>
<td>98.2</td>
</tr>
<tr>
<td>Rice</td>
<td>105.4</td>
<td>Traditional Chinese Medicine</td>
<td>107.9</td>
</tr>
<tr>
<td>Flour</td>
<td>107.3</td>
<td>Western Medicine</td>
<td>99.1</td>
</tr>
<tr>
<td>Starches and Tubers</td>
<td>106.2</td>
<td>Health Care Appliances and Articles</td>
<td>101.1</td>
</tr>
<tr>
<td>Beans and Bean Products</td>
<td>108.0</td>
<td>Health Care Services</td>
<td>102.2</td>
</tr>
<tr>
<td>Oil or Fat</td>
<td>126.7</td>
<td>Personal Articles and Services</td>
<td>102.1</td>
</tr>
<tr>
<td>Meal, Poultry and Processed Products</td>
<td>131.7</td>
<td>Cosmetics</td>
<td>100.1</td>
</tr>
<tr>
<td>Eggs</td>
<td>121.8</td>
<td>Sanitation Articles</td>
<td>100.3</td>
</tr>
<tr>
<td>Aquatic Products</td>
<td>105.1</td>
<td>Personal Ornaments</td>
<td>104.5</td>
</tr>
<tr>
<td>Vegetables</td>
<td>107.9</td>
<td>Personal Services</td>
<td>103.1</td>
</tr>
<tr>
<td>Fresh Vegetables</td>
<td>107.3</td>
<td>Transportation and Communication</td>
<td>99.1</td>
</tr>
<tr>
<td>Flavoring</td>
<td>104.1</td>
<td>Transportation</td>
<td>100.8</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>101.6</td>
<td>Transportation Facility</td>
<td>97.7</td>
</tr>
<tr>
<td>Tea and Beverages</td>
<td>101.5</td>
<td>Fuels and Parts</td>
<td>103.5</td>
</tr>
<tr>
<td>Tea</td>
<td>103.3</td>
<td>Fees for Vehicles Use and Maintenance</td>
<td>102.4</td>
</tr>
<tr>
<td>Beverages</td>
<td>100.7</td>
<td>In city Traffic Fare</td>
<td>101.3</td>
</tr>
<tr>
<td>Dried and Fresh Melons and Fruits</td>
<td>102.2</td>
<td>Intercity Traffic Fare</td>
<td>103.0</td>
</tr>
<tr>
<td>Fresh Fruits</td>
<td>100.1</td>
<td>Communication</td>
<td>97.1</td>
</tr>
<tr>
<td>Cake, Biscuit and Bread</td>
<td>103.6</td>
<td>Communication Facility</td>
<td>81.8</td>
</tr>
<tr>
<td>Milk and Its Products</td>
<td>102.7</td>
<td>Communication Service</td>
<td>100.6</td>
</tr>
<tr>
<td>Dining Out</td>
<td>107.3</td>
<td>Recreation, Education and Culture Articles</td>
<td>99.0</td>
</tr>
<tr>
<td>Other Foods and Manufacturing Services</td>
<td>104.2</td>
<td>Durable Consumer Goods for Cultural</td>
<td>93.1</td>
</tr>
<tr>
<td>Tobacco, Liquor and Articles</td>
<td>101.7</td>
<td>and Recreational Use and Services</td>
<td>99.6</td>
</tr>
<tr>
<td>Tobacco</td>
<td>100.8</td>
<td>Education</td>
<td>99.1</td>
</tr>
<tr>
<td>Liquor</td>
<td>103.5</td>
<td>Teaching Materials and Reference Books</td>
<td>99.6</td>
</tr>
<tr>
<td>Articles for Smoking and Drinking</td>
<td>100.1</td>
<td>Tuition and Child Care</td>
<td>101.0</td>
</tr>
<tr>
<td>Clothing</td>
<td>99.4</td>
<td>Cultural and Recreational Articles</td>
<td>99.5</td>
</tr>
<tr>
<td>Garments</td>
<td>99.4</td>
<td>Cultural Articles</td>
<td>100.7</td>
</tr>
<tr>
<td>Clothing Material</td>
<td>101.6</td>
<td>Newspapers and Magazines</td>
<td>102.7</td>
</tr>
<tr>
<td>Footwear and Hats</td>
<td>99.0</td>
<td>Expenditure on Culture and Recreation</td>
<td>102.3</td>
</tr>
<tr>
<td>Clothing Manufacturing Services</td>
<td>102.3</td>
<td>Touring and Outing</td>
<td>104.5</td>
</tr>
<tr>
<td>Household Facilities, Articles and Services</td>
<td>101.9</td>
<td>Residence</td>
<td>105.1</td>
</tr>
<tr>
<td>Durable Consumer Goods</td>
<td>101.6</td>
<td>Building and Building Decoration Materials</td>
<td>104.2</td>
</tr>
<tr>
<td>Furniture</td>
<td>101.9</td>
<td>Renting</td>
<td>107.0</td>
</tr>
<tr>
<td>Interior Decorations</td>
<td>100.3</td>
<td>Private Housing</td>
<td>103.0</td>
</tr>
<tr>
<td>Bed Articles</td>
<td>99.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily Use Household Articles</td>
<td>101.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household Services and Maintenance and Renovation</td>
<td>107.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In order to show these data of Table 1, we give the histogram of GDP and diagram of curves of CPI in Figure 1 and Figure 2, respectively. From Table 1 and Figure 2, we can see that the growth rate of GDP is about 10% every year. This growth rate is interesting and shows that the economy of China is healthy. From Table 1 and Figure 2, it is easy to observe that the CPI from 1993-1995 are the highest in these years, and we can conclude that China was facing the inflation except for 1998, 1999, and 2002 years. It is not difficult to see that the urban household CPI was larger than the rural household CPI from 1990 to 2000. However, the rural household CPI surpassed the urban household CPI from 2001 year to 2007 year, which shows that the inflation rate of the rural household was larger than the inflation rate of the urban household in this period. This case also shows that the living level of the rural household is becoming better in some situation and the speed is lager than the urban household does. Overall China is in the situation of inflation from these data. From 2005 year, the inflation is arising.

Figure 1. Sources of data: various years of the China Statistical Yearbook and China Data online (2008 year).

Figure 2. The data of GDP, Per Capita GDP, CPI, Urban Household CPI, and Rural Household CPI (preceding year = 100). Sources of data: Various years of the China Statistical Yearbook and China Data Online (2008).
In the following, we will compute the inflation rate by
the normal CPI Formula (1) and the modified Formula (4)
according to the data in Table 1, respectively. From Table 2, it is easy to compute the number of all items is about sixty. Since it is this category of 2007 year, the number of the category may be less than sixty before 2007 year. So we set \( N_t = 50 \) by (4) in this paper. The numerical results of formulas (1) and (4) are listed in Table 3 and Figure 3.

Michael, Ellen, Robert, Zvi, and Dale (1995) conclude that the CPI overestimates the inflation rate 0.8 ~ 1.6 percentage points, and the “best estimation” is $1.1$ percentage points (see [17]). Then many modified CPI methods are presented (see [19]), but the CPI still overestimates the inflation. Table 3 provides the inflation rates of these two indices. Before 1998, relatively high inflation rates were observed, and the CPI overestimated the MCPI from 0.19 to 0.61 percentage points. In this period, the inflation is serious. In 1998, 1999, and 2002, when the deflationary pressure became stronger and the inflation rates became negative, the CPI understated the MCPI by $–0.13$, $–0.12$, and $–0.19$ percentage points, respectively. Since 2000, the inflation rates are positive except for 2002, and the CPI overestimated the MCPI from 0.2 to 0.33 percentage points. Overall, China is facing the pressure of inflation.

Table 3. Inflation rates and substitution bias.

<table>
<thead>
<tr>
<th>Year</th>
<th>CPI Inflation (%)</th>
<th>MCPI Inflation (%)</th>
<th>Bias (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>3.1</td>
<td>2.91</td>
<td>0.19</td>
</tr>
<tr>
<td>1991</td>
<td>3.4</td>
<td>3.1</td>
<td>0.3</td>
</tr>
<tr>
<td>1992</td>
<td>6.4</td>
<td>5.98</td>
<td>0.42</td>
</tr>
<tr>
<td>1993</td>
<td>14.7</td>
<td>14.16</td>
<td>0.54</td>
</tr>
<tr>
<td>1993</td>
<td>24.1</td>
<td>23.49</td>
<td>0.61</td>
</tr>
<tr>
<td>1995</td>
<td>17.1</td>
<td>16.64</td>
<td>0.46</td>
</tr>
<tr>
<td>1996</td>
<td>8.3</td>
<td>7.99</td>
<td>0.31</td>
</tr>
<tr>
<td>1997</td>
<td>2.8</td>
<td>2.6</td>
<td>0.2</td>
</tr>
<tr>
<td>1998</td>
<td>–0.8</td>
<td>–0.67</td>
<td>–0.13</td>
</tr>
<tr>
<td>1999</td>
<td>–1.4</td>
<td>–1.28</td>
<td>–0.12</td>
</tr>
<tr>
<td>2000</td>
<td>0.4</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>2001</td>
<td>0.7</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>2002</td>
<td>–0.8</td>
<td>–0.61</td>
<td>–0.19</td>
</tr>
<tr>
<td>2003</td>
<td>1.2</td>
<td>0.96</td>
<td>0.24</td>
</tr>
<tr>
<td>2004</td>
<td>3.9</td>
<td>3.57</td>
<td>0.33</td>
</tr>
<tr>
<td>2005</td>
<td>1.8</td>
<td>1.53</td>
<td>0.27</td>
</tr>
<tr>
<td>2006</td>
<td>1.5</td>
<td>1.21</td>
<td>0.29</td>
</tr>
<tr>
<td>2007</td>
<td>4.8</td>
<td>4.47</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Figure 3. The CPI and the MCPI denote the consumer price index and the modified consumer price index, respectively.
Figure 3 presents the CPI and the MCPI. The higher inflation rate of the CPI than the MCPI is evident. From the results of Table 3 and Figure 3, it is not difficult to see that the modified CPI method can make the bias decrease in certain extent.

4. Conclusions

In this paper, we only propose a modified CPI formula which combing with the GDP. This modified CPI formula can make the normal CPI decrease in certain extent. From the test results, we can see that this formula is interesting in some cases. Based on the model of this paper, we can get the following conclusions and extensions.

1) According to the data of National Bureau of Statistics of China (2008), it is not difficult to see that China is facing the pressure of inflation now although the Chinese government has drew up related policy.

2) The real GDP should be considered in this modified formula. The use of real GDP maybe make this method more loser to the real inflation. We will also be very interested in researching conducted by other statistical agencies in this area.

3) The method of the CLI estimated should be studied, moreover the accordingly method is measured with the CPI and the MCPI.

5. References


Research on the Relationship between Foreign Trade and the GDP Growth of East China—Empirical Analysis Based on Causality

Yuhong Li, Zhongwen Chen*, Changjian San*
Business School, Jinggangshan University, Ji’an, China
E-mail: czw922@163.com
Received April 19, 2010; revised June 8, 2010; accepted June 12, 2010

Abstract

In open economy, development of foreign trade greatly impacts GDP growth. Adopt modern testing methods like unit root, time-series co-integration analysis and error correction model for researching the causalities between foreign trade including total export and import with the collected 28-year statistical data of east China from 1981 to 2008, including total export and total import and GDP growth of east China. The result suggests that there exist long term or short term causality between GDP and total export and import as well as between GDP and export, foreign trade is the long term and short term reason of GDP growth, but no evidence can prove that there exists long term stationary causality between import trade and GDP. This paper finally provides with some instructive recommendations on how to develop the foreign trade of east China under the new global economy environment.

Keywords: East China, GDP Growth, Foreign Trade, Causality Analysis

1. Introduction

Since the reform and opening up, China’s foreign trade, which is playing a significance role in the world, has become more and more important. But the proportion of China's total import value in the GDP cannot match the average level of developed countries. Obviously, the foreign trade is closely related to economic growth in China. The importance of foreign trade for a country is increasingly prominent, though many researchers like Xu Qifa and Jiang Cuixia (2002) focused on the research related to the contribution of foreign trade on GDP growth, researchers particularly only focused on one region[1], a province as an example, literature related to the research on the economic development of east China is rare. Since the reform and opening up, foreign trade in east has experienced rapid development. From 1981 to 2008, exports and imports in east increased from 8.564 billion dollars to 2289.189 billion dollars. The increase of foreign trade is faster than the increase of GDP, and the proportion of foreign trade in GDP is increasing too. However, is there serious internal logical causality between GDP and foreign trade? or, is there long term or short term causality between them? Thus, this paper will try to research and discover it.

Due to the administrative division of China (2005) and the statement of financial department about graduates going down to the grass-roots units (referring to the less developed areas of east China and the region of western China), now east China refers to the relevantly developed areas including Beijing city, Tianjin city, Shandong province, Liaoning province, Jiangsu province, Shanghai city, Zhejiang province, Fujian province and Guangdong province. However, some data of Beijing city are missing, so the data cited in this paper will not include that of Beijing city. Although it will somewhat affect the research, it will not so much impact the research of the relationship between GDP and foreign trade in east China in essence.

According to the provincial yearbooks (1981-2008), the relevant data of east China (shown as Table 1), including (1981-2008) total foreign trade value (IE), the total export value (EXP) and the total import value (IMP) as well as GDP are collected and sorted out. From the result, it could be seen that the mentioned indexes represent a trend to increase on the whole. In order to further grope for the relationship between GDP and certain index, the concept of foreign trade dependency is cited to describe it [2]. It is just the ratio of certain index of foreign trade and GDP, which can reflect the relationship of
dependency between GDP and certain index. It can be written in a formula as,

\[
\text{Dependence on foreign trade} = \frac{\text{certain index of foreign trade}}{\text{GDP}}
\]

With the result calculated by the above formula, the dependency of each index of foreign trade represents a trend to increase on the whole, while in some years, they occasionally represented fluctuations. With the result, we could see a trend of dependency (Figure 1). The ratio of dependence on foreign trade in east increased from 12.01% in 1981 to 69.37% in 2008. Especially, in 2006, it reached the top (80.88%); the ratio of dependence on export increased from 10.74% in 1981 to 43.17% in 2008; the ratio of dependence on import increased from 1.27% in 1981 to 26.2% in 2008. These figures intuitively indicate that each index of foreign trade of east China contributes to GDP growth at different levels. But, whether there exists internal logical causality should be further tested. Therefore, the time-series data and latest more stationary analysis methods are adopted for testing the relationships of the indexes of foreign trade and GDP of east China. We will use unit root, time-series co-integration long term causality and short term causality analyses to expect more stationary results [3].

Table 1. 1981-2008 relevant statistical data of GDP and foreign trade of east China.

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP (100 million dollars)</th>
<th>Foreign trade (10000 dollars)</th>
<th>export (10000 dollars)</th>
<th>import (10000 dollars)</th>
<th>Dependence On foreign trade (%)</th>
<th>Dependence on export trade (%)</th>
<th>Dependence on import trade (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>1461.75</td>
<td>17535308</td>
<td>1569233</td>
<td>186075</td>
<td>12.01</td>
<td>10.74</td>
<td>1.27</td>
</tr>
<tr>
<td>1982</td>
<td>1455.68</td>
<td>1706645</td>
<td>1517628</td>
<td>189017</td>
<td>11.72</td>
<td>10.43</td>
<td>1.30</td>
</tr>
<tr>
<td>1983</td>
<td>1549.11</td>
<td>1765104</td>
<td>1540626</td>
<td>224478</td>
<td>11.39</td>
<td>9.95</td>
<td>1.45</td>
</tr>
<tr>
<td>1984</td>
<td>1603.69</td>
<td>2119018</td>
<td>1699111</td>
<td>419907</td>
<td>13.21</td>
<td>10.59</td>
<td>2.62</td>
</tr>
<tr>
<td>1985</td>
<td>1597.52</td>
<td>2558642</td>
<td>1793590</td>
<td>765052</td>
<td>16.02</td>
<td>11.23</td>
<td>4.79</td>
</tr>
<tr>
<td>1986</td>
<td>1571.12</td>
<td>2598819</td>
<td>1773466</td>
<td>825353</td>
<td>16.54</td>
<td>11.29</td>
<td>5.25</td>
</tr>
<tr>
<td>1987</td>
<td>1768.34</td>
<td>4303466</td>
<td>2675955</td>
<td>1627511</td>
<td>24.34</td>
<td>15.13</td>
<td>9.20</td>
</tr>
<tr>
<td>1988</td>
<td>2317.23</td>
<td>5901747</td>
<td>3339995</td>
<td>2561752</td>
<td>25.47</td>
<td>14.41</td>
<td>11.06</td>
</tr>
<tr>
<td>1989</td>
<td>2604.58</td>
<td>6692030</td>
<td>3878348</td>
<td>2813682</td>
<td>25.69</td>
<td>14.89</td>
<td>10.80</td>
</tr>
<tr>
<td>1990</td>
<td>2271.60</td>
<td>7339161</td>
<td>4593243</td>
<td>2745918</td>
<td>32.31</td>
<td>20.22</td>
<td>12.09</td>
</tr>
<tr>
<td>1991</td>
<td>2380.09</td>
<td>8907810</td>
<td>5342241</td>
<td>3565659</td>
<td>37.43</td>
<td>22.45</td>
<td>14.98</td>
</tr>
<tr>
<td>1992</td>
<td>3022.14</td>
<td>11334101</td>
<td>6424146</td>
<td>4909555</td>
<td>37.50</td>
<td>21.26</td>
<td>16.25</td>
</tr>
<tr>
<td>1993</td>
<td>4096.97</td>
<td>13560294</td>
<td>7136708</td>
<td>6423586</td>
<td>33.10</td>
<td>17.42</td>
<td>15.68</td>
</tr>
<tr>
<td>1994</td>
<td>3733.62</td>
<td>16810653</td>
<td>9362583</td>
<td>7448070</td>
<td>45.03</td>
<td>25.08</td>
<td>19.95</td>
</tr>
<tr>
<td>1995</td>
<td>4851.21</td>
<td>19671665</td>
<td>11297396</td>
<td>8374269</td>
<td>40.55</td>
<td>23.29</td>
<td>17.26</td>
</tr>
<tr>
<td>1996</td>
<td>5653.93</td>
<td>21668124</td>
<td>12217895</td>
<td>9450229</td>
<td>38.32</td>
<td>21.61</td>
<td>16.71</td>
</tr>
<tr>
<td>1997</td>
<td>6342.48</td>
<td>25125789</td>
<td>14851481</td>
<td>10274308</td>
<td>39.62</td>
<td>23.42</td>
<td>16.20</td>
</tr>
<tr>
<td>1998</td>
<td>6808.93</td>
<td>25955390</td>
<td>15194880</td>
<td>10760510</td>
<td>38.12</td>
<td>22.32</td>
<td>15.80</td>
</tr>
<tr>
<td>1999</td>
<td>7240.87</td>
<td>29076356</td>
<td>16413372</td>
<td>12662984</td>
<td>40.16</td>
<td>22.67</td>
<td>17.49</td>
</tr>
<tr>
<td>2000</td>
<td>8122.25</td>
<td>38067988</td>
<td>21040036</td>
<td>17027952</td>
<td>46.87</td>
<td>25.90</td>
<td>20.96</td>
</tr>
<tr>
<td>2001</td>
<td>8974.95</td>
<td>41122470</td>
<td>22756708</td>
<td>18365762</td>
<td>45.82</td>
<td>25.36</td>
<td>20.46</td>
</tr>
<tr>
<td>2002</td>
<td>9931.45</td>
<td>51292334</td>
<td>23207283</td>
<td>23207283</td>
<td>51.65</td>
<td>28.28</td>
<td>23.37</td>
</tr>
<tr>
<td>2003</td>
<td>11675.58</td>
<td>70691612</td>
<td>37977449</td>
<td>32814163</td>
<td>60.55</td>
<td>32.44</td>
<td>28.10</td>
</tr>
<tr>
<td>2004</td>
<td>14049.33</td>
<td>95750072</td>
<td>51540201</td>
<td>44209871</td>
<td>68.15</td>
<td>36.69</td>
<td>31.47</td>
</tr>
<tr>
<td>2005</td>
<td>16780.12</td>
<td>117542900</td>
<td>66064400</td>
<td>51478500</td>
<td>70.05</td>
<td>39.37</td>
<td>30.68</td>
</tr>
<tr>
<td>2006</td>
<td>20401.49</td>
<td>165002100</td>
<td>99160700</td>
<td>65841400</td>
<td>80.88</td>
<td>48.60</td>
<td>32.27</td>
</tr>
<tr>
<td>2007</td>
<td>26651.01</td>
<td>200954500</td>
<td>122842100</td>
<td>78112400</td>
<td>75.40</td>
<td>46.09</td>
<td>29.31</td>
</tr>
<tr>
<td>2008</td>
<td>33000.07</td>
<td>228918900</td>
<td>142452200</td>
<td>86466700</td>
<td>69.37</td>
<td>43.17</td>
<td>26.20</td>
</tr>
</tbody>
</table>

Data sources: 1981-2008 Provincial Yearbooks

Figure 1. The Trend of dependence of GDP on foreign trade.


2. Literature Review

Economists who concern about foreign trade mainly focus on the effects of foreign trade on national economy, and it has been a focus to discuss the theory about the relationship between foreign trade and economic growth.

It is Adam Smith who first studies the relationship between international trade and economic growth. In his view, the development of division is the principal factor to improve the long-time growth of productivity, and the degree of division is constrained by the scope of market. Expansion of market will naturally deepen the division and improve the productivity, and then improve economic growth; David Ricardo and J. S. Mill as well as D. R. Nurkse all possess the mentioned views shown in their works; while the special dispute starts at Robertson’s proposition that foreign trade is the engine of economic growth (1973) he mainly focus on the theory, which is complemented and developed by Nurkse (the 1950s), that lagging countries can improve their economic growth by foreign trade, especially, by export growth. He suggests that foreign trade is the crucial factor of economic growth engine.

The engine theory causes controversial disputes [4], many economists suggest that trade growth of developing countries is correlated to their own economic growth, their export growths are constrained by the economic growth of developed countries[5]. William. Lewis is the representative personage of such economists. Irving Kravis (1970) puts forward a new viewpoint, which is later accepted by lots of western economists, that foreign trade is a maid of economic growth rather than an engine. Classical school, Marxist school and New classical school all suggest that foreign trade has just indirect impact on accumulation and economic growth, in fact, foreign trade impacts on them through profit margin. Further, some Latin American economists like Prebisch and Singer have completely negative attitude on engine theory, they suggest that in modern global economy regime, developed capitalism countries are the core which is regulating the outer consisting of developing countries, the outer countries must comply with the core countries. This kind of depending relation makes foreign trade the reason of weakening the economy of the developing countries rather than the reason of improving the economy of the developing countries.

Difference of opinions on the relation between foreign trade and economic growth has activated scholars to grope for answers through empirical studies. Such as Jeffrey Sach and Andrew Warner find that the economic growth rate of those developing countries which carry out opening economies reaches 4.5%, while that of those countries which carry out closed economies only researches 0.7%; in the mean time, they find the economic growth rate of those developed countries which carry out open economies reaches 2.3%, while that of the countries which carry out closed economy only reaches 0.7%.

Some of the scholars mainly focus on co-integration analysis. For instance, Lin Yifu and Li Zhengjun improved the traditional single equation model and built simultaneous equations to calculate the contribution of foreign trade to economic growth. The result suggests that 10% of the export growth can lead to 1% of economic growth.

Still, there are many scholars mainly focus on correlation analysis. For instance, Dong Migang (2000) indicated that, in 1978-1998, the correlation of China’s foreign trade and economic growth was significant, the coefficient was $r > 94\%$. Guo Xin (2004) drew the conclusion by recursion model, which indicates there exists a significant positive correlation between foreign trade and economic growth. That is to say, the contribution of foreign trade to economic growth is considerable;

While some of the scholars mainly focus on regression analysis to study foreign trade and economic growth. Such as, Yi Xiangshuo (1997) found that the pull effect of export on non-export sectors or the whole economic growth was not strong at all; Yang Quanfa (1998) took a regression analysis with the data (1978-1995) of relevant indexes through the model built by Balasa and Vedur, and he drew a conclusion that growth of export didn’t meet the expectation of promoting the economic growth. Sun Lin, Wang Qifan (2003) researched, by the improved Vedur Model, and pointed out that the mechanism and approaches of the effect of China’s foreign trade on economic growth has strong time tag.

The above methods all have separate advantages and defects, especially, when single cross-set (time series)
data analyses are adopted for testing. These methods all have the problem of potential on the low side, and they might lead to errors while calculating long term causalities and the instabilities. In addition, simply dealing with the data is just equal to considering them to be coessential, so their heterogeneity was ignored.

But in this paper, the authors will adopt improved co-integration analysis with error correction model for testing time series data of foreign trade and GDP to research the relationship between foreign trade and GDP growth of east China.

3. Models and Methods

Co-integration analysis, which is adopted above, with time-series is adopted in this paper for testing whether there exists long term or short term stationary causality between foreign trade and GDP growth, and for testing the unit root of each variable to confirm their stationarities. The following would be the desired time-sequence data model [7],

\[ y_{it} = \rho_i y_{i,t-1} + X_i \beta_1 + \epsilon_{it} \]

where \( i = 1, \ldots, N \) represent the number of time-series data; \( t = 1, \ldots, T \) represents time span; \( x_i \) are the exogenous variables in the model including fixed effect or time trend of each time-series unit; \( \rho_i \) is autoregressive coefficient, suppose that disturbance terms \( \epsilon_{it} \) are mutual independence. If \( | \rho_i | < 1 \), \( y_{it} \) represents the stationary process; if \( | \rho_i | = 1 \), \( y_{it} \) represents the process of unit root.

Take the logarithms of the gross domestic products (GDP), total import and export value (IE), total export value (EXP) and total import value (IMP) separately, and they are LnGDP, LnIE, LnMP, LnEXP. Then test their logarithm values and first difference values through time-series unit root. Logarithm cited here is for convenience to get stationarity more easily, and is helpful to eliminate the heteroscedasticity of time series and the characteristics of time series and relationships would not be changed.

The relationships between relevant indexes would be tested in this paper by three steps. First of all, test through unit root using time-series data[8]; then, use two-step method put forward by Engle and Granger (1987) to test the mutual long term causalities of relevant indexes; if the long term causality exists, then further test their short term causalities.

3.1. Test of Time-Series Data by Unit Root

In order to overcome the deviation brought out by only one method, LLC test, B test and IPS test are all used in this paper to test the relationships between GDP and relevant indexes (IE, EXP and IMP) of foreign trade of east China by unit root.

3.2. Co-Integration Analysis of Time-Series Data and Long Term Causality Test

In order to test the long term casassions between variables, two-step test method put forward by Engle and Granger (1987) is used. When measuring the long term causalities between GDP and relevant indexes of foreign trade, the measured variables are mutually simple integrated, and then the regression through the following time-series Equation (1) can be processed. Further, residual errors \( E_{it} \) comes out and it’s tested through unit root to determine their stabilities. If \( E_{it} \) is stationary, the mutual long term causalities are proved to exist.

\[ \ln(*) = \alpha + \beta \ln(**) + \epsilon_{it} \]  

(1)

where (*) and (**) separately represent GDP, IE, EXP and IMP.

3.3. Time-Series Data Error Correcting Model and Short Term Causality Test

Co-integration relationships just reflect the long term balanced relations between relevant variables. In order to cover the shortage, correcting mechanism of short term-deviation from long term balance could be cited. At the same time, as the limited number of years, the above test result may cause disputes (Christpoulos and Tsionas, 2004). Therefore, under the circumstance of long term causalities, short term causalities should be further tested as well. The error correcting models could be built as,

\[ d \lnGDP_t = \eta_1 + \sum \alpha_{1i} d \ln GDP_{i,t-1} \]

\[ + \sum \beta_{1i} d \lnIE_{i,t-1} + \lambda \text{ ECM}_{it} + \epsilon_{it} \]  

(2)

\[ d \lnGDP_t = \eta_1 + \sum \alpha_{1i} d \lnGDP_{i,t-1} \]

\[ + \sum \beta_{1i} d \lnEXP_{i,t-1} + \lambda \text{ ECM}_{it} + \epsilon_{it} \]  

(3)

\[ d \lnGDP_t = \eta_1 + \sum \alpha_{1i} d \lnGDP_{i,t-1} \]

\[ + \sum \beta_{1i} d \lnIMP_{i,t-1} + \lambda \text{ ECM}_{it} + \epsilon_{it} \]  

(4)

\[ d \lnIE_t = \eta_i + \sum \alpha_{1i} d \lnIE_{i,t-1} \]

\[ + \sum \beta_{1i} d \lnGDP_{i,t-1} + \lambda \text{ ECM}_{it} + \epsilon_{it} \]  

(5)

\[ d \lnEXP_t = \eta_i + \sum \alpha_{1i} d \lnEXP_{i,t-1} \]

\[ + \sum \beta_{1i} d \lnGDP_{i,t-1} + \lambda \text{ ECM}_{it} + \epsilon_{it} \]  

(6)

\[ d \lnIMP_t = \eta_i + \sum \alpha_{1i} d \lnIMP_{i,t-1} \]

\[ + \sum \beta_{1i} d \lnGDP_{i,t-1} + \lambda \text{ ECM}_{it} + \epsilon_{it} \]  

(7)

where \( t \) represents year, \( d \) represents first difference calculation, ECM, represents the errors of long term balance. If \( \lambda = 0 \) is rejected, error correcting mechanism happens, and the tested long term causality is reliable, it
could be unreliable. If $\beta_1 = 0$ is rejected, and then the short term causality is not proved to exist.

4. Result and Analysis

4.1. Test of Time-Series Data by Unit Root

Software Eview 5.0 is herewith used and the four variables LnGDP, LnIE, LnEXP and LnIMP by LLC test, B test, IPS test are calculated and processed separately (see Table 2). The result indicates that LnGDP, LnIE, LnEXP and LnIMP all perform non-stationary state through the tests by the mentioned method. However, after first order difference, through the same methods, it’s found that all of them passed the significance test by 1%. So we can say GDP growth, total foreign trade value, total export value and total import value are all integrated of order one.

4.2. Co-Integration Analysis of Time-Series Data and Long Term Causality Test

Through the test by unit root, GDP, IE, EXP and IMP all perform one-order simple-integration I (1), there may exist mutual co-integration between relevant variables. The results of their long term causalities and corresponding residual errors $E_t$ can be shown as Table 3.

From Table 3, it’s found that there exists mutual long term causality between LnGDP and LnEXP, two of the three tests (LLC test, B test and IPS test) passed by 90% significance level. Nothing can prove that there exists long term mutual causality between GDP and LnIMP. Corresponding co-integration equations are the following:

\[
\text{LnGDP} = 6.836721 + 0.672795 \times \text{LnEXP} \\
\quad (28.49411) \quad (45.37549) \\
\quad [0.0000] \quad [0.0000] \\
F = 2058.395, R^2 = 0.987530
\]

\[
\text{LnEXP} = -9.933901 + 1.467801 \times \text{LnGDP} \\
\quad (-17.16705) \quad (45.37549) \\
\quad [0.0000] \quad [0.0000] \\
F = 2058.935, R^2 = 0.987530
\]

The above equations all passed t-test and F-test by 95% level. From the co-integration equations, it’s clear that, in the long term, LnGDP and LnEXP are positive. And the elasticity between them is 0.672795; this means one unit of LnIE increment will lead to 0.672795 units of LnGDP increment. Similarly, one unit of LnGDP increment will lead to 1.467801 units of LnEXP increment.

4.3. Time-Series Data Error Correcting Model and Short Term Causality Test

It’s found, according to the co-integration test of time-series data, that there exist mutual long term causality between LnGDP and LnEXP. For the limited number of years, short causality between them should be used to test their stationarities (see Table 4).

The result in Table 4 states the following clear: ECM in model 1, of which test equation is Equation (6), is positive and passes the test by 0.05 level, indicating correcting error mechanism happens, and long term pull effect of export trade on GDP has been proved. ECM in model 6 is also positive and passes the test by 0.05 levels, further indicating that export always promote GDP to

### Table 2. Result of Time-series data test by unit root.

<table>
<thead>
<tr>
<th>Time span: 28</th>
<th>LnGDP</th>
<th>LnEXP</th>
<th>LnIMP</th>
<th>LnIE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level test</td>
<td>first difference</td>
<td>Level test</td>
<td>first difference</td>
</tr>
<tr>
<td></td>
<td>(0.999)</td>
<td>(0.0028)</td>
<td>(0.999)</td>
<td>(0.0040)</td>
</tr>
<tr>
<td>PP test</td>
<td>7.4563</td>
<td>-4.2076**</td>
<td>2.2935</td>
<td>-4.0796**</td>
</tr>
<tr>
<td></td>
<td>(1.000)</td>
<td>(0.0031)</td>
<td>(0.999)</td>
<td>(0.0042)</td>
</tr>
</tbody>
</table>

Notation: 1) the Figures in the brackets are p values; 2) *indicates panel data pass of the significance test by 95% level, **indicates panel data pass of the significance test by 99% level; 3) testing form is only intercept, lagging exponent number is chosen as Schwarz rules.

### Table 3. Result of Time-series Co-integration test (test of residual errors by unit root).

<table>
<thead>
<tr>
<th>Variables</th>
<th>ADF test</th>
<th>PP test</th>
</tr>
</thead>
<tbody>
<tr>
<td>LnGDP is the induced variable of LnIE</td>
<td>-1.6497(0.4444)</td>
<td>-1.5748(0.4813)</td>
</tr>
<tr>
<td>LnIE is the induced variable of LnGDP</td>
<td>-1.8836(0.3345)</td>
<td>-1.8023(0.3714)</td>
</tr>
<tr>
<td>LnGDP is the induced variable of LnIMP</td>
<td>-0.9914(0.7416)</td>
<td>-1.3153(0.6075)</td>
</tr>
<tr>
<td>LnIMP is the induced variable of LnGDP</td>
<td>-1.9525(0.3047)</td>
<td>-2.0177(0.2779)</td>
</tr>
<tr>
<td>LnGDP is the induced variable of LnEXP</td>
<td>-2.9299*(0.0550)</td>
<td>-2.8616*(0.0632)</td>
</tr>
<tr>
<td>LnEXP is the induced variable of LnGDP</td>
<td>-2.9830*(0.0493)</td>
<td>-2.9036*(0.0581)</td>
</tr>
</tbody>
</table>

Notation: *indicates panel data pass of the significance test by 95% level, **indicates panel data pass of the significance test by 99% level.
grow, and it’s passed F-test, so it’s concluded that export trade and GDP are mutually causal.

5. Conclusions and Recommendations

The result of the tests indicates foreign trade is the long term and short termsource of GDP growth of east China. Total export has positive relationship with GDP growth, and they are mutually causal. It has proved the intuitional dependence relationship mentioned in part 1 (INTRODUCTION). Developing foreign trade is good for promoting GDP growth of east China, and GDP growth, in reverse, is also good for promoting the development of open economy. No evidence can prove that there exists long term stationary causality between import and GDP growth as well as that between total foreign trade and GDP; it’s not necessary that import can directly contribute to GDP growth. As the crowding-out effect of imported products from foreign countries and the indirect promoting effect couldn’t be measured, it cannot be proved either there exists long term causality between import and GDP, or there exists long term stationary internal logical causality.

According to the empirical study results, strong development of foreign trade greatly benefits the economic development in east China. To overcome the problems existed in foreign trade, for the current financial crisis and hard retrieve of global economy, and in order to reduce its corresponding economic loss as much as possible, keeping scale of exports is necessary. Thus, governments of all levels in east China should do as the following:

1) Stable exchange rate must be remained. At present, RMB can not be continuously upvalued, and in the long run, it could be devalued. Then it can be helpful to keep or even improve the competitiveness of the products there. Furthermore, it will be good to enrich the commodities to increase export supply.

2) Active industrial policy must be carried out. First, develop hi-tech industries, improve the comparative advantages of the products as well as the competitiveness; Second, develop specialty industries to amplify the comparative advantages to increase exports; Third, cultivate emerging industries, through importing FDI and high technologies, to improve own productivity. That is to say, governments should make great efforts to the construction of export by virtue of a series of industrial restructuring and revitalization, and to the plans continuously introduced by the state in textile, steel, automobile, equipment manufacturing industries. Develop high-tech and eco-friendly products, promote the exports of branded products, and large machinery, complete sets of equipment as well as edge and labor-intensive products to support tech innovation in small and medium enterprises so as to increase competitiveness.

3) Strategic trade policy must be performed. First, choose special industries in east China to protect or provide with subsidies to possess bigger share of global market [9]. Some labor-intensive products, like textile products, have less profit for their lower prices, so subsidies can keep their reversed benefits to some extent, and labor-intensive industries can improve employments; Second, protect domestic market to protect and cultivate emerging industries, and finally increase exports; Third, take advantages of the increased export rebate rate of some products introduced by the states, and improve the upgrade and transformation of the trade in processing.

4) Pro-active fiscal policy should be executed in east China. Governments of all levels should provide the enterprises with more capital supports to improve the financial environment for exportation and financing for the enterprises. Meanwhile, stepping up their supports for entrepreneurs’ credit and improving secured financing conditions are of great importance. However, preferential policies, such as lower income tax and sales tax, also could be provided to support and promote the border trade as well as international trade. And the governments should increase investment in port construction, market development, project declaration, utilization of funds and joint inspection service to help exports, and increase expenditure to bring in and cultivate talents in foreign trade by training the employers’ ideas, practical abilities, knowledge and negotiation skills etc, in order to improve their capability of service and creation.

5) Trade protection must be always aware of under current hard retrieve of global economy. With the wide spread of the international financial crisis, all kinds of trade protectionism, in the form of technique protection, green products standard, anti-dumping, countervailing etc, in countries across the world are getting rampant. In a word, trade barriers are set for many excuses to reduce import, which has become a prescription for some countries to
get rid of crisis. Therefore, governments in east China must be highly aware of it and ready to face provocation of protectionism in foreign trade.

6. Acknowledgements

This paper is assisted by the projects: Jiangxi provincial Co-operated Social Science Projects. A Study on the Development of Service Industry and Trade in Service in Jiangxi Province (Project ID: 09YJ249) and A Research on the Evolution of the Spatial Economy in Jiangxi and Agglomeration of Industry (Project ID: 09YJ245); A Study on the Development of Logistics in Ji’an City Based on the Theory of Industry Cluster (Project ID: JR0816).

7. References


Forecasting Model of Automobile Loan Based on Conditional Expectation

Liang Sun, Derong Tan, Yuqi Nie
School of Transportation and Vehicle Engineering, Shandong, University of technology, Zibo, China
E-mail: liangsunsdut@sdut.edu.cn
Received May 3, 2010; revised June 11, 2010; accepted June 16, 2010

Abstract

A double forecasting model based on conditional expectation was proposed through probability distribution of demand of automobile loan. The demand of automobile loan is the sum of all compound variables which indicated that automobile loan was credited to customer occurring in a certain period of time. Probability distribution of automobile loan was acquired using throughout probability theory. In view of such a fact, demand of automobile loan can be viewed as an conditional mathematic expectation. The forecasting model is proposed using growing function. Theoretical analysis and Case study shows that model based on conditional expectation is better than other model available with respect to forecasting demand of automobile loan.

Keywords: Automobile Loan, Conditional Expectation, Throughput Probability Theory

1. Introduction

In China, the rapid increase in the demand for private cars is an important and sensitive issue. On the one hand, there is the expressed intention of the Chinese government to use the car industry as an engine to promote industrial and economic growth. Forecasting consumer demand for automobile loan is becoming ever more difficult as consumer preferences change rapidly and the market environment becomes more complex. Nevertheless, the importance of forecasting future demand cannot be overemphasized for the purposes of both investment decisions and policymaking. Besides, it has been becoming significant and difficult subject to construct a model of demand of automobile loan to describe the developing trends of automobile loan.

John K. Dagsvik and Gang Liu developed a general random utility framework for analyzing data on individuals’ rank-orderings. They show that in the case with three alternatives one can express the probability of a particular rank-ordering as a simple function of first choice probabilities. Their framework is applied to specify and estimate models of household demand for conventional gasoline cars and alternative fuel vehicles in Shanghai based on rank-ordered data obtained from a stated preference survey [1]. Jongsu Lee and Youngsang Cho predicted consumer demand for diesel passenger cars. The model accommodates governmental policies and car attributes such as price and engine efficiency. They noted that consumers will likely prefer diesel passenger cars to gasoline ones due to the low operation costs of the former in spite of high purchase price when diesel is relatively cheaper than gasoline [2]. Astrid A. Dick proposed a method to estimate a structural demand model for commercial bank deposit services in order to measure the effects on consumers given dramatic changes in bank services throughout US branching deregulation in the 1990s [3]. Wouter J. den Haan et al. investigated the portfolio behavior of bank loans following a monetary tightening and noted that real estate and consumer loans sharply decrease, while commercial and industrial (C & I) loans increase. They presented some arguments why the supply of C & I loans may actually increase after a monetary contraction [4]. Li-Chiu Chi studied the impact of a borrower’s reorganization filing on its lead lending bank and second lending bank. He proposed an innovative application by providing an empirical exposition of the receiver operating characteristic curve analysis and by presenting the results of the model’s performance in reliability and robustness [5].

Wang Qin described the transformation of the consumer durable goods of Chinese citizens in the past fifty years and calculated the future demand on China’s car consumption markets. Meanwhile, he analyzed the status of China’s consumer car loans. He draws a conclusion that the potential car market of China was very big and
the prospect of China’s consumer car loan is immensurable [6]. Ye Qian utilized GM (1, 1) model to predict and analyze the changes of credit in China in recent years. He proposed four schemes to give solutions to problems such as the data deficiencies that results in information excavating distortion and the ‘noises’ included in the data processing [7].

Two major methods are used to forecast the demand for automobile loan, namely, random utility theory and GM (1, 1). Random utility theory focused on the estimation of consumer preferences for the product attributes separately using discrete choice models, and GM (1, 1) is a kind of grey prediction model that extracts valuable information through producing and exploring “some” known information.

Research on demand forecasting for automobile loan has been ongoing in many countries because of the importance of the financial industry. There exists a substantial body of research on demand forecasting for automobile loan using random utility theory and demand forecast based on random utility theory and GM (1, 1) is difficult to dealt with more complex situations. For example, random utility theory is difficult to predict exact value of demand of automobile loan, meanwhile, GM (1, 1) can predict value of demand of automobile loan but it is difficult to cope with some situations depend on social and economic policy.

This paper makes two contributions. The main contribution is to establish a model for demand of automobile loan based on conditional expectation. This implies that a model for demand of automobile loan based on conditional expectation is better than other model available. Second, we apply this model to analyze demand for automobile loan in a bank of Shandong province.

2. Establishment of a Forecasting Model for Automobile Loan

2.1. Problem Statement

m currency unit were credited to customer who apply for automobile for a period of time , number of automobile loan was approved by bank is N. It is a part of stochastic progress \{N(t), t ≥ 0\}. Xk currency unit was handled N(t) times at a certain time t. It is assumed that automobile loan will finish n currency unit. Our aim is to acquire the future demand of automobile loan.

2.2. Basic Notions

Lemma 2.2.1 if X, Y are random variable, then

\[ E[ E(X|Y)] = E(X) \]

Lemma 2.2.2 Let \( S_N = X_1 + X_2 + ... + X_N \). \( N \) is a un-
certain positive integer. \{Xk\} is a sequence of independent identical distribution. We get

\[ M_N(t) = M_N \ln M_X(t) \]

2.2.3 Definition of Growing Function

\[ S(x) = P(X > x) = 1 - F(x), \quad S(0) = 1, \quad S(x) = 0 \]

2.2.4 Conditional Mathematical Expectation of X

On the assumption that \( f(x, y) \) is a combine consistency function of \( (X, Y) \), we get

\[ f(x) = \int_{-\infty}^{\infty} f(x, y)dy \]

\[ g(y) = \int_{-\infty}^{\infty} f(x, y)dx \]

Thus,

\[ g(y|x) = \frac{f(x, y)}{f(x)} \]

\[ f(y|x) = \frac{g(x, y)}{g(x)} \]

Conditional mathematical expectation of Y when \( X = x \) is as follows:

\[ E(Y|X = x) = \int_{-\infty}^{\infty} y \cdot g(y|x)dy \]

Similarity,

\[ E(X|Y = y) = \int_{-\infty}^{\infty} x \cdot g(x|y)dx \]

Theorem 1 Let \( \xi, C \) is a random variable and constant, respectively. Then \( D(\xi) \leq E(\xi - C)^2 \) hold.

2.3. Establishment of the Model

The demand of automobile loan is as follows:

\[ Y(t) = \sum_{i=1}^{N(t)} D_i \]

where, \{N(t): t ≥ 0\} is a stochastic process, and \{D_i: t ≥ 0\} are independent and identically distributed random variables, with distribution function G, which are also independent of \{N(t): t ≥ 0\}.

Some notation used in the model is defined:

\( Y(t) \) demand of automobile loan occurring in a certain time interval \([0, t]\);

\( N(t) \) It is a part of stochastic progress \{N(t), t ≥ 0\}, which indicate that the times of automobile loan was credited to customer occurring in a certain time interval \([0, t]\);

\( D_i \) It indicates that \( D_i \) currency unit was credited to customer occurring in a certain time interval \([0, t]\).

We can acquire distribution function of demanding of
automobile loan using Formula of Total Probability:

\[ F(s) = \sum_{n=0}^{\infty} P(S \leq s | N = n)P(N = n) \]

\[ = \sum_{n=0}^{\infty} P(X_1 + X_2 + \cdots + X_n \leq s)P(N = n) \]

\[ = \sum_{n=0}^{\infty} F_n * F_{n-1} * \cdots * F_1(s)P(N = n) \]

\[ = \sum_{n=0}^{\infty} F^*(s)P(N = n) \]

At the same time, Distribution law of demanding of automobile loan is as follows:

\[ f(s) = \sum_{n=0}^{\infty} p^*(s)P(N = n) \]

The definition of \( p^*(s) \) is similar to \( F^*(s) \).

Obviously,

\[ S = S_1 + S_2 \]

Where \( S_1 \) denotes that automobile loan has been credited to applicants, \( S_2 \) denotes that automobile loan will credited to applicants.

The demand of automobile loan is as follows:

\[ E(S | S_i = m) = E(m + n | S_i = m) = m + \int_0^\infty S(x)dx \]

\[ = m + \int_0^\infty S(x)dx \]

\[ = m + \int_0^\infty 1 - F(x + m) - F(m) dx \]

Thus,

\[ n = \int_0^\infty \frac{1 - F(x + m)}{1 - F(m)} dx \]

The series of automobile loan is as follows:

\[ PHC_{i+1} = \int_0^\infty \frac{1 - F(x + PHC_i)}{1 - F(PHC_i)} dx \]

where \( PHC_{i+1} \) denotes automobile loan in \( i+1 \)-th year, \( PHC_i \) denotes automobile loan \( i \)-th year.

3. Numeric Results

The data set consists of 16,237 applications for an automobile loan at a major bank of Shandong province between September 2002 and August 2009.

In a certain short time interval, the Distribution law of applicants and their total volume per time are Table 1 and Table 2.

Thus, distribution law of automobile loan is acquired using Convolution Table 3.

The total time is divided into some short time interval \( i \). Let \( S_i \) indicate the volume in time interval \( i \), thus is the Convolution of \( S_i \).

Automobile loan in 2006 is as follows:

\[ PHC_{2006} = \int_0^\infty \frac{1 - F(x + PHC_{2005})}{1 - F(PHC_{2005})} dx \]

\[ = 1002.87(100 \text{ millions Yuan}) \]

Actual results in 2006 is 100,900 millions Yuan, relative error is 0.6%.

Aiming to further testify the efficiency of the model, we selected automobile loan in the bank from 2004 to 2006 to test using different models. The results are Table 4.

Table 4 shows that model based on conditional mathematic expectation is an efficient one with respect to forecasting demanding of automobile loan.

4. Conclusions

In this paper we have argued two related points. The first is that model based on conditional mathematic expectation is an efficient approach for forecasting demand of automobile loan.

<table>
<thead>
<tr>
<th>N</th>
<th>6</th>
<th>7</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>0.4</td>
<td>0.5</td>
<td>0.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>X</th>
<th>53</th>
<th>61</th>
<th>72</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>s</th>
<th>p^0(s)</th>
<th>p^1(s)</th>
<th>p^2(s)</th>
<th>p^3(s)</th>
<th>f(s)</th>
<th>F(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0.62</td>
<td>0.17</td>
<td>0.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0.37</td>
<td>0.27</td>
<td>0.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0.14</td>
<td>0.46</td>
<td>0.32</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0.29</td>
<td>0.464</td>
<td>0.86</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*LSI: logarithm second-index flatness LSF: least square fitting ANN: artificial neural network CME: conditional mathematic expectation
automobile loan than other model available. The second is that automobile loan doesn’t increase forever. A more general implication of our finding for demanding for automobile loan is perhaps that it supports the present shift in many countries from monetary targeting to credit targeting with the loan rate as an effective tool of credit control. Banks may also be forecasting survival time, or loss rates, or both using model proposed in this paper.

5. References


Call for Papers

Modern Economy

ISSN 2152-7245 (Print)   ISSN 2152-7261 (Online)
http://www.scirp.org/journal/me

Modern Economy (ME) is an international journal dedicated to the latest advancement of all areas of economics. The goal of this journal is to provide a platform for scientists and academicians all over the world to promote, share, and discuss various new issues and developments in different areas of modern economy.

Editor-in-Chief
Prof. Cuihong Yang
Chinese Academy of Sciences, China

Editorial Board

Prof. Gary C. Anders
Arizona State University, USA

Prof. Giovanni Barone-Adesi
Swiss Finance Institute, Switzerland

Prof. José Luis Vázquez-Burjue				University of León, Spain

Prof. Elias G. Carayannis
George Washington University, USA

Prof. Avik Chakrabarti
University of Wisconsin-Milwaukee, USA

Prof. Luiz Paulo Lopes Favero
University of Sao Paulo, Brazil

Dr. Hesuan Hu
New Jersey Institute of Technology, USA

Prof. Shin-Kunglai
Zhejiang University, China

Dr. Thanh Quang Le
University of Queensland, Australia

Prof. Xinjian Liu
Yanshan University, China

Prof. Boris S. Mordukhovich
Wayne State University, USA

Prof. Iordanis Petsas
University of Scranton, USA

Prof. Panagiotis Petrakis
University of Athens, Greece

Dr. Ugur Soytas
Middle East Technical University, Turkey

Prof. Tulus Tahim Amoanang Tambunan
University of Trisakti, Indonesia

Prof. Hsing Yu
Southeastern Louisiana University, USA

Prof. Francesco Zirilli
Sapienza Universita di Roma, Italy

Prof. Wei Zou
Wuhan University, China

Subject Coverage

The journal publishes original papers including but not limited to the following fields:

Commercial Policy
Economic Development
Economic Integration
Exchange Rates
Finance and Investments
Fiscal and Monetary Policy
International Factor Mobility
International Finance

International Institutions
Labor Issues
Managerial Decision Making
Marketing and Sales
Multilateral Institutions
Multinational Corporations
Open Economy Macroeconomics
Trade Patterns

We are also interested in: 1) Short Reports - 2-5 page papers where an author can either present an idea with theoretical background but has not yet completed the research needed for a complete paper or preliminary data; 2) Book Reviews - Comments and critiques.

Notes for Intending Authors

Submitted papers should not have been previously published nor be currently under consideration for publication elsewhere. Paper submission will be handled electronically through the website. All papers are refereed through a peer review process. For more details about the submissions, please access the website.

Website and E-Mail
http://www.scirp.org/journal/me   E-mail: me@scirp.org
TABLE OF CONTENTS

Volume 1   Number 2  August 2010

The Effects of Low Cost Airlines Growth in Italy
D. Campisi, R. Costa, P. Mancuso................................................................. 59

The Poolean Consensus Model: The Strategic Scope of Monetary Policy
F. L. Sell, B. Sauer, M. Wiens................................................................. 68

How to Reap the Induced Technological Bonus? A Mechanism and Illustrative Implementation
G. G. Das................................................................. 80

An Inflation Targeting Regime in Egypt: A Feasible Option?
T. Ghalwash................................................................. 89

Environmental Standards and Trade Volume
N. Mangee, B. Elmslie................................................................. 100

A Modified Consumer Price Index
G. L. Yuan, X. R. Li................................................................. 112

Research on the Relationship between Foreign Trade and the GDP Growth of East China-Empirical Analysis Based on Causality
Y. H. Li, Z. W. Chen, C. J. San................................................................. 118

Forecasting Model of Automobile Loan Based on Conditional Expectation
L. Sun, D. R. Tan, Y. Q. Nie................................................................. 125

Copyright ©2010 SciRes.  Modern Economy, 2010, 1, 59-128