

Central Bank Economic
Research: Output, Demand,
Productivity, and Relevance

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Central Bank Economic Research: Output, Demand, Productivity, and Relevance*

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Abstract

The economic research of 30 central banks in OECD and Latin America countries from 2000 to 2007 is evaluated in this study. An international comparison based on four indexes that measure central bank research output, demand, productivity and relevance is included. From this view, the European Central Bank, the United States Federal Reserve Bank-Board of Governors- and the Bank of Canada showed the best results. The Central Bank of Colombia achieves an important position among the central banks selected for the study and holds that position in most of the indexes. Three aspects of research were examined in depth: i) focus of the research agenda, ii) the way research is organized, and iii) strategies for its development for six leading central banks in the sample, based on the results of the measure, including the Central Bank of Colombia. The study shows a tendency of central banks to develop studies with academic institutions. This practice allows them to broaden the range of their analysis, by having an outside perspective, while getting expertise with recent techniques and theories for better economic analysis, which contributes to policy design.

JEL Classification: E59; A11

Key words: Central banks; economic research.

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1 Introduction

The research by central banks is intended fundamentally to provide a well-timed theoretical and empirical basis for policy-making to help central banks fulfill their functions. Research also must become an essential tool for divulging and better communicating policies to the market and the general public. From a broader perspective, Berk (2007) noted that research must help the central bank to perform its primary functions (e.g. price and financial system stability). Therefore, it must concentrate on topics that are relevant to policy makers, adhere to the highest standards of academic quality, and contribute to specialized knowledge of economics and financial literature.

Several studies have been done in recent years to evaluate the economic research performance of central banks. In the case of Europe the studies focus on the quality of the articles published by researchers, with various rankings of indexed journals are used to evaluate the articles as a way to compare the performance of central banks (Eiffinger, *et. al.*, 2002; Gaspar and Vega, 2002; Jordeau and Pagès, 2003). In a more extensive study, St-Amant *et. al.* (2005) employed different indexes to evaluate the quantity, quality and relevance of the research produced by 34 central banks in the OECD from 1990 to 2003. Results suggest that central banks with a research agenda concentrated on topics that are extremely relevant to decisions by policy makers produce publications of higher academic quality.

Another approach used to evaluate the function of research is proposed by Ochoa and Schmidt-Hebbel (2006). They define the quantity of working papers (WPs) published by central banks as a measure of research output, and the number of WPs file downloads from *LogEc*, which is the leading electronic system for tracing economic studies throughout the world, as a proxy of demand. The results of the study show the central banks of Chile and Colombia occupy important positions, both at the Latin American level and compared to the central banks of the developed economies.

Unlike most of the studies mentioned, in which the benchmark focus on research quality –measured by publication of the WPs in an indexed journal– the approach used in this study assumes that ultimate publication of the article in a recognized economic journal is an added value for the researcher who wants to position his or her work at the intellectual and academic level, but does not constitute the main purpose of research for a central bank. Therefore, what a central bank needs is research focused on topics of

particular relevance to well-timed and effective decision-making by the monetary authority, in addition to being consistently first-rate from a technical and theoretical perspective.

According with this approach, Skreb (2005) suggests that central bank research should be directed towards providing policy makers with technical support on internal and external economic performance, market development, and the short and medium-term effects of adopted policies, using the most modern economic theories and the latest techniques available to solve the problems central banks face. Similarly, Mester (2007) argues that the mission of research in a central bank is to furnish a strong scientific basis – both theoretical and empirical – to support the design of the central bank’s policies in its areas of assigned responsibility.

A methodology for a comprehensive evaluation of research performance in a central bank is proposed in this study. The measures of research output and demand suggested by Ochoa and Schmidt-Hebbel are formalized and the analysis is expanded with two additional indexes designed to measure research productivity and relevance. An index of the relevance of research to a central bank is constructed based on the classification of central bank WPs done regularly by the Bank for International Settlements (BIS). It is a more inclusive relevance measure than the one suggested by St-Amant *et. al.*, which is based on the number of times central bank WPs are cited in BIS publications and those of the U.S. Federal Reserve System.

According to empirical evidence, 30 central banks in the OECD and Latin America are evaluated during the period (2000-2007). Three aspects of research are examined in depth: focus of the research agenda, the way it is organized and the strategies used to develop it, as employed by six central banks that are shown in the study to be research leaders, including the Central Bank of Colombia.

This paper is organized into five sections, including this introduction. The methodology used to calculate the indexes and the fundamentals for its application in assessing the central banks in the sample are described in Section 2. The results of the international comparison are presented in Section 3. Section 4 is focused on the main aspects of research for the group of reference central banks. Some final thoughts are provided in Section 5.

2 Methodology

The four measures described below are proposed to evaluate research performance in the central banks.

a) Output: Equation (1) offers a measure of research output that measures the quantity of WPs produced by each central bank i , with $i = 1, \dots, I$, where the total number of central banks considered I is 30, and published during the period (2000-2007), with $t = 2000, \dots, T$, where T is 2007:

$$S_i = \sum_{t=2000}^T q_{i,t} \quad (1)$$

b) Demand: Equation (2) represents the demand for research measured by the number of WPs file downloads through *LogEc*² for each central bank i in period t :

$$D_i = \sum_{t=2000}^T d_{i,t} \quad (2)$$

c) Productivity: In economic literature the term productivity is associated with the concept of total factor productivity (TFP); that is, the number of units of output produced by each unit of the factor or input employed (Farrell, 1957).³ In this case, two indexes were used following the approach proposed by Lubrano *et. al.* (2003), where production is measured by the central bank's quantity of WPs and input is measured by the number of authors who took part in producing the research paper.⁴ Equation (3) shows the productivity index (PI) that relates each central bank's quantity of WPs ($q_{i,t}$) to the number of authors who were involved in each paper ($n_{i,t}$), for each year t , as follows:

² LogEc is an electronic system that compiles access statistics on the different services that use the *Research Papers in Economics* (RePEc) database, which is the largest collection of economic WPs and journal articles on the Internet. The WPs file downloads through this system do not include those done from each central banks' website.

³ More structured indexes have been developed to measure productivity in different sectors, due to recent efficiency frontiers developments (Kocher *et. al.*, 2006). One of the most used indexes is the Malmquist Index, which identifies whether changes in a company's productivity are due to efficiency gains and/or a technological change. See Galán and Sarmiento (2008) for one application of this index to central banks.

⁴ In some studies more weight is assigned to the central bank's authors than to the authors of any other institution taking part in the WP (See Neary, *et. al.* 2003). In this case, the assumption is that all authors took part equally in the WP and, therefore, each is given equal weight.

$$PI_i = \sum_{t=2000}^T \frac{q_{i,t}}{n_{i,t}} \quad (3)$$

d) Relevance: The relevance measure is based on the BIS ranking of central bank WPs, according to the categories established by the *Journal of Economic Literature* (JEL). The ranking of WPs published by central banks between 2000 and 2007, pursuant to the JEL classification, is shown in Table 1. Under this approach, macroeconomics and monetary economics constitute the area that accounts for the largest proportion (32.7%), followed by financial economics (18.1%), mathematical and quantitative methods (13%), and international economics (12%). According to this ranking, the WPs in the aforementioned categories are more relevant to the central bank than, for example, a WPs in category P (economic systems), which accounts for 0.21%.⁵ To make the ranking operative, each proportion was transformed on a scale of one to five points, which indicates the value attributed to each published WPs.

Table 1: Working Papers Relevance Scale According to BIS

JEL Category	Topics	Share % 1/	Ranking 2/
E	Macroeconomics and Monetary Economics	32,68	5,00
G	Financial Economics	18,14	3,78
C	Mathematical and Quantitative Methods	12,98	2,99
F	International Economics	12,03	2,84
D	Microeconomics	6,39	1,98
J	Labor and Demographic Economics	3,67	1,56
O	Economic Development, Technological Change, and Growth	3,10	1,47
L	Industrial Organization	2,74	1,42
R	Urban, Rural, and Regional Economics	2,65	1,41
H	Public Economics	2,61	1,40
N	Economic History	1,05	1,16
I	Health, Education, and Welfare	0,38	1,06
K	Law and Economics	0,38	1,06
M	Business Administration and Business Economics; Marketing; Accounting	0,32	1,05
B	History of Economic Thought, Methodology, and Heterodox Approaches	0,21	1,03
P	Economic Systems	0,21	1,03
Q	Agricultural and Natural Resource Economics; Environmental and Ecological Economics	0,19	1,03
Z	Other Special Topics	0,15	1,02
A	General Economics and Teaching	0,12	1,02
	Total	100	..

1/ The JEL category as a share of all central bank WPs ranked by BIS during the period 2000-2007.

2/ Scale of one to five points, denoting the proportion of the WPs selected by BIS.

Source: BIS Research Hub and the author's calculations.

⁵ Gaspar and Vega (2002) suggest the relative importance of the topics measured according to the JEL categories can be considered a good indicator of the policy orientation of central bank research.

The productivity and relevance index (PRI) is shown in Equation (4), where each central bank WPs is evaluated with a relevance measure (w_i) and then corrected by the number of authors for each publication:⁶

$$IPR_i = \sum_{i=2000}^T \frac{q_i \times w_i}{n_i} \quad ; \quad 1 \leq w_i \leq 5 \quad (4)$$

As mentioned earlier, this relevance measure is more inclusive than the one used by St-Amant *et. al.*, which is based on the number of citations of central bank WPs in BIS publications and those of the Federal Reserve System. The assumption, in this case, is that publication of the article in a recognized journal is added value for the researcher who hopes to position his or her work at the academic level, but is not the main purpose of central bank research.

Several ways of ranking journals to measure the quality of the articles are proposed in the literature (Combes and Linnemer, 2003).⁷ However, recent evidence shows these rankings can have important methodological differences that affect the way journals are ranked and, consequently, the ultimate assessment of the articles (Wall, 2009)⁸. Most of the central banks evaluated try to keep a minimum level of academic quality in their publications, which is guaranteed by using anonymous referees to evaluate the WPs. It is another reason for not evaluating the quality of publications and for focusing on the relevance of the topic.

In fact, most central banks use a “light” arbitration procedure that consists of a rather quick look at the article to make sure it says nothing that might compromise or adversely affect the central bank and contains no analytical or conceptual errors or statistical fallacies.⁹ In this respect, the differences among central banks reside in the fact that this arbitration may be

⁶ In the four measures described above, the result for the best performing central bank was transformed on a relative basis to generate comparative indexes for each aspect evaluated; namely: $I_i^* = (I_{i,t} \times 100) / I_{i,t}^{\max}$, where $I_{i,t}$ is the value obtained for each evaluated central bank and $(I_{i,t}^{\max})$ is the maximum value obtained by a central bank for the evaluated aspect.

⁷ Kodrzycki and Yu (2006) proposed a recent approach, where journals are ranked on the basis of the weighted average of the citations of articles in other journals, with the idea to measure the influence of the article in the area of economics, social sciences and policy. See also García-Castrillo *et. al.* (2002).

⁸ Additionally, some studies show there is an institutional concentration of authors in top economics journals (Kocher and Sutter, 2001)

⁹ This process does not include requests for extensions to the model or to the statistical method used, as would be typical in a report subject to “heavy” arbitration, such as one prepared for an academic journal. Nor is it necessary to submit a detailed report on the assessed paper.

done internally by other researchers (e.g. Chile and Colombia), with an outside consultant (e.g. England, Spain and Brazil) or using a combination of internal and outside arbitration (e.g. Canada, the ECB and the Fed-BG). Yet, regardless of the type of arbitration, research quality will always be an aspect of prime importance to central banks.

3 Results of the International Comparison

The indexes described earlier were calculated for 30 central banks with information on WPs published from 2000 to 2007¹⁰. As for research output, a steady increase in WPs production by the central banks in the sample was observed (85% during the period). When arranged according to all published WPs, the European Central Bank (ECB) and the United States Federal Reserve-Board of Governors (Fed-BG) led the output with 912 and 757 WPs, and respective annual averages of 114 and 95 (Table 2).

Table 2: Working Papers of Selected Central Banks (2000-2007)

Ranking	Central Banks	2000	2001	2002	2003	2004	2005	2006	2007	Total	Share %	Average	Var. % (2000-2007)
1	ECB	33	72	93	96	139	166	149	164	912	12,71	114	397
2	FED-BG	92	84	95	107	103	96	84	96	757	10,55	95	4
3	Chile	30	43	62	59	53	50	54	47	398	5,55	50	57
4	Finland	38	43	45	52	53	47	52	55	385	5,37	48	45
5	Colombia	28	27	32	46	48	40	69	49	339	4,72	42	75
6	Canada	23	27	42	44	49	45	49	58	337	4,70	42	152
7	Germany	10	20	31	20	47	58	60	53	299	4,17	37	430
8	Italy	27	46	28	21	54	28	43	42	289	4,03	36	56
9	St. Louis-Fed	10	6	7	45	32	76	62	54	292	4,07	37	440
10	Atlanta-Fed	28	27	33	43	39	30	30	27	257	3,58	32	-4
11	Holland	18	11	24	29	38	53	41	35	249	3,47	31	94
12	Spain	19	21	29	22	23	42	39	41	236	3,29	30	116
13	San Francisco-Fed	19	23	24	24	35	26	50	33	234	3,26	29	74
14	England	19	27	20	39	35	40	32	19	231	3,22	29	0
15	Chicago-Fed	31	24	31	35	30	24	29	24	228	3,18	29	-23
16	New York-Fed	19	28	15	19	21	39	35	33	209	2,91	26	74
17	Philadelphia-Fed	14	16	22	24	24	28	22	34	184	2,56	23	143
18	Brazil	9	26	26	19	11	9	28	29	157	2,19	20	222
19	Cleveland-Fed	15	19	15	21	16	15	24	25	150	2,09	19	67
20	Minneapolis-Fed	25	13	19	16	22	14	17	18	144	2,01	18	-28
21	France	6	9	11	5	17	18	23	30	119	1,66	15	400
22	Kansas City-Fed	11	15	12	13	12	13	16	13	105	1,46	13	18
23	Austria	3	13	25	6	8	12	28	4	99	1,38	12	33
24	Peru	12	15	9	16	8	8	10	19	97	1,35	12	58
25	Boston-Fed	5	6	8	8	8	18	19	16	88	1,23	11	220
26	Richmond-Fed	12	9	4	19	10	13	13	8	88	1,23	11	-33
27	Mexico	8	8	12	5	7	5	15	15	75	1,05	9	88
28	Ireland	5	6	6	9	10	10	17	10	73	1,02	9	100
29	Dallas-Fed	6	17	7	11	6	11	6	9	73	1,02	9	50
30	Venezuela	6	5	6	14	14	4	8	15	72	1,00	9	150
	Total	581	706	793	887	972	1038	1124	1075	7176	100	897	85
	Average	19	24	26	30	32	35	37	36	239	3	30	116

Source: BIS Research Hub, the websites of the central banks and the author's calculations.

¹⁰ The central bank working paper series are showed in the Appendix.

The central banks of Chile, Finland, Colombia and Canada, with more than 300 WPs during the period and 40 per year, exceed the average (239 and 30, respectively). When comparing WPs output between 2000 and 2007, most of the central banks increased their WPs output during those years. The central banks of Germany, France and the St. Louis-Fed are prime examples, having increased their WPs output more than four-fold. In the case of the ECB, the important build-up is explained by the institution's consolidation in the European Union since its start in 1999.

The demand for research, calculated with equation (2), shows an important increase during the period due the raise in the number of WPs file downloads for the majority of the central banks in the sample. The number of downloads went from 122,389 in 2000 to 210,332 in 2007 (72% increase), while the increase for the output was 85% (Table 3).

Table 3: Research Demand in Central Banks (2007)

Ranking	Central Banks	Demand		Var %	Share %	
		2000	2007	2000-2007	2000	2007
1	FED-BG	27.020	30.700	13,62	22,08	14,60
2	ECB	3.809	20.629	441,60	3,11	9,81
3	Canada	5.128	14.092	174,82	4,19	6,70
4	St. Louis-Fed	2.043	12.011	487,98	1,67	5,71
5	New York-Fed	6.261	11.841	89,12	5,12	5,63
6	Italy	6.751	11.435	69,38	5,52	5,44
7	Colombia	5.908	11.258	90,55	4,83	5,35
8	Chile	6.595	11.250	70,59	5,39	5,35
9	England	7.906	8.608	8,89	6,46	4,09
10	Atlanta-Fed	8.020	8.428	5,09	6,55	4,01
11	Holland	3.797	8.038	111,72	3,10	3,82
12	Finland	4.594	7.240	57,60	3,75	3,44
13	Philadelphia-Fed	2.685	7.101	164,44	2,19	3,38
14	Germany	1.209	6.984	477,59	0,99	3,32
15	Chicago-Fed	7.570	6.387	-15,63	6,19	3,04
16	Cleveland-Fed	3.134	5.688	81,48	2,56	2,70
17	San Francisco-Fed	2.998	5.669	89,12	2,45	2,70
18	Boston-Fed	1.339	4.670	248,74	1,09	2,22
19	Kansas City-Fed	2.938	3.781	28,68	2,40	1,80
20	Richmond-Fed	4.480	3.252	-27,41	3,66	1,55
21	Minneapolis-Fed	4.012	3.145	-21,60	3,28	1,50
22	Austria	2.007	2.916	45,31	1,64	1,39
23	Brazil	591	2.074	251,16	0,48	0,99
24	Dallas-Fed	1.146	1.872	63,33	0,94	0,89
25	Spain	319	750	134,96	0,26	0,36
26	France	73	400	444,43	0,06	0,19
27	Ireland	46	100	117,77	0,04	0,05
28	Mexico	5	6	20,00	0,00	0,00
29	Peru	3	5	66,67	0,00	0,00
30	Venezuela	2	2	0,00	0,00	0,00
	Total	122.389	210.332	72	100	100
	Average	4.080	7.011	126

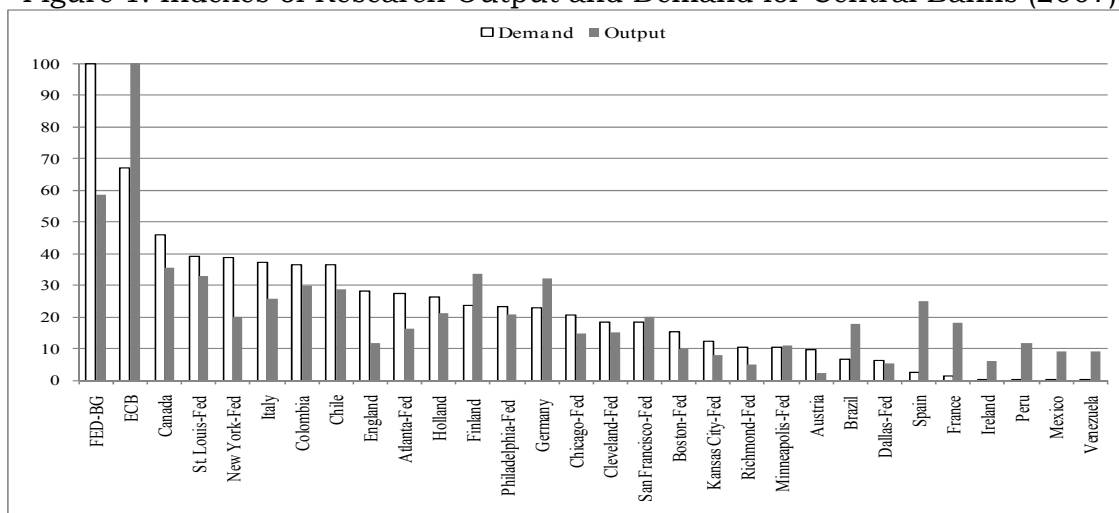
Source: Ideas-LogEc, and the author's calculations.

In 2007, the Fed-BG occupied first place, with 30,700 downloads 49% more than those registered in the ECB (20,629), which went to second place. The Bank of Canada was in third place (14,092), followed by the St. Louis Fed

(12,011), the New York-Fed (11,841) and the Bank of Italy (11,435). The central banks of Colombia and Chile, with 11,258 and 11,250 downloads, were in seventh and eighth place.

The relative indexes of output and demand calculated for 2007, where the performance of each central bank is compared to the best in the sample, indicates that demand for ECB WPs and for those of the central banks of Finland, Germany, Brazil, Spain and France is less than the output level during that year. The comparison of the indexes for the ECB and the Fed-BG indicates the latter continues to dominate with respect to the demand for economic literature, even though the ECB produces more WPs (Figure 1).

Figure 1: Indexes of Research Output and Demand for Central Banks (2007)



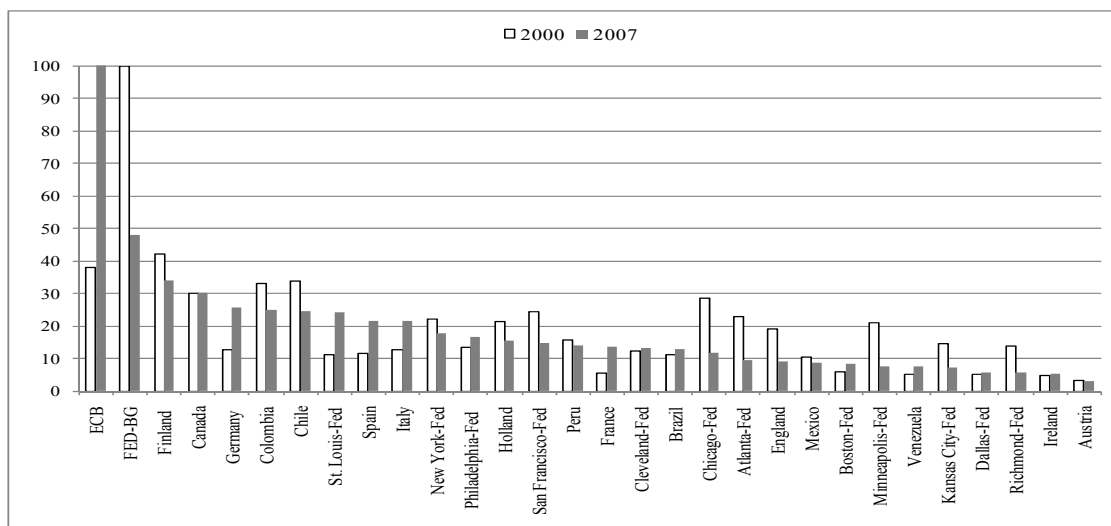
Source: Ideas-LogEc; BIS Research Hub, the websites of the central banks and the author's calculations.

The productivity index (PI) described in Equation (3) is presented in Figure 2. It shows the central banks with the most production also occupy the top positions with respect to productivity. According to the results for 2007, the ECB, the Fed-BG and the central banks of Finland, Canada and Germany lead the PI. The central banks of Colombia, Chile and Peru occupy prominent positions at the regional level.

The relevance of each WPs, done by calculating the PRI (Equation (4)), highlights the progress achieved by the central banks of Peru, Brazil and the Kansas City-Fed, despite having less output. This suggests the topics studied are notably relevant to the central banks. In contrast, when evaluated with this index, the Philadelphia-Fed, the Atlanta-Fed and the Boston-Fed dropped several positions, partly because their research agenda is concentrated on topics that complement the studies done by the Fed-BG and other regional

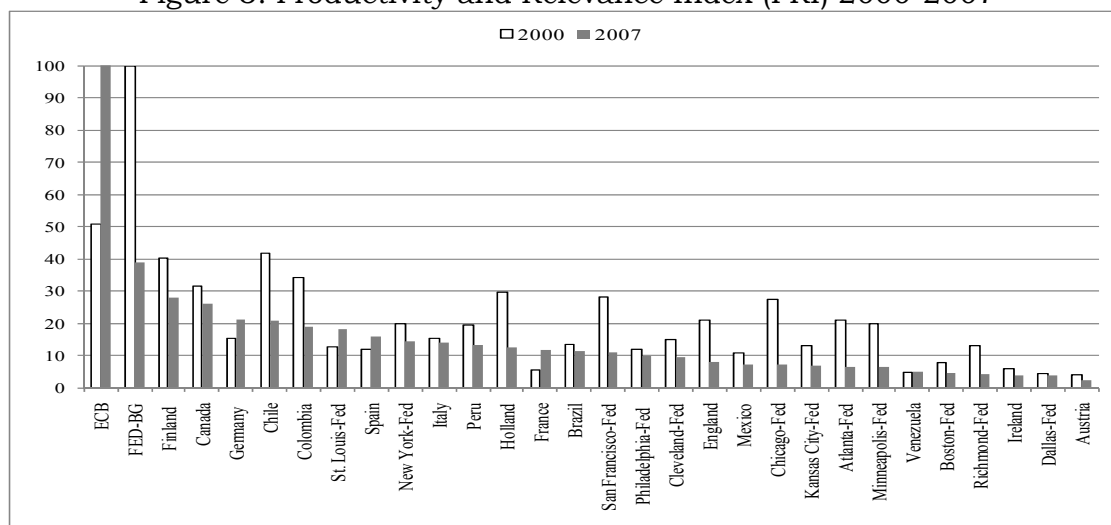
branches (e.g. St. Luis-Fed and the New York-Fed) where the primary focus is on issues related to monetary economics, financial economics and quantitative methods¹¹ (Figure 3).

Figure 2: Productivity Index (PI) 2000-2007



Source: BIS Research Hub, the websites of the central banks and the author's calculations.

Figure 3: Productivity and Relevance Index (PRI) 2000-2007



Source: BIS Research Hub, the websites of the central bank and the author's calculations.

The increase in the PI averaged 8.6% between 2000 and 2007, due to added productivity on the part of 46% of the central banks evaluated. The PRI declined 22.6%, on average, given the reduction made by the 80% of the central banks. The central bank in France, the ECB, the St. Louis Fed and the central banks in Germany, Spain and Venezuela were the only ones to register an increase in the PRI during those years (See Annex 1).

¹¹ In fact, Goodfriend (1999) notes the Federal Reserve System had developed a model whereby its regional branches specialize in different types of research. This provides comparative advantages to the system.

4 Reference Central Banks

Five central banks were selected for comparison to the Central Bank of Colombia. They are the ECB, the Fed-BG and the central banks of Canada, Germany and Chile. These institutions are recognized for their experience in economic research and ranked the best in the indexes calculated earlier. The focus of the research agenda, the way research is organized, and the latest strategies to improve research quality and relevance were examined for this group of institutions.

4.1 Focus of the Research Agenda

A concentration coefficient of the percentage of WPs located in the most relevant JEL categories (E, G, F and C), according to the result of the BIS ranking, was established to measure how focused the research agenda is. The calculated indicator shows that 81% of the research done by these banks, on average, is concentrated in the four most relevant categories, with macroeconomics and monetary economics accounting for the largest share (31%), followed by international economics and financial economics (19%). The central banks of Chile and Canada had the highest concentration coefficient in the group (89% and 86%, respectively). The area of international economics predominates in Chile (43%) and macroeconomics and monetary economics, in Canada (38%). The coefficient for the ECB and the Fed-BG was 84%, with more of an emphasis on macroeconomics in the ECB (43%) and on financial economics and quantitative methods in the Fed-BG (28% and 26%, respectively) (Table 4).

At the Central Bank of Germany, 79% of the research agenda was concentrated, with macroeconomics and financial economics being the topics that account for the largest proportion. In Colombia, the coefficient was 65%, and was below the average in the four main categories. The largest proportion was in the area of macroeconomics (25%) and financial economics (18%). The proportion of studies dealing with the labor market and economic history was larger compared to the reference central banks. The variety of topics studied in the Central Bank of Colombia stems from the fact that part of the research done by the institution is regarded as a contribution to the economic debate in Colombia and to the academy.

Table 4: Concentration of the Research Agenda in Selected Central Banks
(2007)

JEL	Topic	ECB		FED-BG		Canada		Germany		Chile		Colombia		Average	
		WP	%	WP	%	WP	%	WP	%	WP	%	WP	%	WP	%
E	Macroeconomics and Monetary Economics	71	43%	17	18%	22	38%	15	28%	16	34%	12	24%	26	31%
F	International Economics	32	20%	12	13%	10	17%	6	11%	20	43%	5	10%	14	19%
G	Financial Economics	21	13%	27	28%	11	19%	15	28%	3	6%	9	18%	14	19%
C	Mathematical and Quantitative Methods	14	9%	25	26%	7	12%	6	11%	3	6%	6	12%	10	13%
O	Economic Development, Technological Change, and Growth	7	4%	3	3%	1	2%	2	4%	3	6%	4	8%	3	5%
H	Public Economics	5	3%			2	3%	5	9%			3	6%	3	4%
J	Labor and Demographic Economics	7	4%	4	4%	1	2%	2	4%			3	6%	3	3%
D	Microeconomics	4	2%	4	4%	1	2%	2	4%			2	4%	2	3%
N	Economic History			1	1%	2	3%					3	6%	1	2%
L	Industrial Organization	2	1%							2	4%	1	2%	1	1%
I	Health, Education, and Welfare			3	3%									1	1%
K	Law and Economics											1	2%	0	0%
R	Urban, Rural, and Regional Economics					1	2%							0	0%
Q	Agricultural and Natural Resource Economics; Environmental and Ecological	1	1%											0	0%
Total WP		164		96		58		53		47		49		78	
Concentration Coefficient (E, G, F & C)		84,1%		84,4%		86,2%		79,2%		89,4%		65,3%		81,4%	

Source: BIS Research Hub, the websites of the central banks and the author's calculations.

It is important to mention the extensive output of economic research by the academic community in the more developed economies, as it allows the central banks to target their research efforts on topics of concern to their primary functions (e.g. price and financial system stability). Given the absence of specialized research on the part of the academic community, in emerging economies some central banks have assumed a broader and more active role in economic research.

Additionally, longer-term economic research is useful for policymaking, yielding better outcomes. In this respect Mester (2007) suggests that in the monetary policy arena these would include the recent ideas of rational expectations and time inconsistency, the role of central bank independence, and the implementation of a better strategy of price stability. In the financial stability arena, work on capital requirements, risk-modeling, moral hazard, and prompt corrective action are important in formulating better policy¹².

4.2 Research Organization

The bulk of the central banks organize research in three ways. i) The centralized approach: research is concentrated in a department that is

¹² Annex 2 shows the correlation between inflation with the four indexes calculated above, it shows that an increase in WPs generate a reduction in inflation rate near to 13%.

responsible for pushing the research agenda forward (e.g. Germany). ii) The decentralized approach: several departments or branch offices are involved actively in carrying out the research agenda, and studies on the central bank's primary function take precedence (e.g. USA and Canada). iii) The intermediate approach: research is led by a department, which receives support from other areas to conduct a portion of the studies contemplated in the agenda (e.g. the ECB, Chile and Colombia).

In the case of Germany, the central bank has a Research Center comprised of eleven research groups: eight dedicated to monetary policy topics and three to financial stability issues. The research teams are comprised of researchers from the central bank and advisers from German universities and European research centers. Outside consultants and visiting researchers from other central banks (the ECB and the Fed) and multilateral organizations (the WB and the IMF) take part in some of the groups.¹³

The Fed-BG uses a decentralized approach in which research is conducted independently by three divisions: Research and Statistics, Monetary Affairs and International Finance. The last division has become particularly relevant, as it is where the major advanced and emerging economies are monitored, and studies are done on financial markets and developments in banking and international trade.

Using a similar approach, the Bank of Canada conducts its research in four divisions: Research, Financial Markets, the International Division, and Monetary and Financial Analysis. In recent years the Financial Markets Division has developed in-depth studies on topics such as financial infrastructure, risk management and capital market efficiency and stability. Like the Fed-BG, the International Division analysis economies by regions (USA and Mexico, Asia and Europe), develops models to forecast how international markets will perform, and does research on financial stability, exchange rates and global economic growth.

The ECB uses an intermediate approach where two sections interact to produce research. Theoretical and empirical research relevant to monetary-policy implementation is produced under the coordination of the Studies Department, with support from the Economics Department, which does short-term, practical studies (e.g. forecasts on inflation, growth, etc.) to assist

¹³ The framework of Central Bank of Germany Research Center is presented in Annex 3

decision-making by the Board of Governors. This area also is responsible for monitoring economic performance in the European Union, including financial, monetary and fiscal developments in the Euro Zone.

At the Central Bank of Chile research is done mostly by the Economic Research Division, which keeps an agenda focused on monetary and financial conditions in the Chilean economy, measurement and analysis of external conditions, the development of general equilibrium models, monetary-policy implementation, price dynamics and real fluctuations. For some of the studies it receives support from the Macroeconomic Analysis Division, which develops monetary-aggregate, financial and real forecast models to assist the Board of Directors. The Division for International Analysis is in charge of international reserve management and financial system stability; it does studies on topics dealing with international trade and the global financial environment.

The Central Bank of Colombia uses an approach similar to those employed by the ECB and the Central Bank of Chile. The Research Unit pursues the institution's research agenda, conducting studies on long-term topics that contribute to the economic-policy measures adopted by the Board of Directors. The Unit also supports an agenda on topics that contribute to an economic analysis of the country. The researchers in the Unit rely on the Division of Economic Studies for support to develop joint research projects. This Division prepares forecasts on inflation, growth, balance of payments and other economic variables. It also develops models to design and evaluate monetary and exchange policy, produces statistics on monetary aggregates, foreign exchange and credit, and regularly examines the performance of government finances. The Division of Monetary Affairs is responsible for managing the country's international reserves and implements the monetary-policy and exchange measures adopted by the Board of Directors. It also does studies on monetary economics, financial system stability and international economics.

Table 5 shows to the extent to which the researchers in the Research Unit and in other departments contribute in the series of working papers published by the Central Bank of Colombia (*Borradores de Economía*). On average, 53% of the working papers are prepared by researchers from the Research Unit (34 WPs in 2008); the other 47% (32 WPs) are done by other Economic Studies and Monetary Affairs part-time researchers .

Table 5: *Borradores de Economía* by the Central Bank of Colombia (1994-2008)

Years	Economic Studies & Monetary Affairs Divisions		Research Unit		Total WP
	WP	Share %	WP	Share %	
1994	9	64,3	5	35,71	14
1995	15	50,0	15	50,00	30
1996	15	68,2	7	31,82	22
1997	7	43,8	9	56,25	16
1998	10	40,0	15	60,00	25
1999	11	39,3	17	60,71	28
2000	14	48,3	15	51,72	29
2001	6	21,4	22	78,57	28
2002	13	40,6	19	59,38	32
2003	20	43,5	26	56,52	46
2004	15	32,6	31	67,39	46
2005	18	45,0	22	55,00	40
2006	33	47,8	36	52,17	69
2007	22	44,9	27	55,10	49
2008	32	48,5	34	51,52	66
Total	240	..	300	..	540
Average	16	..	20	..	36

Source: Central Bank of Colombia, author's calculations

The Central Bank of Colombia created the Committee on Monitoring Research to coordinate its research agenda. The Committee's primary function is to organize a decision between the researchers and the Board of Directors on the research topics to be pursued. The Committee defines a central topic of study, around which different research projects are developed. In 2007 the study of non-observable variables was the central topic; in 2008, it was an in-depth look at monetary-policy pass-through mechanisms, and in 2009 the topic is wage and price formation. Additionally, there is a long-term research agenda in seven areas: monetary, exchange and credit policy; growth and productivity; consumption-savings-investment; government finance; the labor market; foreign trade and international economics; the financial sector, and economic history.

Regional research plays an important role in the research agenda of the Central Bank of Colombia by providing an insight into the development of national economic activity and making it possible to identify how monetary-policy measures affect the country. There are seven Regional Economic Study Centers, which monitor economic performance in the regions and research current issues. Also, there are two specialized research centers in Cartagena and Medellín that study special topics as input for the regional economic debate and to strengthen local research networks.

4.3 Research Strategies

The reference central banks use different strategies to target and improve economic research. For example, the Research Center operated by the Central Bank of Germany is one of the strategies most accepted by the European academic community, owing to integration with researchers from other institutions, mostly central banks and universities. By targeting the topics on the agenda, it has been possible to develop specialized research and to create a synergy with the Board of Directors that contributes to well-timed and efficient decision-making. The agenda is published every two years for the sake of added transparency and to help socialize the research (Deutsche Bundesbank, 2008).

The strategy used by the Fed-BG has been to support internship programs for students doing doctoral dissertations on topics that deal with macroeconomics, international economics, finance, banking and econometrics. It also has a summer internship program for undergraduates who are majoring in economics and finance.¹⁴

Using a similar approach, the Central Bank of Canada regularly hires undergraduate and graduate students to serve as research assistants and maintains an active alliance with academic institutions for joint research, consultations, courses and seminars. It also has an academic grant program for university professors to promote studies on monetary economics and macroeconomics.

One of the main research strategies at the ECB is based on research networks with European central banks, universities and a number of research centers with which it carries out programs for visiting researchers and/or professors¹⁵. On the other hand, the strategy of the Central Bank of Chile is visiting other central banks in the developed economies to conduct joint research projects and to participate in forums and seminars.

The Central Bank of Colombia has adopted several strategies to improve and increase its research. One of the most effective has been its involvement in the Centre for Latin American Monetary Studies (CEMLA) research network,

¹⁴ The internship programs were started at the St. Louis Fed to advance research on monetary economics and eventually were extended to include the entire Federal Reserve System (Bordo and Schwartz, 2008).

¹⁵ Goodfriend, *et. al*, (2004) suggest that ECB should hiring more research assistants on a temporary basis. Young MSc graduates or PhD students are ideal for these positions because they are familiar with the latest analytical tools and techniques and are highly motivated to spend some time at the ECB. It is possible due the budget flexibility and the independence of central banks, especially in developed economies (Galán and Sarmiento, 2007)

where research topics relevant to monetary policy (e.g. non-observable variables, pass-through mechanisms, DSGE models) are spearheaded and coordinated for the central bank. As a result, it has been possible to work alongside research teams from the most important central banks in Latin America and to provide advice and assistance to smallest central banks.

Another strategy is to develop research with university professors in the United States as a way to delve into specific topics of special interest to the Board of Directors (e.g. bio-fuels, workers' remittances, export markets, etc.). The associate researcher strategy applied at the internal level consists of a researcher from the Unit Research working in association with another department to conduct studies on specific topics, thereby fostering a synergy of knowledge and more decentralization in research.

5 Final Thoughts

The international comparison shows the research agenda should be aligned with the core functions of the central banks and, in turn, with the economic conditions in each country. Accordingly, at central banks that supervise the financial system, the area of financial economics occupies an important part of the research agenda (the Fed-BG and Germany). In the case of Chile, for example, the central bank's ongoing study of international economic behavior is consistent, in part, with the country's many Free Trade Agreements, which require steady analysis of the global economy. In Colombia, the Central Bank has an extensive research agenda that includes the most important topics for decision-making and other, less-explored issues, since academic research in Colombia has yet to be consolidated.

According to the results, the Central Bank of Colombia is in a good position when comparing to the evaluated central banks, both in terms of output and demand for its WPs. The productivity index also places it in a good position with respect to the reference central banks, underscoring the large output of studies in recent years. When the WPs are evaluated for relevance, using the PRI, the ranking declines slightly, because the research agenda is less concentrated on the relevant topics compared to the reference banks. As to how research is organized, the strategies adopted by the Central Bank of Colombia in recent years have made it possible to provide the Board of Directors with appropriate, well-timed support, and to take advantage of the

institution's independence to conduct research in a number of specialized economic areas, which is considered a public good for the country.

In terms of how research is approached, a tendency among the central banks in the sample to develop research and to exchange ideas with academic institutions was identified. The above mentioned gives central banks an outside perspective and helps them to stay abreast of techniques and theories that can be applied to economic analysis and contribute to better policy-making.

Quality of research is not evaluated directly in this study. However, the implementation of a combination of internal and outside arbitration can contribute to increase the quality of research and help to focus in the most relevant topics; it was the practice employed for central banks ranked in the top of this measurement (e.g. Canada, the ECB and the Fed-BG).

Finally, it is important to point out that research in a central bank should be carried out in a stimulating environment with a participatory agenda, but focused on the central bank's primary objectives in a way that helps policy-makers to do their job. The research must be appropriate and developed with modern theories and the latest techniques, so its quality is reflected in the effectiveness of the adopted policies.

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Annex 1.

Table A.1: Index of Productivity (IP) and Relevance (IPR) in Central Banks
(2000-2007)

Central Banks	IP			IPR		
	2000	2007	Var % 2000-2007	2000	2007	Var % 2000-2007
ECB	38	100	162,80	50,96	100,00	96,23
FED-BG	100	48	-52,11	100,00	38,92	-61,08
Finland	42	34	-19,66	40,39	27,97	-30,74
Canada	30	30	0,49	31,57	26,14	-17,22
Germany	13	26	102,56	15,27	21,19	38,75
Chile	34	25	-26,57	41,72	20,76	-50,23
Colombia	33	25	-24,31	34,26	18,77	-45,21
St. Louis-Fed	11	24	118,79	12,80	18,03	40,87
Spain	11	22	88,11	12,10	15,92	31,58
New York-Fed	22	18	-20,32	19,79	14,55	-26,47
Italy	13	22	70,13	15,27	14,20	-7,04
Peru	16	14	-12,46	19,46	13,22	-32,08
Holland	21	16	-26,62	29,77	12,46	-58,15
France	6	14	145,79	5,48	11,91	117,55
Brazil	11	13	12,51	13,28	11,28	-15,09
San Francisco-Fed	24	15	-38,40	28,33	11,03	-61,08
Philadelphia-Fed	13	17	23,04	11,77	9,95	-15,49
Cleveland-Fed	12	13	8,79	15,09	9,64	-36,14
England	19	9	-52,13	20,85	7,81	-62,52
Mexico	10	9	-14,94	10,89	7,40	-32,05
Chicago-Fed	29	12	-59,49	27,39	7,32	-73,28
Kansas City-Fed	14	7	-49,74	12,90	6,93	-46,26
Atlanta-Fed	23	9	-58,80	21,13	6,64	-68,60
Minneapolis-Fed	21	8	-63,37	19,72	6,35	-67,78
Venezuela	5	7	49,70	4,72	5,11	8,26
Boston-Fed	6	8	38,22	7,69	4,71	-38,76
Richmond-Fed	14	6	-60,36	13,07	4,05	-69,01
Ireland	5	5	10,58	5,86	3,94	-32,75
Dallas-Fed	5	6	7,81	4,53	3,71	-17,90
Austria	3	3	-3,24	4,05	2,22	-45,09
Total	606	562	-7	650	462	-29
Average	20	19	9	22	15	-23
Est. Dev.	18	18	63	19	18	47

Source: author's calculations.

Annex 2.

Table A.2: Correlation between Inflation, Output, Demand, IP, and IPR

Weight	Inflation	Output (WP)	Demand (WP)	PI (WP)	PRI (WP)
Inflation	1,00	-0,13	-0,19	-0,13	-0,12
Output (WP)		1,00	0,78	0,99	0,97
Demand (WP)			1,00	0,72	0,67
PI (WP)				1,00	0,99
PRI (WP)					1,00

Source: author's calculations

Annex 3.

Table A.3: Central Bank of Germany Research Center

Research Group	Issues	JEL Classification ^{1/}	Members ^{2/}	Advisors ^{3/}	Visiting Researchers ^{3/}
1	Money and Monetary Policy	E4, E5, G1	15	3	
2	Monetary Policy Implementation and Payment Systems	E5, D4	10		
3	Monetary Policy and Asset Prices	E4, E5	9	7	
4	Corporate Finance, Household Finance and Monetary Transmission	D1, D2, E2, G3	4	4	5
5	Fiscal Policy Interaction with Monetary Policy, Capital Markets & the Real Sector	E6, G1	7	2	
6	The Role of Frictions in goods, Labor and Financial Markets for Business Cycles and Monetary Policy	D5, E2, E3	10	5	
7	Short-term Forecasting	C1, C3, C5, E3	5	3	
8	International Integration	F2, F3, F4	12	1	
9	Financial Stability	G2, G3	15		4
10	Risk Modeling and Financial Markets	G1, G2, G3	7		
11	The Financial System: Structural issues and its changes	E4, E5, G1, G2	17	1	5
Total			111	26	14

1/ Ranked by subject categories, according to the *Journal of Economic Literature* (JEL): C: Mathematical and Quantitative Methods; D: Microeconomics; E: Macroeconomics and Monetary Economics; F: International Economics; G: Financial Economics.

2/ The groups have a team researcher-coordinator. A researcher can belong to several different groups.

3/ Researchers from European universities, OECD, and other central banks (the ECB and the Fed), as well as the World Bank and the IMF.

Source: Deutsche Bundesbank (2008), and author's calculations.

Appendix

Central Bank Working Paper Series

No.	Central Bank	Working Paper Series
1	Banco Central de Chile	Working Papers
2	Banco Central de Reserva del Perú	Working Papers
3	Banco Central de Venezuela	Working Papers
4	Banco Central do Brasil	Working Papers
5	Banco de España	Working Papers, Economic Studies, Economic History Studies
6	Banco de la República de Colombia	Borradores de Economía
7	Banco de México	Research Papers
8	Bank of Canada	Working Papers, Technical Reports
9	Bank of England	Working Papers
10	Bank of Finland	Working Papers, Studies in Economics and Finance, BOFIT Discussion Papers
11	Banque de France	Working Papers
12	Banca d'Italia	Temì di Discussione, Historical Research Papers
13	Central Bank of Ireland	Research Technical Papers
14	De Nederlandsche Bank	WO Research Memoranda, MEB Series, Research Series Supervision, DNB Staff Reports, DNB Occasional Studies
15	Deutsche Bundesbank	Diskussionspapiere
16	European Central Bank	Working Paper Series, Occasional Paper Series
17	Federal Reserve Bank Board of Governors	Finance and Economic Discussion Series, International Finance Discussion Papers
18	Federal Reserve Bank of Atlanta	Working Papers, Research Reports
19	Federal Reserve Bank of Boston	Working Papers
20	Federal Reserve Bank of Chicago	Working Papers, Consumer and Community Affairs Policy Studies, Emerging Issues Series, Occasional Papers; Emerging Payments
21	Federal Reserve Bank of Cleveland	Working Papers, Policy Discussion Papers
22	Federal Reserve Bank of Dallas	Working Papers, Centre for Latin American Economics (CLAE) Working Papers
23	Federal Reserve Bank of Kansas City	Research Working Papers, Payments System Research Working Papers
24	Federal Reserve Bank of Minneapolis	Working Papers, Discussion Papers, Staff Reports
25	Federal Reserve Bank of New York	Staff Reports
26	Federal Reserve Bank of Philadelphia	Working Papers, Payment Cards Center Discussion Papers
27	Federal Reserve Bank of Richmond	Working Papers
28	Federal Reserve Bank of San Francisco	Working Papers, Pacific Basin Working Papers
29	Federal Reserve Bank of St. Louis	Working Papers
30	Oesterreichische Nationalbank	Working Papers

Source: BIS Research Hub and the websites of the central banks.