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**Staff, Functions, and Staff Costs at Central Banks: An International Comparison with
a Labor-demand Model**

**Por:
Jorge E. Galán Camacho
Miguel Sarmiento Paipilla**

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Para comentarios favor dirigirse a los autores
Teléfono: 343 1707 – 343 1560

Staff, Functions, and Staff Costs at Central Banks: An International Comparison with a Labor-demand Model^{*}

Jorge E. Galán Camacho

Miguel Sarmiento Paipilla[♦]

Abstract

During the period 2000-2004 central banks sustained a generalized reduction in their staff, which was accompanied, in most cases, with significant increases in staff costs. This could obey to an enhanced interest of central banks in focusing on their core functions. In fact, central banks have changed the ways they perform their operative functions (*e.g.* currency operations, payment systems operation, printing notes, etc.) through different strategies aimed at gathering the participation of third parties. These strategies differ according to the relationship that central banks have with the financial sector and the government, as well as to their historical tradition and modernization trend. To explain the effect of these changes on the staff, we estimated a short-term labor demand function for 66 central banks using a panel data model with random effects. Results indicate that central banks' labor demand is strongly determined by the country's population, economic development level and changes in operative functions, as well as by staff costs. In addition, we found a low employment-wage elasticity suggesting the presence of a flexible budgetary constrain in central banks.

Key words: Central Banking, Labor Demand, Modernization, Functions, Staff Costs, Panel Data, Random Effects.

JEL Classification: E50, J23, J30, C33

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[♦] J.E. Galán and M. Sarmiento are economists of Planning and Budget Department of Banco de la República. Comments are welcome at jgalanca@banrep.gov.co and nsarmipa@banrep.gov.co. The opinions expressed herein do not involve the Banco de la República or its Board of Directors; these are the authors' exclusive responsibility.

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1. INTRODUCTION

How many employees should a central bank have? What determines its labor demand? What are the central bank's staff costs? These questions have always been of particular interest to central banks, governments and multilateral organizations alike, but they have increased in significance in the past few years with the formation of the European Central Bank and the quest for efficiency in OECD central banks¹.

In fact, when we examine these staffs we can see that the number of employees differs widely between central banks. In the year 2004 the US Federal Reserve (FED) had 20,217 employees, whereas New Zealand's central bank operated with approximately 250 employees. In Latin America, Brazil's central bank employed 4,629 people, whereas Chile's had under 600. These differences also persist in some other developing countries, (*e.g.*, Thailand's central bank operates with about 4,500 employees and Bulgaria's with around 1,000).

The empirical evidence suggests that these differences do not reside exclusively on the size of the population or the characteristics of the economy but also on the number of functions developed by central banks (Vaubel, 1997; 2002). In an extensive work, Banco de la República (2005) has studied the functions carried out by 133 central banks and found out that operative functions (*i.e.*, financial supervision, cash distribution, operation of retail payment systems, and banknotes printing) are more labor-intensive and therefore have the greatest impact on labor demand at central banks.

From the theoretical standpoint, staff costs should be taken into account when estimating labor demand (Hamermesh, 1993). To this respect, Brione (2005) compared the staff costs of 28 OECD central banks, and found wide differences (*e.g.*, the central banks of Austria, Italy and Poland have an average cost per employee three times higher than that of the central banks of New Zealand, Ireland and the Czech Republic). According to the author, these differences can be largely attributed to the heterogeneity in the functions performed by central banks².

In this context, the present paper intends to find the determinants of labor demand at central banks, and to estimate the staff that these institutions require by taking into

¹ Wellink, *et. al.*, (2002) have identified improvements in efficiency attainable by National European Central Banks after the centralization of several functions by the European Central Bank. In the same way, McKinley and Banaian (2005) have studied central bank's functions and its modernization trend in several OECD countries with the aim to identifying operational efficiency.

² On this particular subject, the Governor of Sweden's Central Bank, Mr. Lars Heikensten, has emphasized on the need of central banks becoming involved with cost-efficiency and to be more focused on their core functions (See, Heikensten, 2003).

account how they carry out their operative functions, their staff costs, and the characteristics of the economy where they operate. To this effect, 78 central banks of different regions with information from the 2000-2004 period are studied, and the staff is estimated for 66 banks on which additional information could be obtained on their staff costs.

Thus, this paper wishes to contribute to the body of literature on central banks in three major aspects. First, we identify the usual strategies developed by central banks in the performance of their operative functions. In the theoretical aspect, we construct a real wages' *proxy* in order to characterize the labor-demand function and to validate the assumption of the flexible budgetary restriction of central banks. Finally, as to methodology, we use a panel data model with random effects that contemplates the differences between central banks while at the same time allowing to identify the impact generated on the staff by changes introduced in their functions.

The paper is composed of four sections including this introduction. Section 2 discusses the recent evolution of central banks' staff, functions and staff costs. Section 3 describes the theoretical aspects of labor demand, reviews the empirical evidence for central banks, and the statement of the model. Also shows the results of the model and the staff estimations for central banks. Section 4 concludes.

2. STAFF, FUNCTIONS, AND STAFF COSTS AT CENTRAL BANKS

This section presents some facts that show how the gradual adjustment in central banks' staffs has been accompanied with changes in their operative functions and increases in staff costs. For a better comparative analysis, the selected sample was divided into three subgroups with homogeneous characteristics; two of them by similar degree of economic development, and the other one by geographic region.

2.1. EVOLUTION OF THE CENTRAL BANKS STAFF (2000 – 2004)

A. Advanced Economies

This group comprises the central banks of 30 countries that share as a common characteristic a per capita income of above USD 10,000 per year, according to the classification in IMF (2005). In this group, central banks with the highest number of employees were the FED, which after an approximately 13% reduction during the period, ended the year 2004 with 20,217 employees. Next in size are the central banks of France,

Germany, and Italy, which are characterized by having an extensive presence at the national level. However, these central banks have also made important reductions in their staffs in the past few years; in particular, the reduction carried out by the German central bank (2,200 employees) is worth noting.

During the period under study, the largest staff reductions were presented in the central banks of Canada (26%), England (23%) and Finland (19%). In contrast, the most significant increases occurred in Qatar (71%), Ireland (49%) and Luxembourg (27%). In this group, the central banks of New Zealand, Luxembourg, and Iceland are notorious for their small staffs, with less than 250 employees each. In the year 2004, this group had an average of 2,957 employees, i.e., 8.3% below the figure of 3,226 for the year 2000 (See Figure 1).

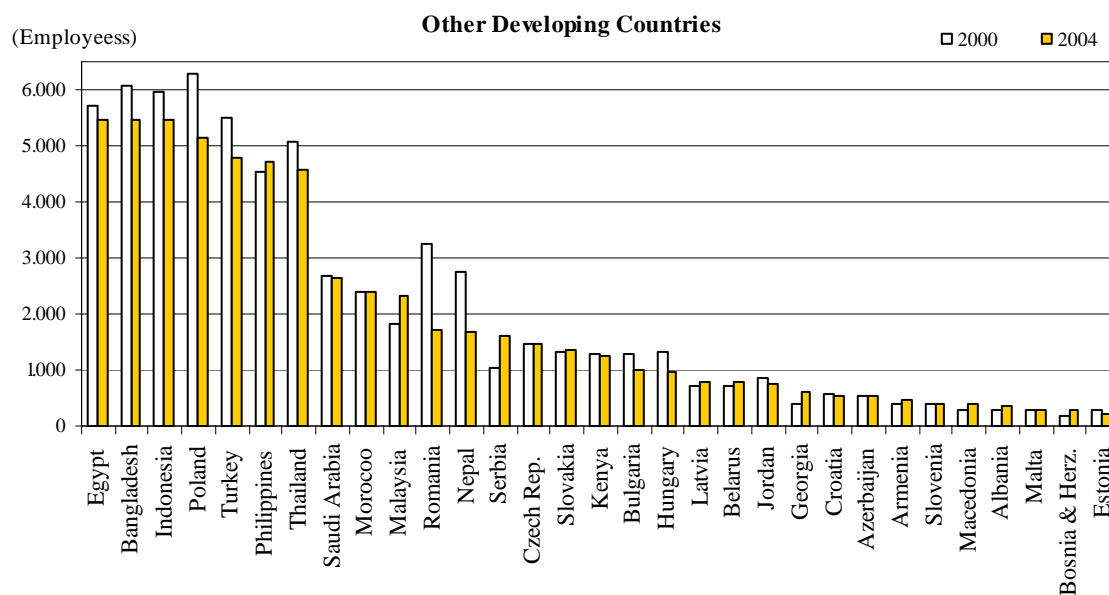
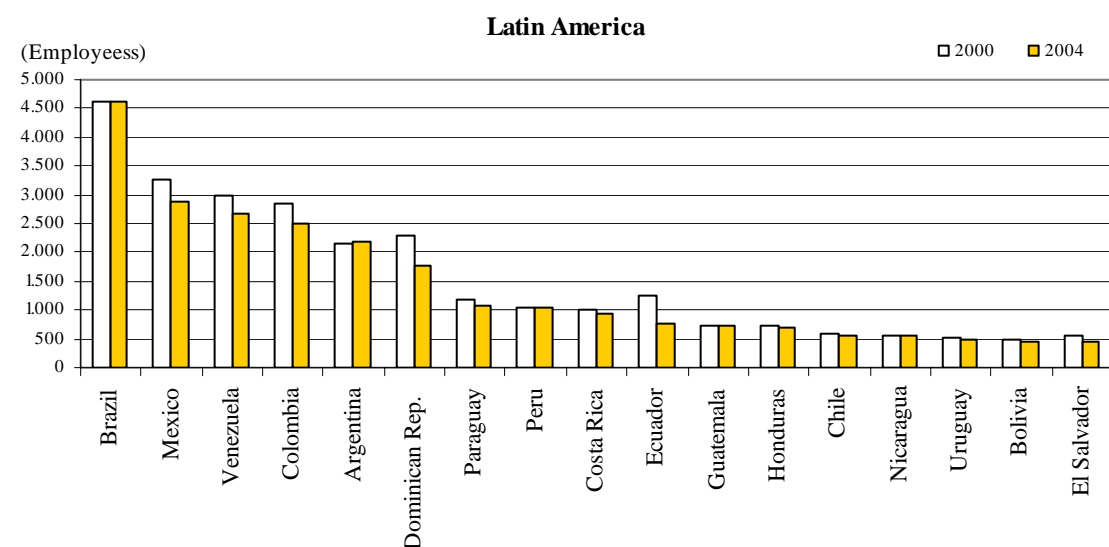
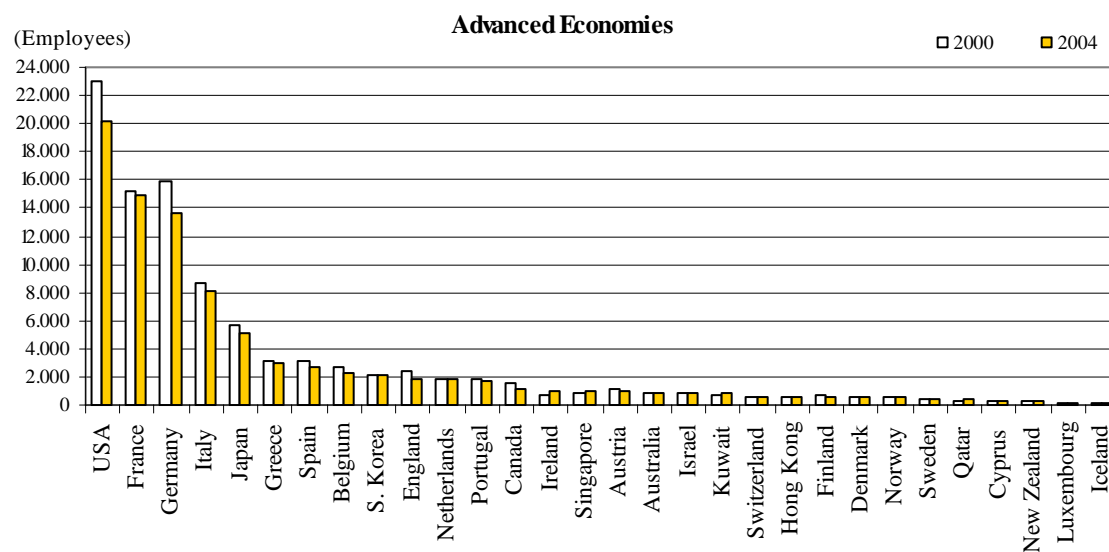
B. Latin America

This group is conformed by central banks from 17 South and Central American countries, including Mexico and the Dominican Republic. Within this group, the central bank of Brazil had the largest staff, with 4,629 employees in 2004. It's remarkable that almost all central banks in this region made staff reductions, with the cases of Ecuador (39,2%) and El Salvador (21%) largely being associated with the dollarization of these economies in the years 2003 and 2001, respectively. Significant employee reductions also took place in the Dominican Republic and Colombia, of about 23% and 12%, respectively. The average number of employees of this region's central banks went down from 1,575 in the year 2000 to 1,434 by the end of 2004, representing an adjustment of approximately 9%.

C. Other Developing Countries

This subgroup is composed of 31 central banks from countries with an annual per capita income of below USD 10,000 in 2004, and not pertaining to the Latin American region. Notorious for their large size are the central banks of Bangladesh, Egypt, Indonesia and Poland, all of which have more than 5,000 employees each. At their turn, the banks of Bosnia & Herzegovina and Estonia are worth mentioning for having less than 300 employees. During the period, important staff reductions took place at the central banks of Rumania (47%), Nepal (39%) and Hungary (27%).

Figure 1.
Central Banks Staff per Comparison Group (2000-2004)



Source: Authors' calculations based on Central Banks Annual Reports and the Central Bank Directory (2000-2004)

It's noticeable that several of these countries are recent members of the European Union or candidates to become members³. In contrast, the central banks of Serbia, Bosnia & Herzegovina, Georgia and Macedonia, have seen their staffs increase in more than 40%. However, the average size of the staff in this group had a 8% decrease, going from 2,117 employees in the year 2000 down to 1,948 in 2004.

2.2. FUNCTIONS OF CENTRAL BANKS

Functions developed by central banks are directly related to a wide array of goals, the most common of which are: To preserve the internal value of the national currency, to manage the country's international reserves, to look after the country's financial stability, to secure a safe and efficient payment system, and to guarantee the issue and circulation of currency (See Fisher, 1994; De Hann and Kooi, 2000). Several of these objectives are related to a group of functions that, due to the related activities, are labor intensive. These functions are: financial supervision, currency operations, banknotes printing, coin minting, and payment systems operation.

Since these are operational functions that, in some cases, involve a moderate degree of risk, central banks have implemented modernization strategies aimed at gathering the involvement of the private sector for their development. Recent experiences also suggest the lack of a consensus about whether central banks should or not carry out these functions or on how they should perform them, these issues depends mostly on their relationship with the government and with the financial sector as well as with their historical tradition⁴.

A. Financial Supervision

The supervision of the financial system is one of the functions that, for reasons of the country's institutional organization, has been delegated from the beginning to central banks, or has been the responsibility of a separate state-owned entity. That is why this particular function has not sustained any significant changes in its administration⁵.

³ On May 1st 2004 ten new countries became members of the European Union (i.e., Cyprus, Slovakia, Slovenia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland and The Czech Republic); today, three more candidates are about to become members: Bulgaria, Romania and Turkey.

⁴ For example, it is common in Latin America to find central banks that develop some type of cultural activity due to the historical support they have given to their country on these particular matters. However, the scope of these activities is very limited in most countries (See Annex 2).

⁵ Although no administrative changes have taken place, it is worth noting that the ways to supervise the financial system have in fact sustained significant changes due to the growth of this sector, market

There is neither a clear trend in the performance of this function nor a wide consensus on who should take care of it. However, there are some arguments in favor of central banks performing it. First, in order to fulfill its role as last-instance lenders, central banks must have first-hand and detailed information on the solvency of commercial banks, and they could perform this function more efficiently if they gathered this information directly instead of having to request it from another entity (Peek *et. al.*, 1999)⁶. Another issue has to do with the potential scale economies that central banks may develop when they take care of that particular function, because they must monitor the movements of the financial system and for that task they usually have a Financial Stability Department (Green, 2003).

In order to review this trend, Figure 2 shows the percentage of central banks that performed this function in 2004 and its comparison with the year 2000. In the advanced economies group, about one half of these central banks supervise financial entities. Among these are central banks that carry out shared supervisory modalities, as in the case of Germany, where the Federal Financial Supervisory Authority (FSSA) and the central bank share supervisory tasks, and the latter is in charge of issuing guidelines and regulations on this matter (For details see Deutsche Bundesbank, 2002).

During the period under study the only relevant change was the merger between Ireland's Financial Supervising Authority and central bank that took place in the year 2003, and that was arranged with the aim of taking advantage of synergies in common tasks and increasing the efficiency in the communication of information. In contrast with what occurred in Ireland, in 1997 England's central bank surrendered its banking supervision functions to the Financial Services Superintendence⁷.

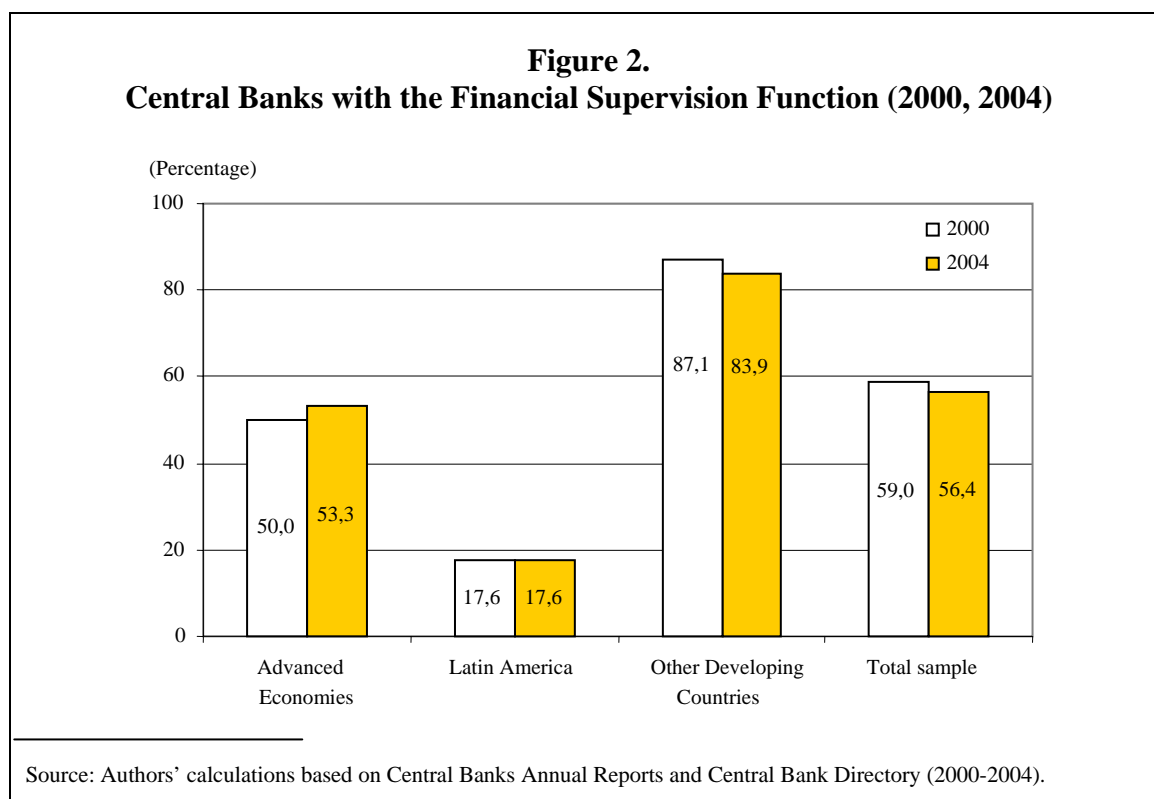
In Latin America, financial supervision has been a role typically played by state-owned entities. In this region, only the central banks of Argentina, Brazil, and Paraguay carry out this function. Contrary to this trend, in the group of other developing countries the supervision of financial entities is mostly a function of central banks. Only the central

globalization, and recent technological advances. For a complete revision of the structural changes in US financial regulation, see Freixas and Santomero (2002).

⁶ In the same sense, Goodhart and Schoenmaker (1995) argue that when an independent central bank perform the financial supervision, a more efficient response is likely to be given to the combined challenges of monetary and financial stability. (See also, Di Noia and Di Giorgio, 1999).

⁷ Briault (2002) has shown that this change has been beneficial for the development of the financial sector in England.

banks of Turkey, Bosnia & Herzegovina and Estonia do not perform this task, the latter country delegated it to a state-owned entity by the end of the year 2003.



B. Currency Operations

Currency operations mainly involve cash handling, distribution, quality check, and destruction. To carry out these activities, central banks may apart themselves from the traditional model, that was characterized by the bank performing the whole activity with its own resources. More particularly, central banks may gather the partial or complete support from third parties, provided that a certain level of supervision is maintained (See Table 1)

Figure 3 shows the percentage of central banks that carry out all or most of currency operations, mainly following the traditional model. Central banks pertaining to advanced economies show a trend toward delegating some activities related to currency operations to third parties. However, most of them still follow a traditional model (*e.g.*, Spain, France, Italy, Germany, and US⁸).

⁸ In an effort to minimise the cost of providing currency, the Federal Reserve recently issued for comments a note of a proposed policy that would involve the development of a custodial inventory program combined with a fee assessed on such cross-shipped currency (McKinley and Banaian, 2005, p.76)

During the period under analysis, the central banks of Austria, Finland and Norway delegated most of their currency operations through a participative model. In the year 2001, the Austrian central bank created a joint-venture with commercial banks in the form of an independent enterprise that assumed all currency operations, with the exception of destruction. In the same year, the central bank of Norway delegated to the private firm *Nokas* all currency operations and the administration of its 9 branches, keeping to itself a third part of the shares in this company. Under a similar view, the Finland's central bank generated a partnership with a cash-processing company owned by commercial banks.

Table 1.
Currency Operations Modalities

-*Traditional Model*: The central bank takes charge of all currency operations.

-*Sharing Model*: The central bank delegates part of these activities to a custodial entity, generally related to commercial banks or to securities transporters.

-*Participative Model*: The central bank acts as stockholder in a private firm that assumes most of these activities. These firms are usually created at the central bank's initiative, seeking to establish partnerships with financial entities or specialized firms.

-*Freelance Operation*: The central bank has a minimum participation, limiting itself only to the destruction process, and leaving to third parties (*e.g.*, private banks) the larger currency operations (*i.e.*, cash handling, distribution, and quality check).

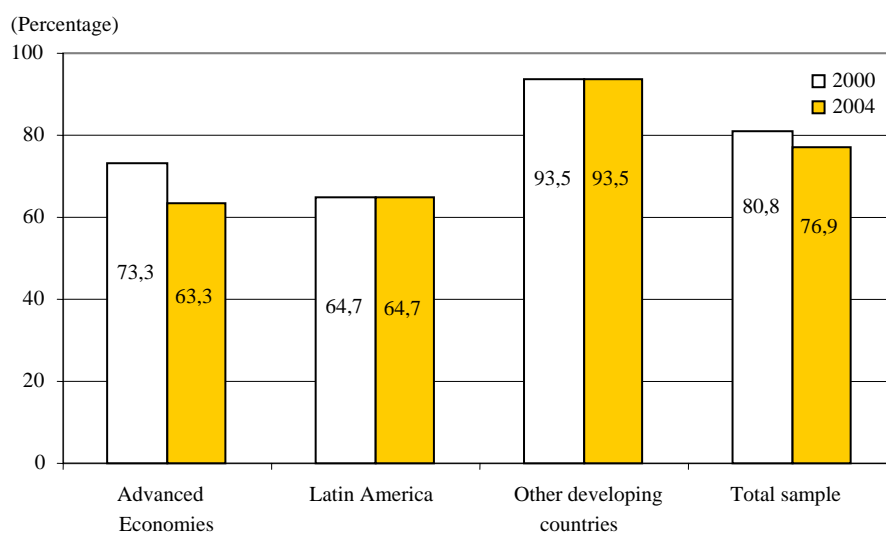
Source: Banco de la República (2005) and Central Banks Annual Reports.

In contrast, the central banks of New Zealand and Canada follow a sharing model, implementing the figure of custodial banks, through an association between commercial banks and securities transporting firms, whereas England and Ireland have adopted a freelance model where the market naturally assumes most currency operations⁹. Hong Kong has an atypical modality amongst the central banks of this group, because the government there has authorized three commercial banks to issue, distribute, and destroy cash under a special regulation¹⁰.

⁹ Baxter *et al.* (2005) provides an analysis of the different strategies used by central banks of Austria, Canada, England, Malaysia, and Norway to perform these currency operations.

¹⁰ Commercial banks in charge of these activities are the Bank of China Ltd., Standard Chartered Bank Ltd., and The Hong Kong and Shanghai Banking Corporation Ltd., which operate under a set of terms and conditions set forth by the government. For more details about operational functions in EMEAP central banks see Nishihara (2006).

Figure 3.
Central Banks using a Traditional Currency Operations Model (2000, 2004)



Source: Authors' calculations based on Central Banks Annual Reports (2000-2004)

About 65% of Latin American central banks adhere primarily to the *traditional model*, with the exceptions of Brazil, Mexico, and Chile, which use shared schemes. Distribution processes are carried out in Brazil through the branches network of *Banco do Brasil*, a state-owned bank with more than 1,800 branches in the whole national territory. Similarly, Brazil's central bank is the only one in this region that does not carry out directly the banknote-destruction process. Mexico's central bank gathers the support from commercial banks, which take care of this function through 549 branches since 1996. Likewise, commercial banks and securities transporters in Chile perform banknotes exchange and quality check, whereas the central bank only performs notes destruction after a verification process of unfit banknotes (See, Leiva, 1998).

All central banks in the group of other developing countries, with the exception of Estonia and Malaysia, follow primarily a traditional model for currency operations. Some possible explanations for the prevalence of this model are the lack of integration with the financial sector and the size of the market, which has been insufficient to generate mechanisms that contribute to facilitate these processes.

a) Branches for Currency Operations

Usually, whenever a central bank adheres closely to a traditional currency operations model, it does so through its own network of branches. The size of these networks differ

widely between central banks due to diverse factors (*e.g.*, geographic, demographic, or economic). Central banks that traditionally have had a wide network of branches are those from France, Germany, Italy, the United States, and Spain. However, in the past few years several of these banks have reduced the size of their networks and will continue to do so, but without abandoning their significant regional presence¹¹.

Germany's central bank has implemented a restructuring plan for its network of branches, going down from 118 in the year 2000 to 85 in 2004, and will pursue this policy until only 47 branches are left in the year 2007. The French central bank closed 26 branches during 2004, ending that year with 185, and the plan contemplates closing 115 more branches between 2004 and 2006 in an attempt to reach a final network of just 96. Similarly, the central bank of Spain closed 30 branches between the years 2000 and 2004, reaching its goal of a 22-branch network.

There is another important group of central banks that began to restructure their branches since the last decade. Among them, the Australian central bank reduced between 1998 and 2003 its network of 8 cash-distribution centers to just one that operates with the banknotes press. Likewise, the central bank of Canada went from 9 branches down to just 2 between 1993 and 1997. As for Latin America, Colombia's central bank has closed 13 currency operations branches since 1997, with 15 remaining to date, whereas the central bank of Chile closed 9 branches since 1992 and only 2 are left today¹².

Most central banks in the group of other developing countries have not sustained significant reductions in their network of branches. Worth remarking due to their extensive networks are the central banks of Turkey (21), Morocco (20) and Poland (16), with the latter having created 3 additional branches since the year 2001. An interesting case is the branch structure of Thailand's central bank, with three regional offices, each operating several independent currency operations and management centers. Under a similar scheme, the central bank of Indonesia manages 8 regional offices.

¹¹ This network reduction has been implemented as the market in the cities where the central bank used to be present have started to create the mechanisms to assume these activities either by themselves or under contracts with other firms (Baxter, *et. al.*, 2005). An assessing on the technical efficiency of the 37 currency operations branches of the FED in the US can be seen in Bohn *et. al.* (2001). For a similar study in the central bank of Colombia, see Sarmiento (2005).

¹² For more details on this and other changes in the operative functions of Colombia's central bank, see Annex 7.

C. Banknotes Printing and Coin Minting

Banknotes printing and coin minting are industrial functions associated with the central banks' core task of issuing currency. There are several forms to meet the cash needs of a given economy. In some countries, either the central bank or the government are in charge of cash production; whereas in other countries, the central bank purchases the currency from private firms under contract or imports it from other countries.

Table 2 shows that the vast majority of central banks do not produce their national currency. For banknotes, primarily in advanced economies, a growing trend is observed toward assigning this function to private entities. During the period under analysis, the central banks of Sweden and England sold their banknote presses to private companies, the former to *Crane & Co. Inc.* in 2001 and the latter to *De la Rue* in 2003. Similarly, the central bank of Austria segregated the production of banknotes in a subsidiary that acts as a private enterprise since the year 2000¹³.

Some other significant changes have taken place in the past few years. In 1999 the central bank of Portugal created a joint venture with *De la Rue* for the banknotes production¹⁴. In 1998, Australia's banknote press was established as a subsidiary of the central bank, which acts as a stockholder¹⁵. In the same year, the Bank of Finland sold 60% of the shares it owned in *Setec Oy*, an independent company established in 1991, when it segregated its banknote press. Unlike these countries, the banknotes printing in Hong Kong is performed by *Hong Kong Note Printing, Ltd.*, an enterprise acquired by the central bank back in 1996.

Most Latin American countries import their banknotes, with only the central banks of Colombia, Mexico and Venezuela operating their own banknote presses. Banknote printing in Brazil and Chile are under the responsibility of the government, whereas in Argentina a private company performs this activity. No changes in the administration of this function have occurred in this region. However, it is important to remark that

¹³ In April 2001 the European Central Bank assigned to each one of the national central banks of the Euro zone the responsibility of producing certain denominations of banknotes with a view to guaranteeing a uniform level of quality and to allow the Eurosystem to take advantage of scale economies (ECB, 2003).

¹⁴ The *Carregado* complex is a center specialized in banknote manufacture and cash distribution. Both Bank of Portugal's Treasury & Issue Department and *Valora*, i.e., the banknote-production unit, operate inside this complex.

¹⁵ *Note Printing Australia* is a complex, which in addition to meeting the country's cash-demand, has specialized in the exportation of banknotes to other countries, and is known for the high quality of its plastic-substrate banknotes.

structural changes, such as the dollarization processes in Ecuador and El Salvador during this period, lead to central banks or government ceasing to be concerned with this task.

In the group of other developing countries, the proportion of central banks that print their own banknotes is higher than in the other two groups, although more than one half does not carry it out at all. In some cases, the government performs this activity, although it is more frequent for the government to import notes from other countries. Some central banks that import banknotes are those from Malaysia, Indonesia, Nepal, and Croatia. A different practice is that of Bulgaria's central bank, which in the year 2002 segregated its banknotes press to a subsidiary firm (*Printing Woks*). The Polish central bank acquires the banknotes from a local privately-owned company.

Table 2.
Central banks with Banknote Printing and Coin Minting Functions (2004)

Production	Advanced Economies		Latin America		Other Developing Countries	
	%	Countries	%	Countries	%	Countries
Notes & Coins	10.0%	Denmark Greece Ireland	11.8%	Colombia Venezuela	19.4%	Albania Armenia Morocco Philippines Serbia Slovenia
Only Notes	20.0%	Belgium France Italy Norway* Hong Kong Portugal**	5.9%	Mexico	25.8%	Azerbaijan Bangladesh Egypt Macedonia Romania Slovenia Thailand Turkey
Only Coins	0.0%	..	5.9%	Peru	3.2%	Nepal

* Norway's central bank is planning to delegate this activity in 2007

** Under a joint venture with De la Rue.

Source: Authors' calculations based on the Central Banks Annual Reports and Bank Note Printers Directory (2000–2004)

Table 2 also shows that coin minting is a function that very few central banks perform directly. This function has been traditionally carried out by governments, although the production has been assigned to private companies in some countries. In the advanced economies group only the central banks of Ireland, Greece and Denmark perform this function directly. In Austria, as occurred with the banknotes press, the central bank segregated coin production to a subsidiary in 2000. Coin minting in Finland

is carried out by a private company, *Mint of Finland Ltd.*, the same that has been producing coins for Sweden since 2002. Coin production in Hong Kong is performed by *UK Royal Mint* and *Royal Canadian Mint*.

Only three Latin American central banks mint their own coins (Peru, Venezuela, and Colombia), whereas this function is performed by the government in Argentina, Brazil, Chile, and Mexico. Likewise, coin minting is mostly a government function in the group of other developing countries. The only central banks of this group that mint coins are those of Serbia, Morocco, The Philippines, Albania, Armenia, and Nepal.

D. Payment Systems Operation

One of central banks' major objectives is to look after the efficiency and security of payment systems. Due to the systemic risk involved in inter-bank transactions and the monetary interventions made by central banks through these mechanisms, the role central banks play in payment systems operation and supervision is central for the well performance of the economy (See, BIS, 2005a).

As to payment systems efficiency, Khiaonarong (2003) found three different approaches taken by central banks in their operation: minimalist, public, and competitive. These approaches differ in the degree of participation of central banks and cost-recovery policy, and have an impact on the efficiency of payment systems¹⁶. Similarly, the author considers that payment systems should be studied independently according to the value or volume of transactions. Therefore, to the effects of this paper, the operation of retail and large-value payment systems was studied separately.

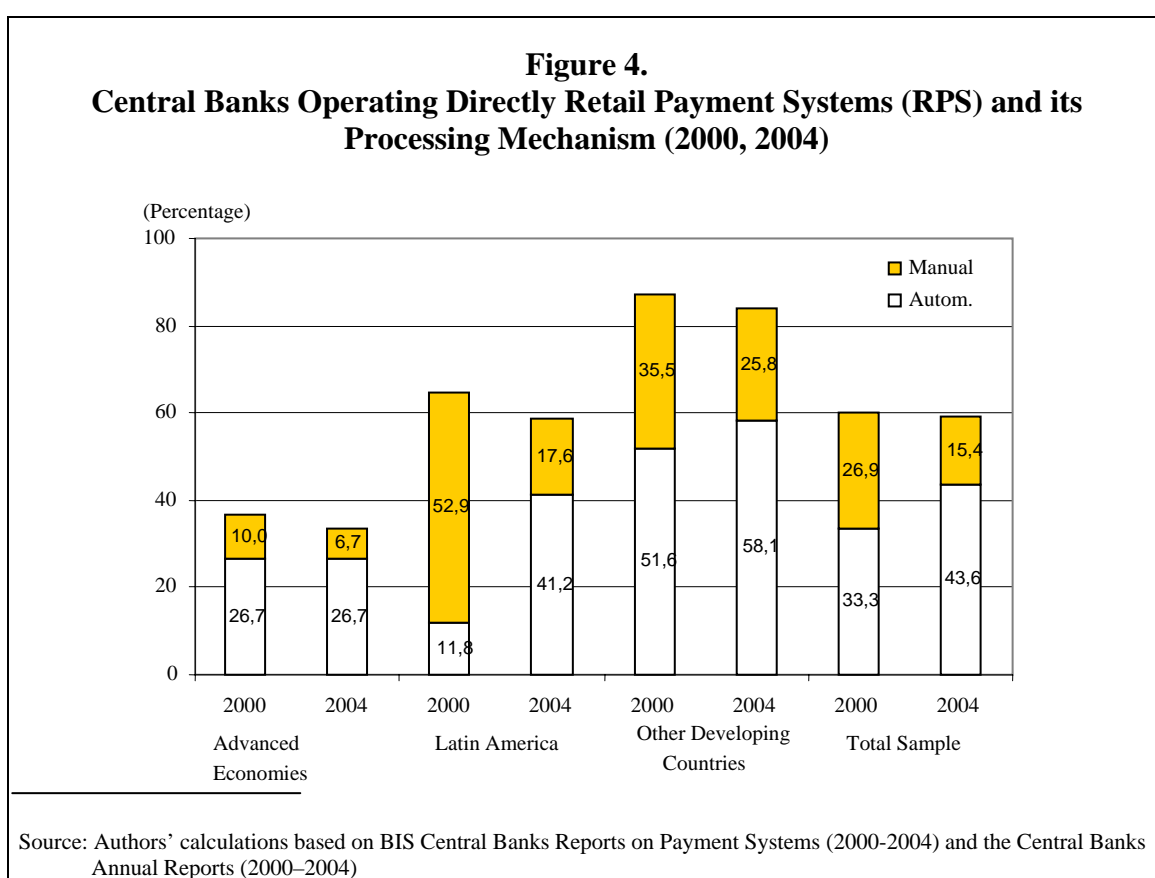
a) Retail Payment Systems

Retail payment systems (RPS) are used for minor inter-bank transferences and payments made with credit cards, debit cards and checks. Central banks differ in the operation of these systems because some of them do it directly, whereas others have established independent partnerships with financial entities, and in some others, both central banks and private entities manage their own systems and may or may not compete with each other. Whenever central banks do not operate directly the payment systems, they play an over-sighting role.

¹⁶ Classifying the sample of central banks under the three said approaches is a laborious task that requires an independent study in which we are actually working. Annex 3 describes the approaches and gives some examples for a several group of central banks.

On the other hand, RPS may be operated either manually or automatically. Manual operation, particularly when related to check clearance, is labor-intensive. However, in some countries both manual and automated RPS coexist.

Figure 4 shows the proportion of central banks directly operating RPS, and its processing mechanism (automated or manual). As can be seen, only one third of the central banks in the advanced economies group operate RPS directly; this includes the central banks of Germany, Italy, Spain, and the FED. The FED plays a different role, because it competes directly with the private sector in all the systems, and maintains a full cost-recovery policy, legally supported by the *Monetary Control Act* of 1980¹⁷.



More than 65% of the central banks in the advanced economies group have created partnerships with financial entities for payment systems operation. Most of these changes

¹⁷ This law provides that the FED must set fees that allow for the recovery of all direct and indirect costs, and to guarantee a return on capital, as a private firm would do. From that time onwards, the enforcement of this regulation has resulted in great improvements in the efficiency of payment systems (See, Bauer and Hancock, 1993; Wheelock and Wilson, 2004).

took place during the 80's with the central bank of Canada starting the process, followed by England's central bank¹⁸.

In this group, RPS are operated automatically by most central banks. Only the banks of Cyprus and Portugal do it manually. Cyprus's central bank has found this to be the most efficient way to operate due to the small size of the financial system and the high costs that automation would carry. In Portugal, the manual system coexists with automated systems pertaining to private entities, but they do not compete with each other because the central bank's manual system operates in small towns where the private sector is absent. During the period under study, the only change occurred in France's central bank, which ceased to operate manually the Provincial Clearing Houses and authorized a privately-owned automated clearing house to assume this role.

Most Latin American central banks operate directly RPS. As to the processing mechanism, central banks have shown a strong trend towards automation after the initial reforms implemented by the central banks of Mexico and Colombia at the beginning of the 90's. The most recent automation processes took place in Ecuador and the Dominican Republic. However, the central banks of Honduras, Nicaragua, and Paraguay still operate manually these payment systems.

In many cases, automation has also resulted in changes in the administration of payment systems through the creation of associations with financial entities in which the central bank maintains a significant interest, but without using its own staff. This obeys to the necessity of sharing with the financial sector the elevated costs involved in these automation processes¹⁹. Examples of central banks that have ceased to operate retail

¹⁸ The central bank of Canada has delegated the operation of both retail and large-value payment systems, and has limited its role to oversight, and to provide accounts-settlement services. Since 1980 the Canadian Payments Association (CPA), conformed by financial institutions and the central bank, operates the two national payment systems: the LVTS, for large-value transactions, and the ACSS for retail transactions. The CPA operates as a non-profit organization and maintains a full cost recovery policy (Dingle, 2003). In England the Association for Payment Clearing Services (APACS) has been operating both retail and large-value payment systems since 1985. This association is conformed by commercial banks, financial institutions, building companies, and the central bank. The APACS assumed the control of the firms CHAPS Clearing Company, BACS Ltd. and Cheque and Credit Clearing Company Ltd., which used to operate payment systems independently. Given its private nature, it follows a full cost recovery policy. Since then, the central bank has limited its functions to oversight payment systems.

¹⁹ Costs and investments involved in automating and updating payment systems are in general very high. To this respect, Khiaonarong (2005) showed that these costs were above USD \$28 million in the SEACEN countries during the period 2000-2004.

systems directly are Brazil in 2001 and Peru in 2000. Previously, the central banks of Argentina and Mexico ceased to perform this task in 1997 and 1995, respectively²⁰.

In the group of other developing countries the percentage of central banks operating retail payment systems directly approaches is 85%, the highest amongst the studied groups. Some central banks discussed here are those of Malaysia, Hungary, Slovenia and Georgia. Likewise, an increase has been observed in the automation of payment systems, although more than one fourth of the central banks still operate them manually. Among the banks that have ceased to operate these systems directly are those from Bulgaria, Poland, the Czech Republic, and Thailand, with the latter having made the change during the period under analysis.

b) Large-Value Payment Systems

Almost all central banks operate large-value payment systems (LVPS) directly due to the high risk involved in these transactions. However, some central banks, such as Canada's and England's, have delegated the LVPS operation to the same associations that operate RPS, although the central banks maintain settlement accounts for financial agents and provides final settlement of payments among participants. Additionally, they play a over-sighting role²¹.

Among central banks differences are mainly presented on the processing mechanism (manual or automated) of these systems. Figure 5 shows that the proportion of central banks currently operating LVPS manually in advanced economies is very low (3,3%). Also, it's noticeable that during the period central banks from Latin America and other developing countries initiated a strong trend towards automation²².

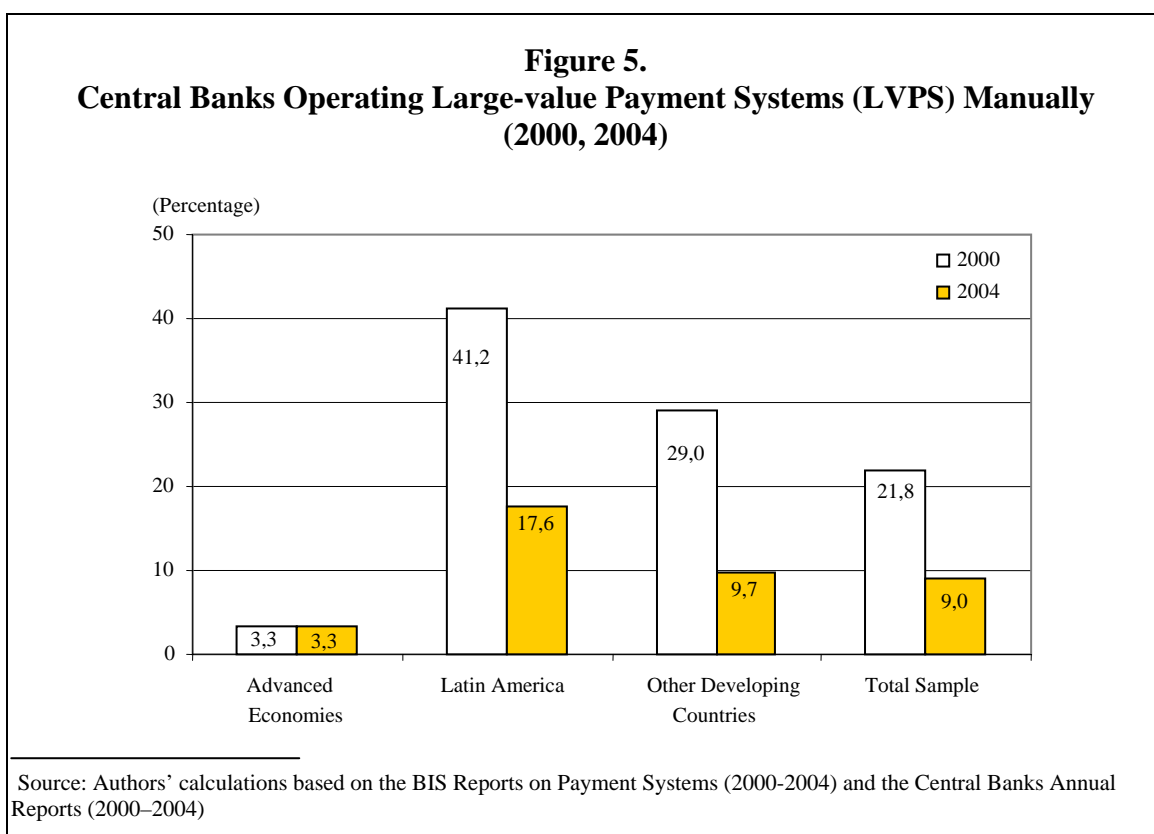
²⁰ Differences still remain in the region on cost recovery and subsidies policies. For example, Venezuela's central bank does not charge any fee, and subsidizes all of the transactions. In Nicaragua, a symbolic fee is charged, with most of the operation being subsidized by the government, whereas in Costa Rica all operation costs are recovered through fees. In the other countries of the region cost recovery is partial (See, CEMLA, 2003). For other differences in payment systems within the region, see Arango and Bernal (2003).

²¹ Something similar occurs with the central bank of Chile, which in April 2004 implemented a real-time gross settlement system (RTGS) for operations made by the Large-value Clearing House *Combanc*, a company operated by commercial banks and oversighted by the central bank (For more details, see Herrera, 2006).

²² In the Latin American region, Colombia's central bank has led the implementation of policies aimed at improving intra-day liquidity of systems operating under the RTGS system (See, Bernal and Merlano, 2005).

Currently, only 7 out of the 78 central banks of the sample operate large-value payment systems manually. These are: Albania, Egypt, Rumania, Paraguay, Guatemala, Honduras, and Cyprus. As with retail systems, the central bank of Cyprus is the only one operating large-value systems manually in the group of advanced economies, because it has considered this to be more efficient given the low number of transactions and the high costs involved in automation.

Also worth noting, competition for this type of payment systems between the central bank and a private agent is uncommon. The most representative case is that of the United States, where the FED also competes with the private sector for the operation of LVPS. Another interesting case is Argentina, where two private companies in addition to the central bank operate large-value systems. However, no direct competition exists because the central bank operates a real-time gross settlement (RTGS) system, whereas private entities operate a multilateral net-off system²³.



²³ For more on recent developments in large-value payment systems and operation modalities, see BIS (2005b).

2.3. CENTRAL BANK STAFF COSTS

After examining staff sizes and labor-intensive functions, a question on staff costs arises. The study by Mendzela (2003) was the first to compare cost levels. Using data from the year 2001, he estimated indicators relating gross operational expenses to population and GDP as a measure of efficiency in 18 OECD central banks. With information from the same year, McKinley and Banaian (2005) calculated average expenses per employee in 32 central banks and used this as an input to their model designed to estimate operational efficiency.

However, a closer approach was made by Brione (2005) in his comparison of 28 OECD central banks between 1999 and 2004. This author found wide differences between the staff costs of central banks, which could obey to the heterogeneity of functions they develop. He suggests that a deeper insight should be taken into the tasks performed by central banks in order to get better comparisons.

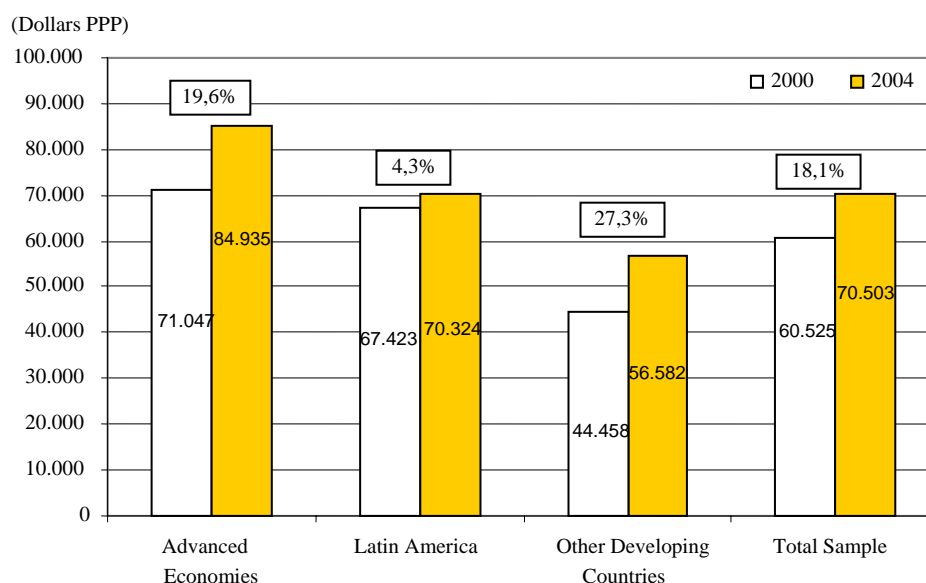
Under a similar view, this section analyzes the staff costs of 66 of the 78 central banks studied above²⁴. For these data to reflect the differences related to the acquisitive capacity of the wages, staff costs were calculated on a per-employee basis using the purchasing power parity (PPP) exchange rate during the period 2000-2004.

Figure 6 shows that central banks from advanced economies had the highest costs per employee during this period. For the year 2004, these costs were on average 20% above the whole sample, and 50% higher than those observed in the group of other developing countries. On the other hand, Latin American central banks exhibited costs per employee very close to the average of the sample.

The largest increase in staff costs during these five years occurred in the group of other developing countries (27.3%), a result that could be interpreted as an adjustment in the face of a certain lag with respect to the world average. However, it should be noted that staff costs also sustained significant increases in the central banks of advanced economies (19.6%). In contrast with what occurred in these groups, Latin American central banks exhibited the lowest increase during the period (4.3%).

²⁴ Staff costs include: wages, mandatory legal contributions to schemes of social security and additional benefits (social welfare, additional health programs, and compensations, among others, with training and travel expenses excluded). Data on staff costs were obtained from the Financial Statements of Central Banks Annual Reports. Central banks excluded from the sample due to lack of detailed information were: Saudi Arabia, Egypt, El Salvador, Honduras, Malaysia, Mexico, Morocco, Nepal, Paraguay, Qatar, Serbia and Montenegro, and Venezuela.

Figure 6.
Average Cost per Central Bank Employee and Percent Variation (2000, 2004)



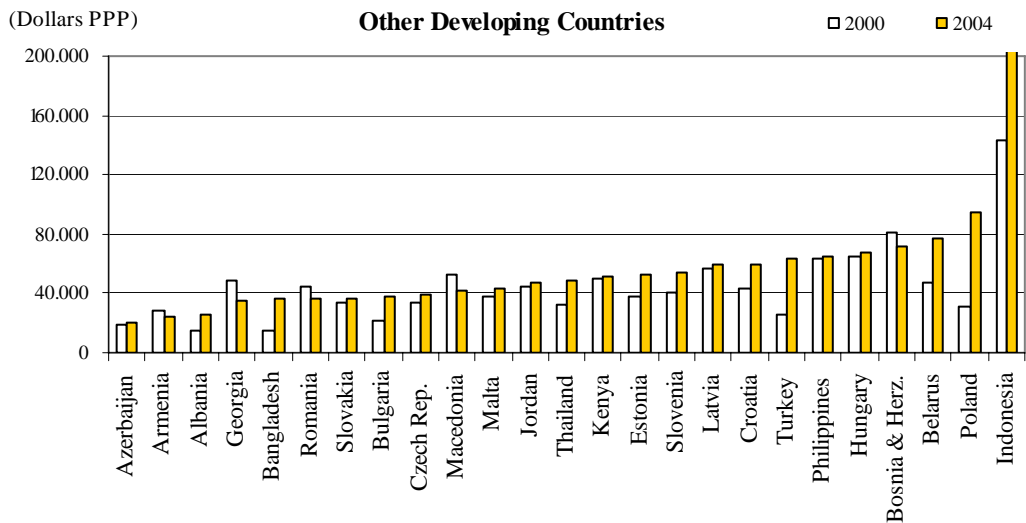
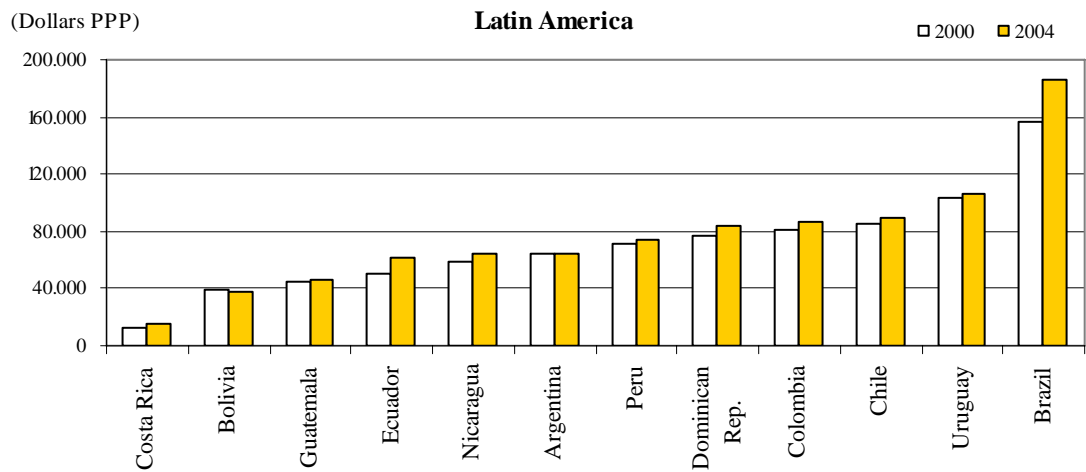
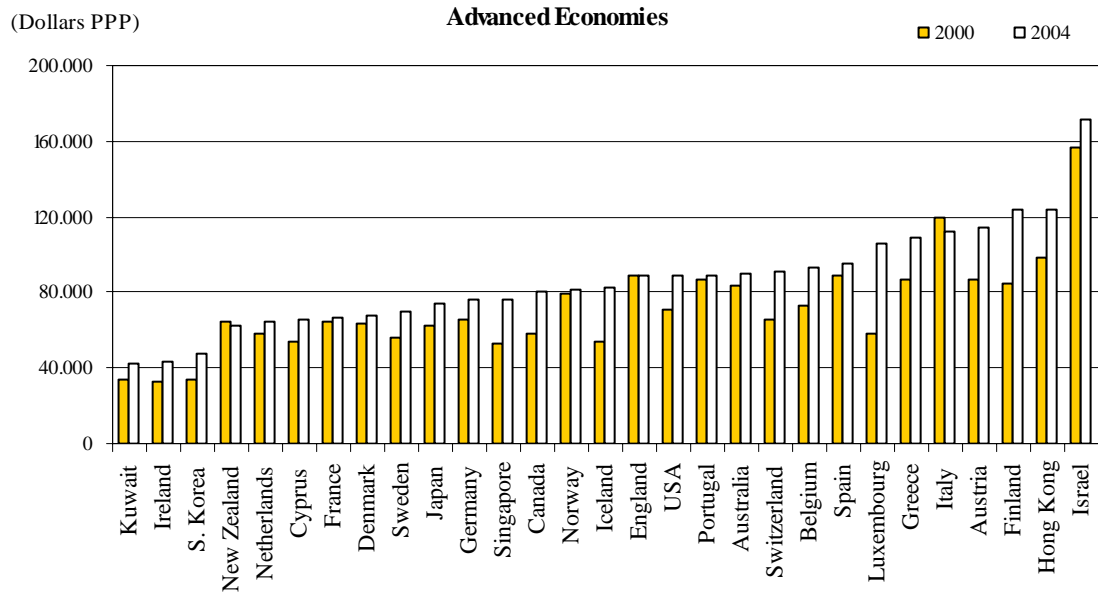
Source: Authors' calculations based on the Central Banks Financial Statements and Annual Reports (2000-2004) and IMF (2005).

For a more detailed analysis, central bank staff costs were compared within each group. Figure 7 shows that the highest cost per employee in 2004 in the group of advanced economies were found in the central banks of Israel followed by Hong Kong, Finland, and Austria²⁵. The highest increases during the period (above 50%) occurred at the central banks of Luxembourg and Iceland. In contrast, the only central banks that exhibited reductions were those of Italy and New Zealand, this latter, together with Korea, Ireland, and Kuwait, showing the lowest staff costs in the year 2004.

Brazil's central bank has the highest staff costs in the whole Latin American region. The highest increases during the period (close to 20%) occurred in Ecuador and Costa Rica, although the latter has the lowest costs in the region. The only reduction took place at Bolivia's central bank.

²⁵ In the case of Israel, this confirms a recent concern raised by Mr. Stanley Fisher, Governor of the Central Bank, who has led significant reforms in the contracting scheme aimed at curtailing high staff costs. One of his relevant proposals is for new employees to be engaged with wages 30% below those currently in force, a concept largely supported by a recent paper that shows that average wages in the Bank of Israel are among the highest in the whole country (Central Banking, 2005b). For more details on Fisher's proposals, see Gerstenfeld (2005).

Figure 7.
Average Cost per Central Bank Employee (2000, 2004)



Source: Authors' calculations based on Central Banks Financial Statements, Annual Reports (2000-2004) and IMF (2005).

In the group of other developing countries, Indonesia's central bank has the highest staff costs, with an increase of more than 50% during the period. However, the largest increases in the 5-year period (i.e., above 100%) occurred in Poland, Bangladesh, and Turkey, with the greatest reductions (above 15%) being those of Romania, Macedonia and Georgia. The banks with the lowest costs in this group are Azerbaijan, Armenia, and Albania.

3. LABOR DEMAND AT CENTRAL BANKS

This section delves deeply into the theoretical aspects of the labor-demand function and its application for central banks. Recent studies on labor demand in central banks and the estimations of the econometric model are discussed.

3.1. LABOR-DEMAND FUNCTION

The microeconomic theory indicates that labor, being a production factor, will be demanded as the demand for other goods or services increases. Therefore, the demand for labor is conceived as a derived demand since it depends on the good or service it contributes to produce or provide (McConnell et al., 2005).

In order to verify this premise, let us assume that a firm engages two production factors: labor (L) and capital (K), in order to produce a final good (Y); with the real wage (w) and the unit cost of the capital (r), representing the relative prices of the two factors considered. Thus, for the firm to maximize benefits a minimum cost function that relates price and optimum amount of each factor should exist. This cost function will also depend on the production level and on the price of the factors:

$$(1) \quad C \equiv wL^* + rK^* = C(Y, w, r)$$

Once the cost function is defined, demand for labor can be found by applying the Theorem of Shepard, that is, a partial differentiation of expression (1) with respect to real wage (w):

$$(2) \quad L^d = \frac{\partial C(Y, w, r)}{\partial w} = L(Y, w, r)$$

Equation (2) above shows that labor demand (L^d) is a function of the relation between costs and output level. Since this is a short-term demand, labor is assumed to be the only variable factor. Therefore, for the purposes of the econometric estimation the equation (2) can be expressed as a log-linear function as follows (See, Hamermesh, 1993):

$$(3) \quad \ln L_{it}^d = \alpha_0 + \alpha_1 \ln Y_{it} + \alpha_2 \ln w_{it} + e_{it}$$

Equation (3) shows that a firm's short-term labor demand will depend primarily on the labor-output elasticity (α_1) and on the labor-real wage elasticity (α_2). As will be shown hereinafter, this approach is closer to the case of the central banks.

A. Empirical Evidence

Literature on labor demand in central banks is scarce. One of the first approaches was made by Vaubel (1997), who selected some of the central bank's functions as proxies of its output, and also considered variables such as number of inhabitants, per-capita GDP, and geographic area as measures of the magnitude of a central bank's output. The author intended to identify the impact of the central bank's independence on the staff and for this he also used some institutional variables (*e.g.*, indicators of central bank independence, and exchange rate regime).

Later on, Vaubel (2002) calculated a similar model for a group of 21 central banks from OECD countries, further linking banknote printing, currency quality check, and securities management as proxies of central bank's output²⁶. The study intended to find the staff the European Central Bank should have in relation with the size of the staff of central banks within the Euro zone and other advanced economies.

In a recent study, Banco de la República (2005) estimated a labor-demand function for 133 central banks using data from the years 1998 and 2003. In contrast with Vaubel's works, this paper included payment systems operation and coin minting variables (See, Table 3).

Although Vaubel's works have shed light on the role of labor demand at a central bank, both of them have limitations in the set of variables selected. A possible

²⁶ In contrast with the model stated by Vaubel (1997), this model excludes geographic area, participation in central banks associations, and monetary base (M1), because these variables had exhibited no significance in Vaubel's first estimation.

explanation for this may be that these works are focused on a more institutional perspective (Public Choice) than on labor economy. Therefore, aspects such as the central bank's independence and exchange rate regime are given a greater importance than those about the performance of operative functions.

On the other hand, Banco de la República (2005) analyzes a wider array of functions in a relevant sample of central banks (133), thus having a greater robustness to its estimations. However, as with the above-discussed models, these estimations are cross sections examining the situation at a given point in time. For this reason, they do not link the effects on the staff that could be exercised by changes in the central bank's functions over time.

Table 3.
Estimations of Labor Demand in Central Banks

Author	Variables 1/	Sample 2/	Years 3/	Estimation Method
Vaubel (1997)	<ul style="list-style-type: none"> - Monetary Supply (M1) - Financial Supervision - Central bank independence - Exchange rate regime - Participation in central banks Association 	<ul style="list-style-type: none"> - Population (in millions) - GDP per capita (USD) - Geographic area 	(n= 97) 1993	MCO Cross-section
Vaubel (2002)	<ul style="list-style-type: none"> - Banknote Printing - Currency quality check - Discounting of private bills of exchange and other commercial paper - Central bank independence - Exchange rate regime 	<ul style="list-style-type: none"> - Population (in millions) - GDP per capita (USD) 	(n=21) 1999	MCO Cross-section
Banco de la República (2005)	<ul style="list-style-type: none"> - Financial Supervision - RPS Operation 4/ - Manual operation of RPS 4/ - Banknote Printing - Coin Minting 	<ul style="list-style-type: none"> - Population (in millions) - GDP per capita (USD) 	(n=133) 1998 (n=133) 2003	MCO Cross-section

1/ Variables included in the models as proxies of central bank's output. All models use the number of central banks employees as a dependent variable and also use log- linear functions.
2/ Number of central banks included in the sample
3/ Year of information for which a staff estimation was made
4/ Retail payment systems

Source: Vaubel (1997; 2002) and Banco de la República (2005)

From the theoretical standpoint, the works discussed hereinabove also share their exclusion of the labor factor price to characterize the labor-demand function, under the

assumption of a very low employment-wage elasticity in central banks. However, as the previous section has shown, the theory indicates that real wages should be included in the labor-demand function.

B. The Model

Following the specifications of equation (3) above, short-term labor demand for central banks is given by:

$$(4) \quad \begin{aligned} \ln(L_{it}) = & B_{0i} + B_1 \cdot \ln(N_{it}) + B_2 \cdot \ln(Y_{it}) + B_3 \cdot \ln(S_{it}) + B_4 \cdot \ln(CO_{it}) + B_5 \cdot \ln(BP_{it}) + \\ & B_6 \cdot \ln(CM_{it}) + B_7 \cdot \ln(RPSat_{it}) + B_8 \cdot \ln(RPSm_{it}) + B_9 \cdot \ln(LVPSm_{it}) + \\ & B_{10} \ln(W_{it}) + u_{it} \end{aligned}$$

In equation (4) a central bank's staff (L) is a function of the country's population (N), GDP per-capita (Y), and previously discussed operative functions. These functions are represented with *dummy* variables and are referred to financial system supervision (S), currency operations (CO), banknote printing (BP), coin minting (CM), automated operation of retail payment systems ($RPSat$), manual operation of retail payment systems ($RPSm$), and manual operation of large-value payment systems ($LVPSm$). Finally, a proxy to real wages is included (W).

Functions included in the model are those in which the central bank has a high operational component, and labor intensive. Some core functions (*e.g.*, monetary policy conduction, international reserves management) are not segregated in the model because they are homogeneous functions across all central banks. However, the model's constant is assumed to capture the minimal staff devoted to these functions.

On the other hand, the variables of GDP per-capita and number of inhabitants are deemed to serve as measures of the magnitude of the central banks' output, and these variables are expected to have a positive sign²⁷. For real wage, its relation with the demanded amount of labor is assumed to be inverse and a negative effect is to be expected on the central bank's labor demand (See Annexes 4 and 5).

²⁷ Economic magnitude variables are very relevant for our analysis, since they allow differentiating the size of the activities developed by central banks. For example, transactions volume or currency demand in the United States are different from those of other countries largely due to the high level of economic development and extensive population as compared with the activity of a country such as, let us say, Estonia or Costa Rica.

C. Methodology

In order to estimate equation (4), a panel data model with dynamic effects was used, with the following expression:

$$(5) \quad y_{it} = X_{it}\beta + u_{it}$$

Equation (5) represents the traditional panel model, wherein Y_{it} is the dependent variable that varies for each central bank i ($i = 1, \dots, 66$) during any given period of time t ($t = 2000, \dots, 2004$), X_{it} is referred to the set of explanatory variables, and u_{it} represents the error term, which at its turn is composed of:

$$(6) \quad u_{it} = \mu_i + \varepsilon_{it}$$

In expression (6), μ_i represents individual effect (either fixed or random) and ε_{it} is observation error²⁸. In practice, including an estimator with dynamic effects generates differentiation because different values are allocated to each observation, thus admitting differences in the minimal staff between central banks²⁹. Similarly, the usefulness of implementing a panel model lies in that it allows to examine dynamic changes in time (*e.g.*, changes in the functions of central banks).

3.2. RESULTS

The model stated in equation (4) was estimated through the generalized least squares (GLS) method and under the random-effects condition that results from applying Hausman's test. For the first estimation (Model 1), coin minting (*CM*) and manual operation of large-value payment systems (*LVPSm*) variables were non-significant; moreover, they showed a wrong sign to the expected one. Therefore, a new estimation was made with the exclusion of these variables. In the new estimation (Model 2), output

²⁸ The difference between a fixed-effects model and a random-effects model resides in that the latter adduces a random variable that changes for each individual, whereas in the former the effect is a fixed number. The selection of the model depends on the correlation between the individual effect and the explanatory variable, which is reviewed with Hausman's test (See, Hsiao, 2003).

²⁹ An interesting exercise would be to obtain different coefficients for all variables at each central bank by using a Swamy model. However, the number of years from which data were obtained is very short and does not allow using this type of models (See Amemiya, 1978).

magnitude variables, i.e., GDP per capita (Y) and population (N), showed a high degree of significance³⁰.

Table 4 shows that of all functions, financial supervision (S) had the highest significance and coefficient, suggesting that changes in its operation have the largest impact on the central bank staff. This finding is supported by the case of Ireland's central bank, which increased its staff in 226 employees (22%) between 2003 and 2004, when it assumed the financial supervision function.

Table 4. Model Results		
Dependent Variable Ln(L) - Panel Data (330 Obs.) - Random Effects - GLS Regression		
Variables	Model 1	Model 2
Intercept	0.9040 (2.01)**	0.8652 (1.93)**
<i>Ln (N)</i>	0.6450 (17.82)***	0.6489 (17.98)***
<i>Ln (Y)</i>	0.0730 (2.61)***	0.0816 (2.92)***
<i>Ln (S)</i>	0.1958 (3.09)***	0.1962 (3.08)***
<i>Ln (CO)</i>	0.1439 (2.55)**	0.1504 (2.65)***
<i>Ln (BPl)</i>	0.1186 (2.08)**	0.1099 (1.96)**
<i>Ln (CM)</i>	W.S. (-0.64)	..
<i>Ln (RPSm)</i>	0.1643 (2.58)**	0.0910 (1.64)*
<i>Ln (RPSat)</i>	0.0406 (0.75)	0.0179 (0.34)
<i>Ln (LVPSm)</i>	W.S. (-0.69)	..
<i>Ln (W)</i>	-0.0728 (-2.54)**	-0.0804 (-2.80)***
R-sq	0.8207	0.8184
Wald (p-value)	379.89 (0.00)	375.24 (0.00)
Hausman (p-value)	3.3925 (0.89)	2.9472 (0.91)

Symbols (**,**,*) indicate that the statistics are significantly different from zero at 1%, 5% and 10%, respectively. Statistics are shown between parentheses.
W.S: Wrong sign
Wald's test: Joint significance of the variables (Prob. > Chi 2)
Hausman's test: Differences in coefficients are not systematic (Prob. > Chi 2)
Source: Authors' calculations

The findings on the currency operations (CO) variable were consistent with both theoretical position and empirical evidence, because this function encompasses numerous

³⁰ These results are consistent with the estimations of Vaubel (1997; 2002) and Banco de la República (2005), which also used these variables as measures of the magnitude of central banks' output.

activities that typically are labor-intensive due to their extensive infrastructure³¹. Likewise, the coefficient suggests that when a central bank changes the operations of this function through a traditional model for other less interventionists schemes (*e.g.*, sharing, participative, or freelance), a significant staff reduction should be expected.

The banknote printing (*BP*) function was also significant, indicating this to be a relevant function for determining labor demand. This could obey to the fact that its direct operation involves a large industrial infrastructure and a trained staff devoted exclusively to this task³². Likewise, manual operation of retail payment systems (*RPSm*) was significant at 10%. This shows the impact of manual processes on these systems (*e.g.*, manual clearing of checks). In contrast, the variable that represents automated operations of retail payment systems (*RPSat*) was non-significant, but showed the expected sign, suggesting that when these payment systems are automated, the staff a central bank needs is very small, although probably more specialized or highly trained.

On the other hand, the real-wage variable (*W*) was highly significant, and had the expected negative sign. However, the coefficient shows that labor-wage elasticity is lower in central banks than in private firms³³. This could also suggest the presence of a certain budgetary flexibility in central banks, a feature already highlighted by Heikensten (2003).

3.3. ESTIMATIONS AND INTERNATIONAL COMPARISON

Based on the results of the model, a staff prediction was carried out with the purpose of comparing central banks and identifying recent changes in their labor demand during the period 2000-2004. These results should not be interpreted as measures of efficiency³⁴. Staff deviations from predicted values represent either staff excesses or deficits, possibly

³¹ For example, in 1998 Sweden's central bank implemented a currency operations participative model that resulted in 250 employees being transferred to a new enterprise (PSAB), and other 75 employees accepted a voluntary retirement plan (See, Sveriges Riksbank, 2006)

³² As was shown in a previous section, a significant number of central banks have established partnerships with private operators for banknote printing (*e.g.*, Australia, Portugal, and Austria), or have completely delegated this function (*e.g.*, Sweden, England, Finland).

³³ Comparing a wide group of countries, Hammerseh (1993) found that labor-wage elasticity for homogeneous labor, both in private firms and in the economy's aggregate, ranges between 0.15 and 0.75, that is, far above the value recorded in the central banks under study (0.08).

³⁴ This is opposite to the results interpretation made by Vaubel (1997). Estimating efficiency measures require linking inputs and outputs directly through either a cost or production function to finding an efficient frontier for the comparison. Mester (2003) provide a discussion on the techniques for measuring efficiency in central banks.

associated with differences in labor productivity. Also, they might be attributable to some other factors not directly captured by the model (*e.g.*, organizational structure, bureaucracy, technology and staff qualification), but related with the staff size.

A. Advanced Economies

Estimation results of this group from the year 2000 indicate that more than one half central banks (55.2%) had a staff larger than the model's prediction. However, an adjustment implying a reversion of this staff-related status was noticed in the year 2004. In fact, 16 out of 29 central banks recorded a staff smaller than the estimate. Among these central banks are those from Canada and Belgium, which had the most overstaffed central bank in the year 2000, whereas for 2004 they recorded a staff below the estimate in 10.2% and 9.7%, respectively. A similar situation was observed in another important group of central banks (*e.g.*, Germany, Spain, United States, and England). In contrast, the largest staff excesses in 2004 were seen at the central banks of Iceland, Singapore and Switzerland, with a positive deviation of about 8% (See Table 5 and Annex 6).

B. Latin America

The results of the staff estimations for Latin American central banks suggest that for the year 2000, 71.4% of central banks in this group were overstaffed. For the year 2004 the staff adjustment in the region was of 8%, this being the largest average adjustment among the groups of comparison. The most favorable changes occurred in Ecuador, Dominican Republic, and Colombia³⁵. In spite of its extensive adjustment, the central bank of Costa Rica continued being the largest overstaffed of the region.

C. Other Developing Countries

Staff estimates in other developing countries show that in 2000, 52% of the central banks were overstaffed. For 2004, central banks from European Union member or candidate countries were seen to make significant staff reductions and to sustain the largest adjustments versus the estimates. (*e.g.* Poland, Romania, Hungary, and Bulgaria). In contrast, most of smallest central banks presented important staff increases during the

³⁵ In the case of the Ecuador's central bank this wide difference could be attributed in part to the recent process of dollarization of its economy. Results for Colombia's central bank are analyzed in Annex 7.

period and several of them had staff excesses in 2004 (e.g., Georgia, Albania and Bosnia & Herzegovina).

Table 5.
Deviation of Actual from Predicted Staff in Central Banks
(2000-2004)

Advanced Economies			Latin America			Other Developing Countries		
País	2000	2004	País	2000	2004	País	2000	2004
Australia	0,17%	0,15%	Argentina	-0,06%	-1,87%	Albania	-12,49%	12,06%
Austria	-5,60%	-10,26%	Bolivia	2,57%	-6,37%	Armenia	-2,86%	8,26%
Belgium	16,07%	-9,72%	Brazil	-3,99%	3,20%	Azerbaijan	12,83%	11,65%
Canada	22,81%	-10,24%	Chile	4,16%	-3,39%	Bangladesh	6,92%	-2,85%
Cyprus	-5,02%	1,52%	Colombia	13,28%	-8,23%	Belarus	-7,71%	-1,32%
Denmark	-1,15%	3,25%	Costa Rica	32,44%	19,97%	Bosnia & H.	-19,74%	7,20%
England	8,95%	-3,97%	Dominican Rep.	8,16%	-15,69%	Bulgaria	18,73%	-4,15%
Finland	-1,98%	-10,99%	Ecuador	9,10%	-31,11%	Croatia	0,85%	-6,07%
France	2,57%	-6,94%	Guatemala	-5,12%	9,22%	Czech Rep.	-0,18%	-0,07%
Germany	7,20%	-12,99%	Nicaragua	-0,62%	-1,77%	Estonia	-23,66%	-5,15%
Greece	5,27%	-5,32%	Peru	0,90%	-4,09%	Georgia	7,35%	15,42%
Hong Kong	1,10%	-1,64%	Uruguay	12,23%	-1,40%	Hungary	20,70%	-10,15%
Iceland	-7,60%	8,20%				Indonesia	2,68%	-4,24%
Ireland	-9,40%	2,08%				Jordan	-1,62%	5,42%
Israel	5,62%	-5,78%				Kenya	-17,95%	-4,67%
Italy	6,37%	-7,87%				Latvia	-0,26%	4,64%
Japan	4,91%	-5,51%				Macedonia	1,30%	13,79%
Kuwait	-3,15%	4,48%				Malta	-0,54%	-0,04%
Luxembourg	-15,77%	6,81%				Philippines	23,36%	-1,34%
Netherlands	0,97%	0,50%				Poland	40,37%	-11,35%
New Zealand	11,21%	3,29%				Romania	-2,18%	-28,87%
Norway	-12,27%	-3,47%				Slovakia	-0,09%	2,36%
Portugal	2,47%	-7,56%				Slovenia	11,96%	3,90%
S. Korea	-1,99%	2,78%				Thailand	4,98%	-2,92%
Singapore	-8,24%	8,17%				Turkey	1,19%	-8,51%
Spain	7,19%	-10,72%						
Sweden	-12,18%	1,56%						
Switzerland	-9,72%	7,91%						
USA	5,84%	-9,46%						
Mean	0,51%	-2,47%		6,09%	-3,46%		2,56%	-0,28%
SD	8,83%	6,58%		10,23%	12,47%		14,05%	9,52%

Source: Authors' calculations

4. CONCLUSIONS

This paper shows that most central banks sustained significant staff reductions, with the cases of England, Germany, and the United States being worth noting. In Latin America the central banks of Ecuador, Dominican Republic and Colombia should also be

mentioned, whereas for other developing countries, the most important reductions were carried on by the banks of Romania, Poland, and Hungary, also driven by their access to the European Union.

However, central bank staff reductions were accompanied by an increase in their costs, which could be largely attributed to a higher degree of specialization of the staff, often resulting from their focusing on their core functions. Overall, as central banks cease to perform operative functions, they will require less low-qualified personnel, resulting in an increase in the ratio of highly qualified employees and, in the short term, in higher staff costs.

In the past few years the quest for efficiency in most central banks has driven modernization strategies based on the private sector's active participation, primarily in functions such as operation of payment systems, currency operations, and banknote printing. In fact, this paper identifies the existence of multiple modalities for the performance of the operative functions in central banks. Strategies differ widely between countries, thus reflecting the role of the private sector, the central bank-government relationship, and historical traditions. Also, it should be taken into account the existence of external factors in some countries, such as a strict regulatory environment, that avoid central banks from delegating part of their activities.

On the other hand, our empirical exercise succeeded in identifying the relevance of operative functions in determining labor demand at central banks. In particular, financial supervision was found to have a large impact on central bank staff, as well as, going from a traditional model to a less interventionist scheme in currency operations. Similarly, low employment-wage elasticity was identified suggesting the existence of a flexible budgetary constrain in central banks. This highlights the efforts made by some central banks to control the growth of their staffs.

We deem that these findings are highly relevant for central banks, governments, and central banking organizations. Likewise, we recognize that this paper could be extended and delve deeply into several other directions. In particular, efficiency measures by functions should be estimated in order to identify the best practices for central banks. With this purpose, part of our research agenda is focused on measuring efficiency by functions, comparing central banks with different efficient-frontier techniques.

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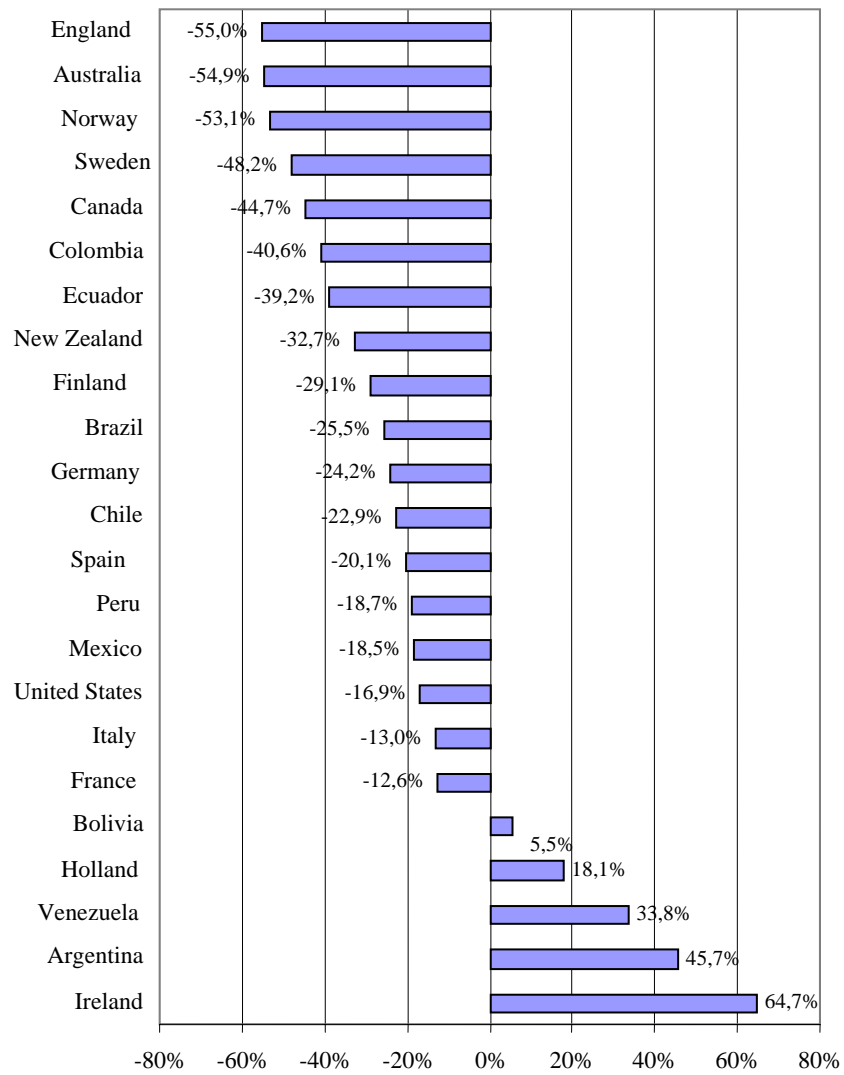
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Annex 1.

Percent Staff Variation in Selected Central Banks (1993-2004)



Source: Authors' calculations based on the Central Bank Directory (1993, 2004)

Annex 2.

Cultural Activity at the Central Banks

The cultural activity developed by central banks is for the most part related to libraries and museums. The vast majority of central banks only have a small numismatic exhibition, usually inside their premises, and a library specialized in economic and financial matters for their researchers. In advanced economies, for example, only the central banks of Switzerland, Germany and the United States have more than one library open to the public, and these are only of a specialized nature. Similarly, only Finland, Italy, and Belgium have one or two museums larger than the average.

Something similar occurs within the group of other developing countries. Only the central banks of Malta, the Philippines and Pakistan have a library open to the general public, and only the library of this latter country contains works on matters other than economics and finances. As to the museums, only the central banks of Morocco, Rumania, Malaysia, and Thailand have a sizable numismatic or thematic museum.

Of the three groups of countries, Latin America is the region where the cultural activity developed by central banks is more notorious due to the historical and political legacy of their governments. Since their establishment, most central banks in the region were given the responsibility of approaching people through cultural activities because of the lack of state policies on this matter. The majority of these central banks have at least one library open to the public, either specialized in economic matters, or of general purpose, that include social, artistic, and historic works.

However, the only central banks in these countries that maintain a significant network of libraries are those from Guatemala, with 53, and Colombia with 19. Likewise, the 6 museums of Ecuador and the 8 museums managed by the central bank in Colombia are worth noting. It is important to say that some central banks, such as those of Guatemala, Bolivia, and Costa Rica, have chosen to assign the administration of their libraries or museums to non-profit organizations to which the central banks only contribute with financial resources.

Source: Central Banks Annual Reports (2000-2004)

Annex 3.

Payment Systems Operation at the Central Banks

Khiaonarong (2003) identified three approaches to how central banks operate payment systems. These approaches differ primarily in the degree of participation of the private sector and the existence of a cost-recovery policy. For a better understanding of this classification, the following table shows some examples of countries that fall within each approach.

Approaches in the Payment Systems Operation

Approach	Central Bank Participation	Cost Recovery Policy	Examples
Minimalist	The central bank owns and operates only large-value payment systems or limits itself to providing account settlement services. The private sector operates low-value systems, generally through commercial banks associations.	There is generally a total cost recovery policy.	England Canada New Zealand Sweden Australia Brazil Mexico
Public	The central banks owns and operates all or most payment systems. When the private sector participates, it does not compete with the central bank	Cost recovery is usually partial	Germany Spain Italy Costa Rica Venezuela
Competitive	The central bank operates most payment systems and competes directly with the private sector.	Cost recovery is total	United States

Fuente: Khiaonarong (2003) and Central Banks Annual Reports (2000-2004)

Annex 4.

Variables used in the Model by Groups of Countries (2000-2004)

Variable	Max.	Min.	Mean	SD
Total Sample (n=66)				
<i>L</i>	23.438	105	2.341	3.804
<i>N</i>	293.028	281	30.245	52.713
<i>Y</i>	63.727	316	12.152	12.605
<i>W</i>	127.446	2.984	40.606	29.290
Advanced Economies (n=29)				
<i>L</i>	23.438	105	3.240	5.331
<i>N</i>	293.028	281	32.059	56.742
<i>Y</i>	63.727	9.276	24.621	9.598
<i>W</i>	127.446	6.435	66.583	24.313
Latin America (n=12)				
<i>L</i>	4.694	437	1.328	1.116
<i>N</i>	184.101	3.324	26.358	44.521
<i>Y</i>	7.675	435	2.422	1.514
<i>W</i>	73.825	6.025	27.175	14.166
Other Developing Countries (n=25)				
<i>L</i>	6.375	184	1.865	2.030
<i>N</i>	238.453	390	30.317	52.367
<i>Y</i>	14.988	316	3.137	2.992
<i>W</i>	80.793	2.984	17.994	11.868

L: Number of employees of central banks

N: Population in thousands of inhabitants

Y: GDP per-capita in constant UDS of 2000

W: Annual cost per employee in constant USD of 2000

Source: Authors' calculations based on data from Morgan Stanley Central Bank Directory, US Census Bureau, IMF (2005), Annual Reports, and Financial Statements of Central Banks.

Annex 5.

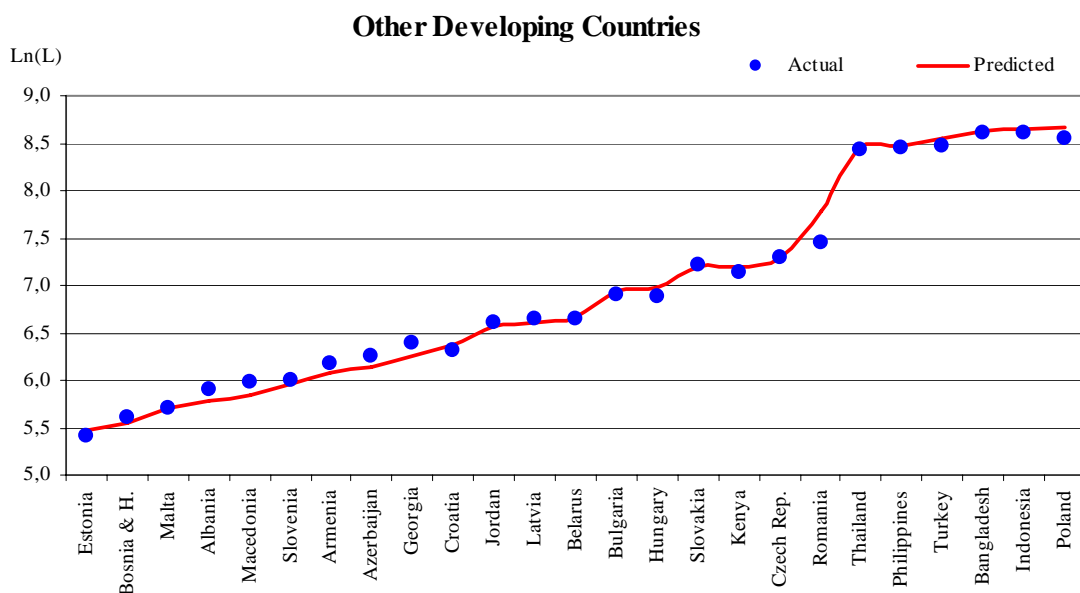
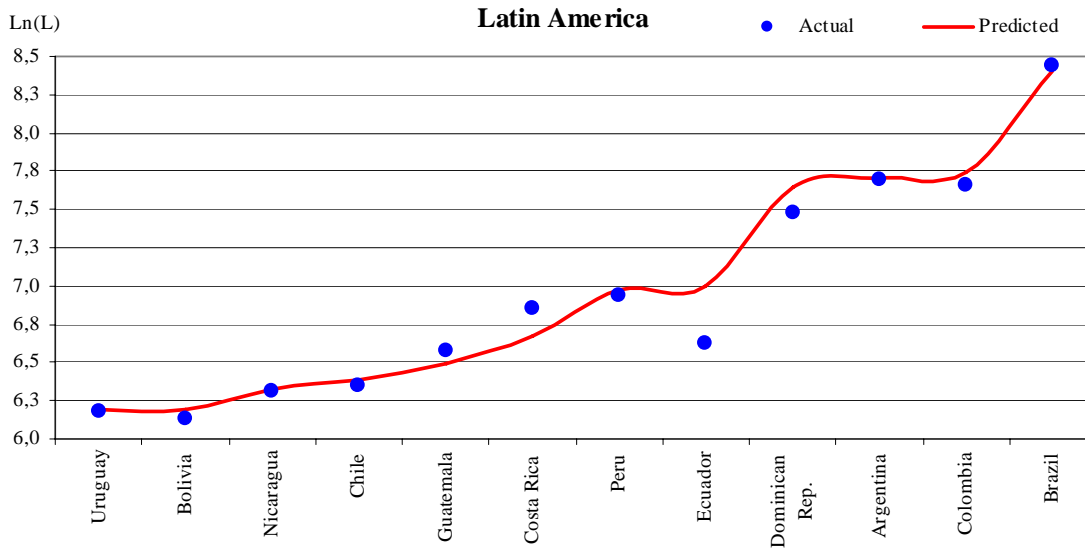
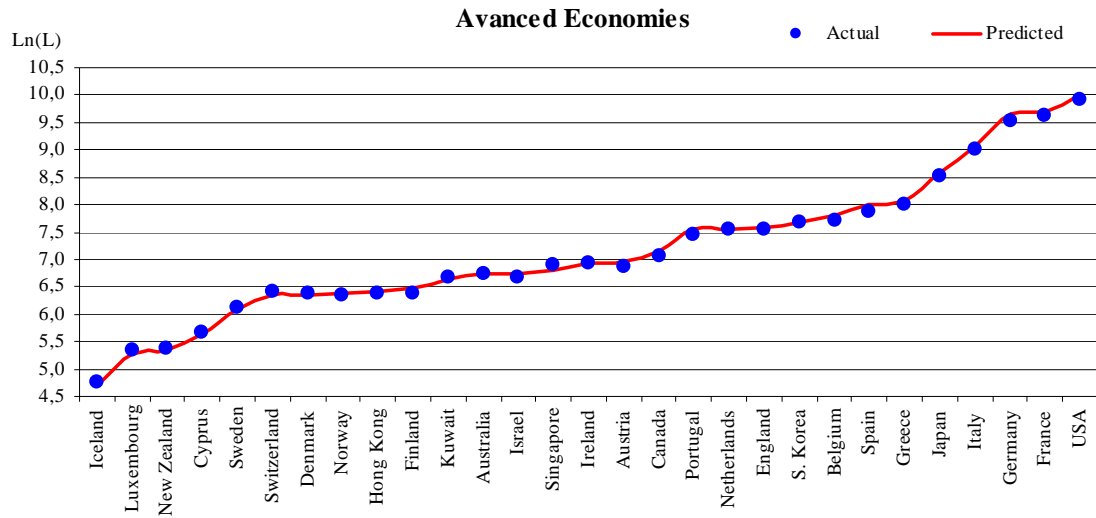
Operational Functions Performed by Central Banks (2000, 2004)*														
Central Bank / Function	Financial Supervision		Currency Operations		Banknote Printing		RPS Operation				LVPS Manual Operation		Coin Minting	
							Automated		Manual					
	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004
Australia	..	..	..	..	..	..	..	..	..	..	..	..	..
Austria	..	..	Yes	..	..	..	..	..	..	..	..	..	..
Belgium	..	..	Yes	Yes	Yes	Yes	..	..	..	..	..	..	..
Canada	..	..	Yes	..	..	..	..	..	..	..	..	..	..
Cyprus	Yes	Yes	Yes	Yes	..	..	..	..	Yes	Yes	Yes	Yes	..
Denmark	..	..	..	..	Yes	Yes	..	..	..	..	..	..	Yes
England	..	..	..	..	Yes	..	..	..	..	..	..	..	..
Finland	..	..	Yes	..	..	..	..	..	..	..	..	..	..
France	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	..	..	..	..
Germany	Yes	Yes	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Greece	Yes	Yes	Yes	Yes	Yes	Yes	..	..	..	..	..	..	Yes
Hong Kong	Yes	Yes	..	..	..	..	..	..	..	..	..	..	..
Iceland	..	..	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Ireland	..	Yes	..	..	Yes	Yes	..	..	..	..	..	..	Yes
Israel	Yes	Yes	Yes	Yes	..	..	..	..	..	..	..	..	..
Italy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	..	..	..	..	..
Japan	..	..	Yes	Yes	..	..	..	..	..	..	..	..	..
Kuwait	Yes	Yes	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Luxembourg	..	..	Yes	Yes	..	..	..	..	..	..	..	..	..
Netherlands	Yes	Yes	Yes	Yes	..	..	..	..	..	..	..	..	..
New Zealand	Yes	Yes	..	..	..	..	..	..	..	..	..	..	..
Norway	..	..	Yes	..	Yes	Yes	..	..	..	..	..	..	..
Portugal	Yes	Yes	Yes	Yes	Yes	Yes	..	..	Yes	Yes	..	..	..
S. Korea	..	..	Yes	Yes	..	..	..	..	..	..	..	..	..
Singapore	Yes	Yes	Yes	Yes	..	..	..	..	..	..	..	..	..
Spain	Yes	Yes	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Sweden	..	..	..	..	Yes	..	..	..	..	..	..	..	..
Switzerland	..	..	Yes	Yes	..	..	..	..	..	..	..	..	..
USA	Yes	Yes	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	
Argentina	Yes	Yes	..	..	..	..	..	..	..	..	..	..	..
Bolivia	..	..	Yes	Yes	..	..	..	..	..	Yes	..	..	..
Brazil	Yes	Yes	..	..	..	..	..	..	Yes	..	..	..	..
Chile	..	..	..	..	..	..	..	..	..	..	..	..	..
Colombia	..	..	Yes	Yes	Yes	Yes	Yes	Yes	..	..	..	Yes	Yes
Costa Rica	..	..	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Ecuador	..	..	Yes	Yes	..	..	..	Yes	Yes	..	Yes	..	..
Guatemala	..	..	Yes	Yes	..	..	..	..	Yes	..	Yes	Yes	..
Nicaragua	..	..	Yes	Yes	..	..	Yes	Yes	Yes	Yes	..	..	..
Peru	..	..	..	..	..	..	..	..	..	..	..	Yes	Yes
Dominican Rep.	..	..	Yes	Yes	..	..	..	Yes	Yes	..	..	..	..
Uruguay	..	..	..	..	..	..	Yes	Yes	..	..	..	..	..
Total	3	3	9	9	1	1	4	6	7	2	5	2	2	
Albania	Yes	Yes	Yes	Yes	Yes	Yes	..	..	Yes	Yes	Yes	Yes	Yes
Armenia	Yes	Yes	Yes	Yes	Yes	Yes	..	..	Yes	Yes	..	..	Yes
Azerbaijan	Yes	Yes	Yes	Yes	Yes	Yes	..	Yes	Yes	..	Yes	..	..
Bangladesh	Yes	Yes	Yes	Yes	Yes	Yes	..	..	Yes	Yes	..	..	..
Belarus	Yes	Yes	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Bosnia & Herz.	..	..	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Bulgaria	Yes	Yes	Yes	Yes	Yes	..	..	..	..	..	..	..	..
Croatia	Yes	Yes	Yes	Yes	Yes	..	Yes	Yes	..	..	..	..	..
Slovakia	Yes	Yes	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Slovenia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	..	..	..	Yes	Yes
Estonia	Yes	..	..	..	..	..	Yes	Yes	..	..	..	..	..
Philippines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	..	..	..	Yes	Yes
Georgia	Yes	Yes	Yes	Yes	..	..	..	Yes	Yes	..	Yes	..	..
Hungary	Yes	Yes	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Indonesia	Yes	Yes	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Jordan	Yes	Yes	Yes	Yes	..	..	Yes	Yes	Yes	..	..	..	..
Kenya	Yes	Yes	Yes	Yes	..	..	..	..	..	..	..	..	..
Latvia	..	..	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Macedonia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	..	..	..	..	..
Malta	..	..	Yes	Yes	..	..	Yes	Yes	..	..	..	..	..
Poland	Yes	Yes	Yes	Yes	..	..	..	..	..	..	..	..	..
Czech Rep.	Yes	Yes	Yes	Yes	..	..	..	..	..	..	..	..	..
Romania	Yes	Yes	Yes	Yes	..	..	..	..	Yes	Yes	Yes	Yes	..
Thailand	Yes	Yes	Yes	Yes	Yes	Yes	Yes	..	..	..	..	..	..
Turkey	..	..	Yes	Yes	Yes	Yes	Yes	Yes	..	..	..	..	..
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	

* Dummy variables used in the model

Authors' calculations based on data from Central Bank Annual Reports (2000-2004)

Annex 6.

Deviation of Actual from Predicted Staff in Central Banks (2004)



Source: Authors' calculations

Annex 7.

The Case of Colombia's Central Bank

Like most central banks, Banco de la República (BR) has made a significant staff reduction in the past few years (40.6% since 1993). During the period 2000-2004 this reduction reached 12%, driven by function restructuring, process automation, and support-functions outsourcing (See, Banco de la República, 2005b).

As to labor-intensive secondary and operational functions, the BR performs, mostly with its own resources, four out of the five core functions analyzed in this paper. Financial supervision is the only function not under the responsibility of the central bank because since 1923 it is performed by a state-owned entity (Financial Superintendence).

As to currency operations, BR follows primarily a traditional model. However, freelance and sharing models have been implemented in some cities, thus promoting the participation of securities transporting firms. These changes, aimed at increasing efficiency, have resulted in a reduction of the bank's network of branches associated to this function since 1997.

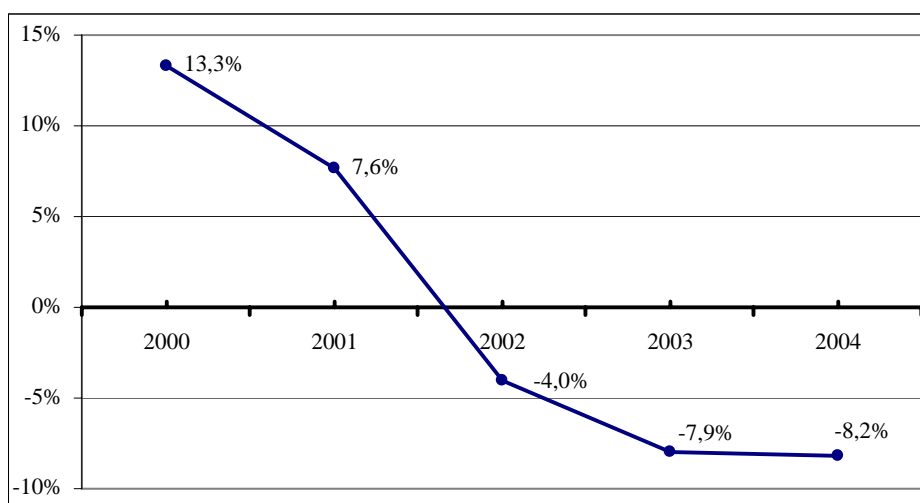
With respect to industrial activities such as coin minting and banknote printing, these are performed directly by BR. Recently, the *Central de Efectivo*, a complex with top facilities for the production of banknotes and currency operations related activities, very similar to Portugal's *Carregado* complex, came into operation. As to coin minting, BR redesigned and enhanced the process in its *Fabrica de Moneda*, which currently operates with a minimal staff (30 employees) and a rotary that has resulted in an improved productivity of this function.

BR manages directly fully automated large-value and retail payment systems, thus being one of the first central banks in Latin America in having automated these processes to date. These changes resulted in significant staff reductions, more particularly in labor-intensive activities such as manual clearing of checks. Likewise, reforms implemented since the end of the 90's allowed for a deeper capital market and for more efficient and safe payment systems financial management in Colombia (For more details, see Bernal and Merlano, 2005; Uribe, 2005a).

On the other hand, cultural promotion is one of BR's major responsibilities toward the community. BR has never had doubts on the continuity of this function due to its high social impact. In fact, BR is the central bank with the widest infrastructure and largest staff devoted to cultural activities in the entire central banks environment. BR operates a network of 18 libraries in the national territory, plus a main library located in Bogotá, which has the largest number of books among the libraries of all central banks (1,500,000 books). Additionally, BR operates an ethnographic museum and seven gold museums in the whole country. Similarly, BR organizes a continual program composed of diverse musical and artistic activities distributed in 15 branches and 12 cultural agencies (See, Uribe, 2005b).

In fact, the percentage of employees devoted to these activities as of December 31st 2004 accounted for 15.7% (392 employees) of the total Bank's staff, this being the most numerous staff of all central banks developing some cultural activity. Since the proportion of cultural activities developed by BR is not comparable with other central banks, and since this function is not taken into account within the econometric model, employees devoted to these tasks are excluded from the data on the BR's staff. Model estimates for BR for the years 2000 to 2004 are illustrated in the following figure:

Deviations from Actual to Predicted Staff at the Banco de la República (2000-2004)



Source: Authors' calculations.

As can be seen, in the years 2000 and 2001, BR's was overstaffed. A breakpoint appears the year 2002, and BR's staff goes below the estimate. This is attributed to a 252 staff downsizing during that year. For the year 2004 the percent deviation from the estimate was of -8.2%, value above the average for the region in that year (-4.8%).

Results from Colombia in Other Studies

In Vaubel (1997) results showed that in 1993 BR had 2,076 employees in excess (45% above the estimate) compared with the observed staff of 4,583 in that year. Later, Banco de la República (2005) estimated a model for the year 2003 finding that BR had a staff 10.9% below the estimate. The panel data model used in this paper allows to identify the structural change that took place in the year 2002, that is, when the BR staff began to appear below the estimate.