



Gender and central banking

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ABSTRACT

Female Central Bank chairs represent but a tiny minority. To understand why, this article analyzes socio-economic and socio-political characteristics of the countries where women have chaired Central Banks. Then, it suggests that gender differences in preferences as regards monetary policy goals may have some influence. This hypothesis is based on an empirical analysis showing that female Central Bank chairs focus more than their male counterparts on achieving the price stability goal. This means, then, that women are more resistant than men to political pressures. Finally, it concludes that gender differences in degree of conservatism may be an explanatory factor in female underrepresentation in the Central Bank chairs.

1. Introduction

« Mr. Summers and Mr. Yellen... euh, Ms. Yellen ».

This slip of the tongue by President Obama speaks volumes about women's absence in the world of central bankers (Perlberg, 2013).

As known, Central Banks are among the largest institutions in modern economies. In charge of defining and implementing of monetary policy, they determine the stock of money in circulation, set the level of short rates and perform the essential public functions (management of foreign exchange reserves, banking supervision). Central Bankers' actions have an immense impact on the functioning of our economy. But, until recently, women were deeply underrepresented in Central Banks. It seems that women have greater access to positions of responsibility in politics than in Central Banks where the *glass ceiling* is tougher. For instance, in Europe, among the 23-member policy board and the six-member Executive Board of the European Central Bank (ECB), there are no women at all. Since its creation, the ECB's Executive Board has included only two.

The literature has just begun to worry about women's absence in monetary policy making (Chappell and McGregor, 2000). Most of the existing studies focus on the composition of the Monetary Policy Committees (MPC). They are related to the Federal Open Market Committee (FOMC) of the US Federal Reserve and the Board of the European Central Bank (ECB). The main idea is that the diversity in the

MPC, in terms of gender, but also of age, of professional, sectoral and academic backgrounds, can influence the monetary policy decisions (Farvaque et al., 2014; Masciandaro et al., 2016). In particular, it points out that women's presence in the MPC could have an important effect on policy outcomes (Chappell et al., 2005; Farvaque et al., 2011; Bennani et al., 2015; Masciandaro et al., 2016). The findings obtained by the empirical literature highlighted a higher share of women in the MPC is associated positively with price stability.

In others words, in their decisions, female monetary policymakers are rather inclined to fight against inflation. To explain this attitude, it is observed that, from some level of responsibility, women seek to prove that they can be tougher than men. In particular, as central bankers, they need to make or to acquire a reputation and credibility. Hence they are invited to have hawkish rather than dovish attitude (Wilson, 2014; Hix et al., 2010; Farvaque et al., 2011, 2014; Eijffinger et al., 2015; Masciandaro et al., 2016). Thus, higher women's presence in MPC is associated with better performance in terms of price stability.

In this paper, we try to identify the factors which may explain the absence of females' Central Bank chairs. Indeed, in many countries, women have access to the highest political positions as Head of State, Prime ministers. For instance, in Germany, France, England, Norway, women have been Prime ministers, but, have never been appointed Central Bank chairwoman. Only a minority of women have managed to break the *glass ceiling* and reached the Central Bank chair. This

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prestigious function remains monopolized by men.

Nowadays, there is every indication Central Bank chairs are important people. In their duties, they have the mastering of the monetary policy agenda (Riboni and Francisco, 2008). This tends to show that they are powerful and influential: powerful, because the Central Bank's independence protect them from all kinds of political pressures; influential, through the credit that markets and governments attribute to their words and the consequences of their decisions on the economy. This is why Ms. Janet Yellen is considered as the second most powerful person after the US President (Gergen, 2013). Her appointment, in 2014, as the first female to chair the Federal Reserve Bank, i.e. the world's largest Central Bank, is definitely an essential milestone for female representation in the world of central bankers, i.e. people who actually make monetary policy (Jones, 2013).

So what factors can account for the women's absence as Central Bank chairs? Obviously, there is not one specific factor. Formal or informal barriers are often pointed out, for example:

- A) The reluctance of women for economics and finance studies (Hale and Regev, 2001);
- B) The women's absence in the closed networks of influence from which Central Bank chairs are chosen.

The first argument is not consistent with the facts. As noted by the website *Worldwide Guide to Women in Leadership*, between 2000 and 2015, over 200 women headed the Ministry of economy, finance and/or budget in their country or territory. In early 2015, five are still in office, in: East Timor; Lesotho; Republic of Bosnia-Herzegovina; Somaliland; the United Kingdom. Holding these positions requires commitment, availability and skills, at least equal with those of a Central Bank chair.

The second argument is, finally, misleading. That is what appears from Galbraith (1977, p. 217) ironic words when he observed "In Central Banks, as in diplomacy, the look, well-cut conventional clothing and an ease to keep company with very rich people counts for a lot with much lower results". However, it should not be excluded from discussion. The idea is that there are differences in preferences for the monetary policy goals (Krause and Méndez, 2008). These differences are explained simply because monetary policy decisions will affect, as the case may be, price levels, economic growth, employment and income with consequences on individual and collective well-being (Epstein and Yeldan, 2010). Hence, the aversion to inflation will change according to individuals or individual generations (Farvaque and Mihailov, 2009, Scheve, 2004). Thus, considering the independence that Central Banks enjoy, governments want someone with preferences compatible with theirs to chair Central Banks. Commercial banks wish to know the Central Bank chair appointed to ensure that the preferences are not in conflict with their own interests.

Indeed, according to the economic theory of bureaucracy, people are driven by self-interest, and appointing them as central banker does not change his nature. In others words, Central Banks' decisions can be politically expensive (Toma and Toma, 1986). Hence, the rational choice(s) made by governments when appointing Central Bank chair with particular profiles (Chang, 2006). This rationality can be extended to commercial banks concerned to preserve their interests. In the light of the effects of central bankers' decisions, we assume that the women's absence from Central Bank chairs can be accounted for by their version to inflation.

In this respect, this paper examines female Central Bank chairs' degree of conservatism, as defined by Rogoff (1985), with respect to their male counterparts. For that purpose, an innovative econometric methodology, which does not require estimating all the structural and preference parameters of a monetary model, but only how men and women's parameters differ, is developed to measure the influence of gender's role in central banking. But first, it is worth to note that only a minority of women have managed to break the *glass ceiling* to reach

the chair of the Central Bank.

2. A minority of female Central Bank chairs

A close scrutiny of Central Banks' organization charts reveals that they are overwhelmingly chaired by men. The oldest among them, the Swedish Riksbank (founded in 1668), has never been chaired by a female.¹ Since the 1950s, only 56 women have chaired a Central Bank. In 2015, on a full-time basis, only 16 women chaired a Central Bank out of a total of 184 worldwide i.e. less than 10% (8.69%). Among the 34 Organization for Economic Cooperation and Development (OECD) countries, i.e. economically influential, 27 have never appointed female Central Bank chairs; the seven exceptions are Austria, Denmark, Finland, former East Germany, Israel, Poland and the United States.

By crossing available data in periodicals and newspapers (Central Banking; Financial Times) and several websites (CentralBankNews.info; The Group of Thirty; Council for Parity Democracy; Worldwide Guide to Women in Leadership; www.guide2womenleaders.com; BloombergBusiness; CentralBanking.com; Connecting Women in Sovereign Entities Globally (WSE)), we have identified 56 female chairs, since 1949, for 46 Central Banks.² The results obtained are summarized in Table 1.

The majority of female Central Bank chairs were appointed in emerging countries. Among the 46 Central Banks listed, only seven (Belarus, East Germany, Russia, Serbia, Honduras, Kyrgyzstan) have been chaired by women more than once³ since 1949. Similarly, those with a high turnover rate have only one nomination. Thus, the Banco Central de Bolivia has only one female (less than 2%) among its 53 successive governors; Banco Central de la Republica de Argentina, one out of 36 (2.7%); Banco Central del Ecuador, one out of 35, (2.8%); Central Bank of Finland, one out of 32 (3%).

Many arguments have been put forward to explain this underrepresentation, including: the conservative and reactionary ideology of Central Banks; the stereotypes in children's education related to customs, religion; the differentiated educational guidance received by boys and girls in terms of curriculum preparing them for the world of work; the absence, in some countries, of gender-positive policies; the way Central Bank chairs are appointed with a sort of natural bias in favor of men.⁴

These arguments pose the existence of circumstances that are more or less favorable to the promotion of female as Central Bank chairs. What are those circumstances? What are their characteristics? To highlight them, we will refer to the socio-economic and socio-political indicators established by the United Nations Development Program (UNDP).

2.1. The socio-economic indicators

They concern the Human Development Index (HDI) and the Gender Inequality Index (GII). The HDI measures the average level of human development achieved in a country in three basic dimensions: health and life expectancy, access to education and decent

¹ That even with the highest proportion of females members in the MPC (50% since 2003) (see Farvaque et al., 2011)

² Some websites, such as the *Worldwide Guide to Women in Leadership*, wrongly include female Central Bank chairs: Ms Ellen Johnson Sirleaf (the current president of Liberia); Violeta Asfura in Venezuela; Felisa Miceli Jsefina (former Minister of Economy and Production of Argentina, 2005–2007); Ana Dias Lourenco (former Ministry of Planning in Angola). On Guatemala, there is confusion between Ms. Lilly Zapata and Mr. Willy Zapata Waldemar Sagastume (President of the Banco Central, 1993–1997).

³ Of the 56 female Central Bank chairs, 4 were named twice at different periods (Ms. Maria Elena Mondragón Villar in Honduras; Ms Zeti Akhtar Aziz in Malaysia; Ms Yathotou Pany in Lao PDR; Ms Maria Do Carmo Trovoada in Sao Tome principle). In total, there are thus 60 nominations.

⁴ See interviews of female Central Bank chairs in Central Banking Journal, Vol. XI, No. 3, Feb 16, 2001.

Table 1
Central Banks with female chairs.

Central Banks	Year of creation	Number of Governors	Female chairs	Date of appointment
National Bank of Ukraine	1992	10	Valeriya Gontareva	Since 06/2014
Central Bank of Cyprus	1963	7	Chrystalla Georghadji	Since 04/2014
Maldives Monetary Authority	1981	6	Azeema Adam	Since 04/2014
Federal Reserve Bank	1913	15	Janet Yellen	Since 02/2014
Central Bank of Nigeria	1958	10	Sarah Alade	02/2014–06/2014
Central Bank of Madagascar	1960	9	Vonimanitra Razafimbelo	10/2013–10/2014
Central Bank of Somalia	1960	na	Yussur Abrar	09/2013–12/2013
Reserve Bank of Tonga	1989	4	Siosi Cocker Mafi	07/2003–07/2013
Bank of Israel	1954	10	Karnit Flug	Since 11/2013
Bank of Russia	1990	7	Elvira Sakh. Nabiullina	Since 06/2013
			Tatiana V Paramonova	10/1994–12/1995
Banco Central de El Salvador	1961	19	Marta Evelyn A. de Rivera	04/2013–05/2014
			Luz Maria S. de Portillo	08/2002–5/2009
Central Bank of Venezuela	1939	21	Edmee Betancourt	04/2013–08/2013
			Ruth de Krivoy	04/1992–04/1994
National Bank of Serbia	2003	5	Jorgovanka Tabakovic	08/2012
			Kori Udovicki	07/2003–02/2004
Central Bank of Seychelles	1983	6	Caroline Abel	Since 03/2012
Central Bank of Lesotho	1978	7	Retselisitsoe A. Matlanyane	Since 01/2012
Central Bank of Samoa	1984	6	Atalina Ainuu Enari	Since 08/2011
National Bank of Republic of Belarus	1992	6	Nadejda Ermakova	07/2011–12/2014
National Bank of Kyrgyzstan	1991	4	Tamara D Vinnikova	02/1996–01/1997
			Zina Asankojoeva	06/2011–04/2014
Banco central de la Republica de Argentina	1935	36	Jeenbaeva Baktygyl	07/2010–06/2011
Banco Central de Honduras	1950	11	Mercedes Marcó del Pont	02/2010–11/2013
			Maria Elena Mondragon de Villar	01/2010–01/2014
				2002–2006
			Sandra Regnia de Midence	2009–2010
			Gabriela Nunez de Reyes	2006–2009
			Victoria Asfura de Diaz	1998–06/1999
Bank of the Marshall Islands	1982	na	Ann Marie Muller	Since 2009–
South Africa Reserve Bank	1921	7	Gill Marcus	11/2009–11/2014
Central Bank Van Aruba	1986	10	Jeanette R. Semeleer	Since 09/2008
Bank of Thailand	1942	13	Tarisa Wantanagase	11/2006–09/2010
Banco de Guatemala	1945	20	María A. Del Cid Navas de Bonilla	10/2006–09/2010
Central Bank of Kenya	1966	9	Jancinta Mwatela (acting)	03/2006–03/2007
State Bank of Pakistan	1948	17	Shamshad Akhtar	01/2006 01/2009
Central Bank of the Bahamas	1974	5	Wendy Craig	Since 06/2005–
Banco Central del Paraguay	1952	13	Monica L. Perez dos Santos	05/2005–02/2007
Central Bank of Turkmenistan	1991	na	Mukhammedova Shakersoltan	Since 2003
Bank Negara Malaysia	1959	6	Zeti Akhtar Aziz	05/2000–2005
				Since 04/2011
Bank of Botswana	1975	7	Linah Mohohlo	Since 10/1999
Central Bank of Barbados	1972	6	Marion Williams	11/1999–11/2009
Central Bank of Sao Tome e Principe	1975	6	Maria Do Carmo Trovoada Silveira	1999–06/2005
				Since 03/2011
Monetary Authority of Bermuda	1969	10	Cheryl Ann Lister	1999–12/2006
Cayman Islands Currency Board	1971	na	Cindy Scotland Bush	Since 06/2002–
Bank of Guyana	1965	6	Dolly Sursattie Singh	04/1998–12/2014
Denmark Nationalbank	1818	42	Bodil Nyboe Andersen	11/1995–10/2005
Banco Central del Ecuador	1926	35	Ana Lucia Armijos	07/1993–08/1996
National Bank of Poland	1945	15	Hanna Gronkiewicz-Waltz	03/1992–12/2000
Bank of the Lao PDR (Laos)	1968	11	Pany Yathotou	1988–1992
				1995–1997
Central Bank of Finland	1812	32	Sirkka Hämäläinen	4/1992–5/1998
National bank of Austria	1816	11	Maria Schaumayer	05/1990–05/1995
People's Bank of China	1948	11	Chen Muhua	03/1985–04/1988
Banco Central de Bolivia	1928	53	Tamara Sánchez Peña	1985/1985
National Bank of East Germany	1949	6	Margarete Wittkowski	1967–1974
			Margaretha Kuckhoff	1950–1958

Note: We count the number of governors in charge since 1949, except for Ecuador (since 1986) and Austria (since 1992).

standards of living. Its value is between 0 and 1. The higher the index, the higher the number of people in the country enjoying significant well-being. Depending on the HDI value, UNDP ranks 195 countries or territories in four categories: very High human development (49 countries); High human development (52 countries); Medium human development (41 countries); Low human development (42 countries). Eight countries are not classified. From the available data, Table 2 shows countries with female Central Bank chairs.

By crossing data from Tables 1 and 2, among the 56 female Central

Bank chairs: Ten are from nine of the 49 countries classified as *Very High human development*; seventeen, from thirteen countries of the 52 ranked in *High human development*; nineteen, from fourteen countries of the 41 ranked in *Medium human development*; five, from five of the 42 countries classified as *low human development*; two, from eight unclassified countries.

Female Central Bank chairs are, hence, mostly to be found in *Medium human development* countries (33.9% of the total). Then respectively in: *High human development countries* (30.3%);

Table 2
Indicators of Human Development 2013.

	Country	HDI rank	Human Development value	Gender Inequality Index value	GII rank	Share of seats in parliament	Number of female Central Bank chairs
Very high human development (HDI > 0,80)	United States	5	0.914	0.262	47	18.2	1
	Germany	6	0.911	0.046	3	32.4	2
	Denmark	10	0.900	0.056	5	39.1	1
	Israel	19	0.888	0.101	17	22.5	1
	Austria	21	0.881	0.056	5	28.7	1
	Finland	24	0.879	0.075	11	42.5	1
	Cyprus	32	0.845	0.136	23	10.7	1
	Poland	35	0.834	0.139	26	21.8	1
High human development (0,80 > HDI > 0,70)	Argentina	49	0.808	0.381	74	37.7	1
	Bahamas	51	0.789	0.316	53	16.7	1
	Belarus	53	0.786	0.152	28	29.5	2
	Russia	57	0.778	0.314	52	12.1	2
	Barbados	59	0.776	0.350	66	21.6	1
	Malaysia	62	0.773	0.210	39	13.9	1
	Venezuela	67	0.764	0.464	96	17.0	2
	Seychelles	71	0.756	na	na	43.8	1
	Serbia	77	0.745	na	na	33.2	2
	Ukraine	83	0.734	0.326	61	9.4	1
	Thailand	89	0.722	0.364	70	15.7	1
	China	91	0.719	0.202	37	23.4	1
	Ecuador	98	0.711	0.429	82	38.7	1
	Tonga	100	0.705	0.458	90	3.6	1
Medium human development (0,70 > HDI > 0,55)	Maldives	103	0.698	0.283	49	6.5	1
	Turkmenistan	103	0.698	Na	na	16.8	1
	Samoa	106	0.694	0.517	111	4.1	1
	Botswana	109	0.683	0.486	100	7.9	1
	Paraguay	111	0.676	0.457	88	18.4	1
	Bolivia	113	0.667	0.472	97	30.1	1
	El Salvador	115	0.662	0.441	85	26.2	2
	South Africa	118	0.658	0.461	94	41.1	1
	Guyana	121	0.638	0.524	113	31.3	1
	Guatemala	125	0.628	0.523	112	13.3	1
	Kyrgyzstan	125	0.628	0.348	64	23.3	2
	Honduras	129	0.617	0.482	99	19.5	4
	Lao PDR	139	0.569	0.534	118	25.0	1
	Sao Tome & Principe	142	0.558	na	na	18.2	1
Low human development (HDI < 0,550)	Pakistan	146	0.537	0.563	127	24,5	1
	Kenya	147	0.535	0.548	122	19.9	1
	Nigeria	152	0.504	na	na	6.6	1
	Madagascar	155	0.498	na	na	15.8	1
	Lesotho	162	0.486	0.557	126	26.8	1
Others countries or territories	Marshall Islands	na	na	na	na	3.0	1
	Somalia	na	na	na	na	13.8	1

Note: Data in the tables are those available to the Human Development Report Office as of 15 November, 2013, UNDP report. Data on territories of Bermuda, Cayman Islands and Van Aruba do not appear in the UNDP ranking.

Very high human development countries (17.8%); Low human development countries (8.9%). This distribution shows there is no obvious relationship between the countries' level of human development and female Central Bank chair appointments.

2.2. Inequality gaps between men and women

Those are measured by the Gender Inequality Index (GII), which provides a measure of the losses in terms of human development caused by inequalities between women and men in the three dimensions of reproductive health, empowerment and the labor market. Its value varies from 0 (situation in which women have a salary equal to men) to 1 (situation in which the status of women is as bad as possible).

By crossing available data from Tables 1 and 2, among the 56 female Central Bank chairs:

Five (8.9% of the total) are from 4 countries, out of the 15 ($0 \leq \text{GII} < 0.1$), where the treatment of women is almost identical to that of men; nine (16.0%) from 8 countries, out of the 35 ($0.1 \leq \text{GII} < 0.3$), where the

treatment of women is similar to that of men; twenty-two (39.3%) from 15, of the 52 countries ($0.3 \leq \text{GII} < 0.5$), where the treatment of women is quite remote from that of men; seven (12.5%) from 7 countries, out of the 85 ($0.5 \leq \text{GII}$), where the treatment of women is very remote from that of men.

These different distributions indicate that the socio-economic indicators of female/male inequality gaps, as measured by the Gender Inequality Index (GII), have more influence than the level of human development, measured by the Human Development Index (HDI) for the access of women to Central Bank chairmanship.

2.3. Socio-political characteristics

They are observed from three types of indicators: the importance of the females' political representation; the political system; the dominant religion.

The importance of the females' political representation is measured by their weight in Parliament. In the UNDP ranking, only Rwanda has a

female majority in Parliament. It has not, however, appointed a female Central Bank chair. The analysis of data from Tables 1 and 2 shows where women have in the Parliament:

- A) Under 10% of the seats, there are seven female Central Bank chairs (12.5% of the total) in 6 countries out of a total of 33;
- B) Between 10% and 30% of the seats, there are thirty-four female Central Bank chairs (60.7% of total) in 17 countries out of 153;
- C) Between 30% and 50% of the seats, twelve women have succeeded to one another at the Central Bank chair (17.8%) in 10 countries out of a total of 32.

This distribution helps establish a relationship between the relative importance of the females' political representation and their appointment as Central Bank chairs.

As for the nature of the organization of the political system, countries can be divided into four subsets of political systems⁵ (western-style democracies, former popular democracies, monarchies, others):

Crossing data from Tables 1 and 3 shows the earliest female Central Bank chair appointments were made in countries claiming *progressive ideology*, namely: East Germany (1950, 1967); China (1985); Lao PDR (1988); Poland (1992); Russia (1994, 2013); Belarus (1996, 2011); Kyrgyzstan (2010, 2011); Serbia (2003, 2012); Turkmenistan (2003); Ukraine (2014). These countries have quickly promoted the emancipation of women through the implementation of gender-friendly policies so as to ensure equality between men and women in all spheres of society: political, economic, cultural, educational and family life. For example, in China, in 1954, the constitution stipulated equality between men and women and, in 1956, a law was passed to protect the rights and interests of women (Cox-Fill, 1996).

The 56 female Central Bank chairs are divided as follows: 24 in the Western-type democratic countries; 10 in the former people's democracies; 11 in the constitutional monarchies; one in a country with another political system.

Thus, even though the former people's democracies did make the first appointments of female Central Bank chairs, their number is twice as important in countries whose organization is based on the model of Western democracy; they account for 51.7% of appointments compared to 26.7% for former people's democracies against 19.6% for constitutional monarchies. Finally, the weight of tradition and/or the characteristics of the majority religion may more or less influence the role and status of women in society. Indeed, some factors related to traditions influence economic choices and the economic development process (Alesina and Giuliano, 2013). By and large, these factors can be approached in reference to the geographical location of countries (Table 4).

The 56 female Central Bank chairs are distributed in 46 countries belonging, geographically, to the mainland: *America*, 17 countries, including 11 in South America; *Europe*, 10 countries; *Asian, Pacific and the Indian subcontinent*, 10 countries; *Africa and the Indian Ocean*, 9 countries.

Thus, the American continent has the highest proportion of female Central Bank chairs (39.2% of the total), followed by: Europe (25%); Asia, the Indian subcontinent and the Pacific (19.6%); Africa and the Indian Ocean (16.07%).

The weight of religion impacts the countries' development processes (Barro and McCleary, 2003). In particular, according to the importance given to the family, the women's status in the society, it can encourage more or less the female professional careers. If we take into account religion, countries with female Central Bank chairs are

⁵ With the exception of Denmark, Finland and the United State, all countries are in democratic transition: free elections are held periodically. But in most, there is no social compromise and not really thorough legal system.

distributed as follows:

When classifying religions into three subsets (Christian-Jewish, Muslim-others Buddhist-Taoist), and crossing data from Tables 1 and 5, it appears that 56 female Central Bank chairs are located in: 36 predominantly Christian (Catholic, Orthodox, Lutheran) and Jewish countries; 7 countries where the majority is Muslim-others; 3 countries where Buddhist-Taoist is predominant. Countries with a majority of Christian-Jewish therefore account for 80.0% of female Central Bank chairs against 14.3% in the countries where Muslim-others is predominant, and 5.35% with a majority of Buddhist/Taoist.

Thus, the observation of countries with female Central Bank chairs, according to socio-economic criteria (level of human development (HDI), gap of inequality of treatment between men and women (GII)), socio-political criteria (nature of the political organization, weight of cultural traditions, majority religion) shows that:

- A) Female Central Bank chair nominations seem correlated to the relative weight of tradition, the majority religion and the gap in treatment between men and women;
- B) There is no obvious relationship between the countries' level of human development and the female Central Bank chairs named.

As shown by Table 1, there is a small minority of women in the closed world of Central Banks. This situation is partly due to the fact that appointing Central Bank chairs is strictly the government or parliament prerogative. Hence, it would appear important to focus on the profile of appointed female Central Bank chairs.

2.4. Female Central Bank chairs: academic and career backgrounds

To analyze the profile of female Central Bank chairs, we collected biographical data available from the websites of national Central Banks and supplemented them with those available from other websites. Data are summarized in Table 6.

Central Bank chair preferences, on monetary policy goals, are influenced by their career background. That is the case when he is encouraged to express his loyalty to some lobbies, an industry, a political party or a bureaucracy. In particular, a past career as Central Bank staff may encourage executives to identify their own interests with the Central Bank's goals. Indeed, as an institution, the Central Bank seeks to build up a reputation and maintain credibility. Those reputation and credibility are based on its ability to fulfill its mission, mainly summarized by maintaining price stability. Compared to a previous career as a politician or official (including international civil servants), the Central Bank chair is prompted to a stronger preference for price stability.⁶ Those differences stem from motivations that are linked with redistribution policies, real state debt reduction, stimulus policy. A past career in the private sector (in companies, financial and banking sectors) will influence the Central Bank chair's preferences in the direction of business satisfaction. All in all, officers with a background as Central Bank staff members, as business executives (insurance companies, commercial banks, managerial sector) or as public servant have, on average, a stronger preference for price stability than those with a background as politicians or trade-unionists.

A scrutiny of female Central Bank chairs career background data reveals that: 71.4% have held various responsibilities within the Central Bank as vice-chair, board member, economist or department manager; 40.8% have had experience in banking and/or finance and insurance; 26.5% have taught as university professors or assistants; 51.0% have worked in the public sector; against 39.6% for the private sector; 39.6% have been very active in politics as members of

⁶ From the *Public Choice* perspective, Central Bank chairs' preferences have influence on the monetary policy goals. Hence, it is in the service of their own interests or special interest groups. For example, a past of commercial banker will lead to the capture of the Central Bank to the banking sector.

Table 3
The political systems.

Western-style democracies	Former popular democracies	Others	Constitutional monarchies
Argentina; Austria; Bolivia; Botswana; Cyprus; Ecuador; El Salvador; Finland; Guatemala; Guyana; Honduras; Kenya; Maldives; Marshall Islands; Paraguay; Israel; Madagascar; Nigeria; Pakistan; Sao Tome e Principe; Seychelles; South Africa; United States; Venezuela 24 countries, twenty nine female Central Bank chairs	Belarus; China; East Germany; Lao PDR; Kyrgyzstan; Poland; Russia; Serbia; Turkmenistan; Ukraine 10 countries, fifteen female Central Bank chairs	Somalia 1 country, one female Central Bank chair	Bahamas; Barbados; Bermuda; Cayman Islands; Denmark; Lesotho; Malaysia; Samoa; Thailand; Tonga; Van Aruba 11 countries, eleven female Central Bank chairs

Table 4
Number of female Central Bank chairs distributed by Continent and Country.

Europe	America	Africa and Indian Ocean	Asia, Indian-subcontinent and the Pacific
Austria (1); Belarus (2); Cyprus (1); Denmark (1); East Germany (2); Finland (1); Poland (1); Russia (2); Serbia (2); Ukraine (1) 10 countries, 14 female Central Bank chairs	Argentina (1); Bahamas (1); Barbados (1); Bermuda (1); Bolivia (1); Cayman Islands (1); Ecuador (1); El Salvador (2); Guatemala (1); Guyana (1); Honduras (4); Marshall Islands (1); Paraguay (1); Samoa (1); United States (1); Van Aruba (1); Venezuela (2) 16 countries, 22 female Central Bank chairs	Botswana (1); Kenya (1); Lesotho (1); Madagascar (1); Nigeria (1); Sao Tome e Principe (1); Seychelles (1); Somalia (1); South Africa (1) 9 countries, 9 female Central Bank chairs	China (1); Israel (1); Kyrgyzstan (2); Lao PDR (1); Malaysia (1); Maldives (1); Pakistan (1); Thailand; Tonga (1); Turkmenistan (1) 10 countries, 11 female Central Bank chairs

parliament, ministers, prime ministers; 33.3% have worked for international institutions such as IMF, World Bank, UNPD.

Thus, a vast majority of female Central Bank chairs held various positions in the Central Bank before being appointed. Many worked in the public and private sectors and they had experience in the banking and financial sectors. A significant proportion was very active in politics. It would thus seem that the profiles of these female Central Bank chairs seem to tilt the preferences in favor of price stability.

The ability to understand economic and inflation mechanisms depends on their academic background. From a *Public Choice* perspective, the Central Bank chairs are driven by their own narrow professional perspectives and ambitions. With an economist's profile will normally have an advantage enabling him to influence policy decisions in favor of his own preferences or specific targets (Acheson and John, 1973). A more business-oriented training (managers, engineers) will predispose the Central Bank chair to greater aversion to inflation. Indeed, price stability is a major asset for the economy and business development (Mishkin, 2007).

The academic background data for female Central Bank chairs reveal (see Table 6) that 40.8% of them hold a PhD or equivalent (in economics for 31.2% for them against 10.4% in business and management); 48.98% hold a Master's degree or equivalent (including 31.25% specialized in economics and 18.7% in finance or business administration or commerce); 6.12% a specialized Bachelor or equivalent in economics, finance, commerce or accounting techniques; 4.08% another diploma or certificate (accounting, engineering).

Thus, female Central Bank chairs mostly possess technical skills to influence monetary policy decisions in the direction of their preferences. Even if a significant proportion holds a business-related diploma, it would be premature to infer their preferences between various potential monetary policy goals. Overall, the analysis of data related to the female Central Bank chairs career background leads us to the conclusion that, concerning the monetary policy goals, their preferences mostly go towards price stability. The examination of their academic training shows that they have the ability to assert their preferences. However, only the results of the empirical analysis can robustly establish the exact nature of their preferences with respect to price stability, in comparison with male Central Bank chairs. To this aim, the model we are presenting hereafter has been designed to estimate the policy parameter of female Central Bank chairs compared to their male counterparts.

3. Gender and the inflation/output trade-off

In the literature about the optimal monetary policy, it is standard to assume that monetary authorities operate by following a targeting rule, as defined by Svensson (1999). The Central Bank chair is supposed to minimize a quadratic loss function L_t , which penalizes deviations of the objective variables from their target. Let us assume that these objective variables are the output gap x_t (the deviation of the actual GDP from its potential value) and the inflation rate π_t , which the Central Bank chair wants as close as possible to zero and the inflation target $\bar{\pi}$. The quadratic loss function is specified as

$$L_t = \alpha x_t^2 + E_t [(\pi_{t+1} - \bar{\pi})^2] + \sum_{i=1}^{\infty} \beta^i E_t (\alpha x_{t+i}^2 + (\pi_{t+i+1} - \bar{\pi})^2), \quad 0 < \beta < 1, \quad \alpha \geq 0, \tag{1}$$

where β is an intertemporal discount factor and α represents preferences of the Central Bank chair regarding the stabilization of the output, relatively to the stabilization of the inflation rate around its target $\bar{\pi}$. This quadratic loss function is a slightly modified version of the loss function frequently used in the literature, with the present quadratic inflation deviation $(\pi_t - \bar{\pi})^2$ replaced with the expected value $E_t [(\pi_{t+1} - \bar{\pi})^2]$. This is because we suppose that π_t does not depend on the current monetary policy. Due to delay of the monetary transmission mechanism, the monetary policy cannot influence the contemporaneous value of the inflation rate, and it operates only on one-year forward inflation rate anticipation. Apart from that, Eq. (1) is conventionally interpreted; the higher α , the less conservative the Central Bank chair is in the sense of Rogoff (1985). Our aim is to estimate the value of α for female Central Bank chairs comparatively to their male counterparts. Are female Central Bank chairs more, less or as conservative as men?

The Central Bank chair is supposed to control the output gap x_t . At first sight it may seem too strong a hypothesis, but it is in fact a common tacit assumption in monetary models, the policy-maker setting the interest rate to control the output gap (see for example Clarida et al., 1999). With this assumption, we will not need to specify a demand or 'IS' curve. This is clearly an advantage as our results are independent of the demand equation specification. The only structural equation we need to specify is a New-Keynesian Phillips equation, which is supposed to be of the form

Table 5

Distribution of countries by majority religion (at percentage).

Sources – The data for each country are obtained from websites: Wikipedia; Le Guide du Routard; Encyclopedia of the Nations.

	Christian	Jewish	Buddhist/Taoist	Muslim	Others
Argentina	70–90				
Austria	90				
Bahamas	81				
Barbados	67				
Belarus	55				
Bermuda	90				
Bolivia	76				
Botswana	70				
China			87,5		
Cayman Islands	81				
Cyprus	78				
Denmark	77,8				
Ecuador	80				
El Salvador	83				
Finland	75				
East Germany	85				
Guatemala	87				
Guyana	57				
Honduras	87				
Israel		75,4			
Kenya	82,6				
Kyrgyzstan				80	
Lao PDR			67		
Lesotho	90				
Madagascar					52
Malaysia				62	
Maldives				99	
Marshall Islands	97				
Nigeria	50,8				
Pakistan				98	
Paraguay	96				
Poland	87,5				
Russian Federation	41				
Samoa	98				
Sao Tome & Principe	82				
Serbia	85				
Seychelles	90				
Somalia				99,8	
South Africa	80				
Thailand			94		
Tonga	83				
Turkmenistan				89	
Ukraine	72				
United States	70				
Van Aruba	81				
Venezuela	92				

$$\pi_{t+1} - \bar{\pi} = \lambda x_t + \beta(E_t \pi_{t+2} - \bar{\pi}) + u_{t+1}, \lambda > 0, \tag{2}$$

where E_t is the expectation operator, conditional on information available at date t , and u_{t+1} is a supply shock, eventually autocorrelated. In this forward-looking formulation of the Phillips equation, output gap affects the inflation rate with one-year lag, which is consistent with annual data according to Svensson (1997). Eq. (2) is grounded on dynamic general equilibrium theory, which keeps the Lucas critic away, and apart from the fact we suppose that there is a control lag of one year, it is of the same form as the Phillips curve considered in Clarida et al. (1999).

The policy problem is to choose a time path for x_t which minimizes the loss function (1), subject to the constraint (2). This problem reduces to minimizing $\alpha x_t^2 + E_t[(\pi_{t+1} - \bar{\pi})^2]$, the controllable part of (1), subject to (2). The first order condition of this problem is $2\alpha x_t + 2\lambda E_t(\pi_{t+1} - \bar{\pi}) = 0$, which can be written

$$-\frac{\lambda}{\alpha}[E_t(\pi_{t+1}) - \bar{\pi}] = x_t. \tag{3}$$

When the expected inflation rate is above (below) target, the Central Bank reduces (raises) the output gap. The aggressiveness of

this response depends on parameters λ and α . The response is more aggressive if the influence of output gap on inflation is high (λ is high), and if the conservatism of the Central Bank chair is more pronounced (α^{-1} is high). This last parameter is likely to depend on the personality of the policy maker. It may also depend on the economic, political context in which the Central Bank chair is doing his or her job.

Let $\varepsilon_{t+1} = \pi_{t+1} - E_t(\pi_{t+1})$ denote the inflation forecast error. Eq. (3) can be rearranged

$$\pi_{t+1} = \bar{\pi} - \gamma x_t + \varepsilon_{t+1} \gamma = \frac{\alpha}{\lambda} > 0, E_t(\varepsilon_{t+1}) = 0. \tag{4}$$

Eq. (4) can be estimated by OLS. According to condition $E_t(\varepsilon_{t+1}) = 0$, errors of this model cannot be serially correlated. Eq. (4) shows that for a country whose monetary policy is consistent with the model defined by (1) and (2), the regression of π_{t+1} on x_t must produce a negative slope $-\gamma$ and must be characterized by a serially uncorrelated error term. But not every country's monetary policy is consistent with this model. Countries which are not consistent with it, particularly those which are not following a targeting rule described by the loss function (1), should not be included in our empirical analysis. Eq. (4) suggests that the way to select those which are consistent with the model is to look at the estimated slope and at the residuals of the regression Eq. (4).

In case the Central Bank policy is not constant, depending on the current Central Bank chair, we have to make allowance for its variability. In particular, if female Central Bank chairs operate differently from their male counterparts, it should be the case that α , and thus γ , differ depending on the gender of the policymaker. The loss function (1) would be different for men and women, in that the constant parameter α would be replaced with a variable parameter α^t . In order to generalize the model in this way, let us consider the exogenous gender indicator d_t which can either be $d_t = 0$ (the Central Bank chair of period t is a male) or $d_t = 1$ (the Central Bank chair of period t is a female). According to the gender of the Central Bank chair, the relative weight for stabilization of the output gap in the loss function can be either $\alpha^t = \alpha^M$ (for $d_t = 0$) or $\alpha^t = \alpha^F$ (for $d_t = 1$).

So the slope of the regression of π_{t+1} on x_t can vary with the value of the gender indicator; it can be either $\gamma^t = \gamma^M = \frac{\alpha^M}{\lambda}$ for ($d_t = 0$) or $\gamma^t = \gamma^F = \frac{\alpha^F}{\lambda}$ (for $d_t = 1$). The generalized model of the inflation/output trade-off is then

$$\pi_{t+1} = \bar{\pi} - \gamma x_t - \varphi d_t x_t + \varepsilon_{t+1}, E_t(\varepsilon_{t+1}) = 0. \tag{5}$$

For $d_t = 0$, $\partial E_t(\pi_{t+1})/\partial x_t = -\gamma$ so $\gamma^M = \gamma$, whereas for $d_t = 1$, $\partial E_t(\pi_{t+1})/\partial x_t = -\gamma - \varphi$ so $\gamma^F = \gamma + \varphi$. A positive (negative) value for φ indicates that the female Central Bank chairs are less (more) conservative than their male counterparts. More precisely, as $\frac{\gamma^F}{\gamma^M} = \frac{\alpha^F}{\alpha^M}$, we get that $\frac{\varphi}{\gamma} = \frac{\alpha^F - \alpha^M}{\alpha^M}$. The ratio φ/γ measures in percentage how much female Central Bank chairs are more cautious about output stabilization than men.

Estimating the policy preferences by the way of running the regression Eq. (5) is a much more simple methodology than those used in the literature (see Cecchetti and Ehrmann, 2002, Favero and Rovelli, 2003, Ozlale 2003, Castelnuovo and Surico, 2003, Tachibana, 2004, Krause and Méndez, 2005, Dennis, 2006). In these aforementioned studies about the estimation of Central Banks' preferences, an identification problem arises, due to the nature of the objective. In effect, the common objective to all these studies is to get an estimate of the preference parameters. It requires estimating all the structural and preference parameters in order to recover the preference parameters from the reduced form of the model. On the contrary, our methodology is simpler (and presumably more robust to error specification) because we do not try to estimate the preference coefficients α^F and α^M but only to estimate how they differ. To do so, we don't need to estimate the structural parameter λ ; it is not even necessary to estimate an aggregate demand curve. The basic principle of this methodology is borrowed

Table 6 Data on the academic and career backgrounds. Sources: websites: Bank for International Settlements; The Group of Thirty; Women in Sovereign Entities; periodic reviews: World Who's who – Marquis Who's who; The Banker; Europa Year Book.

	Governors	Career background					Academic background							
		Central Bank	Banks/ Insurance	Academia	Public sector	Private sector	Politics	International functions	Ph.D. of Economics	Ph.D. of Business management	Masters of Economics	MBA/ finances/ commerce	Bachelor	Others diploma
Ukraine	Valeriya Gontareva		X		X					X				
Cyprus	Christalla Georghadjji		X		X									
Maldives	Azeema Adam	X			X			X						
US	Janet Yellen	X		X	X		X							
Nigeria	Sarah Alade	X		X	X			X						
Madagascar	Vonimanitra Razafimbelo	X			X									
Somalia	Yussur Abrar		X		X					X				
Tonga	Siosi Cocker Mafi	X		X	X			X						
Israel	Karnit Flug	X		X	X			X						
Russia	Elvira Sakhipzadovna Nabiullina	X		X	X			X						
El Salvador	Tatiana V Paramonova Martia Evelyn Arévalo de Rivera	X X		X	X			X		X				
	Luz Maria Serpas de Portillo	X			X					X				
Venezuela	Edmee Betancourt	X		X	X									X
	Ruth de Krivoy	X		X	X			X						
Serbia	Jorgovanka Tabakovic	X		X	X			X						
	Kori Udovicki	X		X	X			X						
Seychelles	Caroline Abel	X		X	X			X						
Lesotho	Rets elisitsoe Adelaide Matlanyane	X		X	X									
Samoa	Atalina Ainuu Enari	X			X									
Belarus	Nadejda Ermakova	X		X	X									
	Tamara D Vinnikova	X		X	X									
Kyrgyzstan	Zina Asankojoiyeva	X		X	X									
	Jeenbaeva Baktygyl	X		X	X									
Argentina	Mercedes Marcó del Pont	X		X	X									
Honduras	María Elena Mondragón de Villar	X		X	X									
	Sandra Regnia de Midence	X		X	X									
	Gabriela Nunez de Reyes	X		X	X									
	Victoria Asfura de Diaz	X		X	X									
Marshall Islands	Ann Marie Muller	X		X	X									
Van Aruba	Jeanette R. Semeleer	X		X	X									
South Africa	Gill Marcus	X		X	X									X
Thailand	Tarisa Wantanagase	X		X	X									
Guatemala	María A. Del Cid Navas de Bonilla	X		X	X									
Kenya	Jancinta Mwatela	X		X	X									
Pakistan	Shamshad Akhtar	X		X	X									
Bahamas	Wendy Craigg	X		X	X									
Paraguay	Monica Luján Perez dos Santos	X		X	X									

(continued on next page)

Table 6 (continued)

Central Banks	Governors	Career background				Academic background								
		Central Bank	Banks/ Insurance	Academia	Public sector	Private sector	Politics	International functions	Ph.D. of Economics	Ph.D. of Business management	Masters of Economics	MBA/ finances/ commerce	Bachelor	Others diploma
Turkmenistan	Mukhammedova, Shakersoltan								Na	na	na	na	na	na
Malaysia	Zeti Akhtar Aziz	X						X	X					
Botswana	Linah Mohohlo	X			X			X			X			
Barbados	Marion Williams	X						X						
Sao Tome Principe	Maria Do Carmo Trovoada Silveira					X					X			
Bermuda	Cheryl Ann Lister		X								X			
Cayman Islands	Cindy Scotland Bush	X		X								X		
Guyana	Dolly Sursattie Singh	X		X		X								
Denmark	Bodil Nyboe Andersen	X		X		X					X			
Ecuador	Ana Lucia Armijos	X				X								
Poland	Hanna Gronkiewicz-Waltz			X		X			X					
Laos	Pany Yathotou	X						X					X	
Finland	Sirkka Hämmäläinen	X		X		X			X					
Austria	Maria Schumayer		X		X	X			X					
China	Chen Muhua				X	X								
Bolivia	Tamara Sánchez Peña	na				X								X
East Germany	Margarete Kueckhoff			X	X	X					X			
	Margaretha Wittkowski			X	X	X			X					

from Diouf and Pépin (2010).

Estimation of policy preferences are usually based on estimation of all policy and structural parameters. These traditional estimation procedures require an estimation of the structural macroeconomic model and an interest rate rule, in order to recover all the parameters (Favero and Rovelli, 2003, Ozlale, 2003, Castelnuovo and Surico, 2003, Dennis, 2006), or of the structural macroeconomic model and the first-order equation of the loss function's minimization (Favero and Rovelli, 2003, Tachibana, 2004), using an approach close to ours. Another approach is to estimate the structural macroeconomic model and to use an estimation of the variances of inflation and output gap to recover the preference parameters (Cecchetti and Ehrmann, 2002, Krause and Méndez, 2005). More simply, we focus on the first-order condition, which solves the optimization problem faced by the Central Bank chair. Our methodology is also distinctive in preferring a forward-looking model to a backward-looking one, and using annual data (instead of quarterly data).

Estimating Eq. (4) and testing the significance of $\hat{\varphi}$ (the OLS estimator of φ) is then sufficient to find out if female and male Central Bank chairs behave similarly way or not, and in case they don't, to infer about their differences. Theoretically, we can run such a regression for every country to assess the differences between women and men. For every country, we can estimate the country parameters γ and φ . The drawback of running individual (country) regressions is that the individual estimators $\hat{\varphi}$ will be imprecisely estimated if the number of observations characterized by $d_{it} = 1$ is low. And it is in fact the case for almost every country that this number is very low, because of the overrepresentation of men in the Central Banks' management. If we estimate φ country by country, the variance of $\hat{\varphi}$ would be high, and the estimated parameter would not be statistically significant, even if the true parameter is non zero. Thus we prefer to adopt an alternative estimation and test methodology, based on a panel data analysis. On the one hand, the drawback of such a methodology is to impose a restriction on country regressions that implies the existence of a common parameter; but on the other hand, using the panel sample produces a better estimate of this common parameter.

The panel model can be written

$$\pi_{j,t+1} = \bar{\pi}_j - \gamma_j x_{j,t} - \rho \gamma_j d_{j,t} x_{j,t} + \varepsilon_{j,t+1}, \quad E_t(\varepsilon_{j,t+1}) = 0 \quad (6)$$

where j is introduced to identify the country j ($j=1..N$). All the variables $\pi_{j,t+1}$, $x_{j,t}$, $d_{j,t}$ and $\varepsilon_{j,t+1}$ are country-specific, just like the parameters $\bar{\pi}_j$ and γ_j . The parameter ρ is common to all countries included in the panel.

By generalizing our previous notations, we can write $\gamma_j^M = \gamma_j = \frac{\alpha_j^M}{\lambda_j}$ and $\gamma_j^F = (1 + \rho)\gamma_j = \frac{\alpha_j^F}{\lambda_j}$. So $\gamma_j^F = (1 + \rho)\gamma_j^M$ or in an equivalent manner $\alpha_j^F = (1 + \rho)\alpha_j^M$. The common parameter ρ represents the deviation of the weights given to stabilization of output by women, against the weights given by men, in percentage of the weights given by men. For example, if $\rho = 0.10$, then female Central Bank chairs are 10% more inclined to stabilize output gap than men. The panel model restricts this difference between female and male Central Bank chairs to be the same, regardless of the country considered.

Eq. (6) is a non-linear panel model, which has to be estimated by numeric methods (like Gauss-Newton). The system of N Eq. (6) can be estimated by non-linear Least Squares. But as the errors $\varepsilon_{j,t+1}$ are contemporaneously correlated between countries, we implement a non-linear Seemingly Unrelated Regression (SUR) method to estimate this system, exploiting this additional information.

4. A panel data analysis

The macroeconomic data used is from the FMI web site. At the time we picked up the data the last update was 03/2015. We use annual GDP data (valued at constant prices in national currency) and annual

end of period consumer prices index⁷ relative to thirty-three countries (Argentina, Austria, Bahamas, Barbados, Belarus, Bolivia, Botswana, China, Denmark, Ecuador, Salvador, Finland, Guatemala, Guyana, Honduras, Kenya, Kyrgyzstan, Lao, Lesotho, Malaysia, Marshall Islands, Pakistan, Paraguay, Poland, Russia, Samoa, Sao Tome, Serbia, Seychelles, South Africa, Tonga, Turkmenistan and Venezuela). Data are collected on the period 1980–2014 or on a shorter period for some countries.⁸ We calculate the inflation rate for every country by applying the formula $\pi_t = 100 \times \ln(P_t/P_{t-1})$, with P_t designating the price index. The potential GDP is estimated by regressing the actual GDP on a quadratic trend, and the output gap is then defined by $x_t = 100 \times \ln(Y_t/Y_t^*)$, with Y_t and Y_t^* for respectively the actual and potential GDP.

For every country j and every year t we set the dummy variable d_{jt} to 1 if a female was the Central Bank chairman for at least six months. Otherwise the dummy is set to 0. In the initial data set, seven countries have a unique $d_t = 1$ in 2014 (Cyprus, Israel, Madagascar, Maldives, Nigeria, Ukraine and the US). As inflation depends on monetary policy with a delay of one year, and because we have not the 2015 data yet, these countries don't bring any information about the parameter of interest in this study (ρ). This is why they are not included in the previous list of thirty-three countries.

4.1. Individual regressions

In order to select countries to be included in the panel analysis, individual regressions were run. For every country, Eq. (5) is estimated by OLS.

Some adjustments have been made for some countries, about the intercept $\bar{\pi}$ of the regression and about the sample period. These adjustments were necessary because the countries examined in the study are not similar, particularly concerning inflation rates. Firstly, some countries have experienced disinflationist processes. So the implicit inflation target $\bar{\pi}$, which equals the long term inflation rate if the Central Bank hits the target in the long run, cannot be supposed constant. So the constant intercept $\bar{\pi}$ was replaced with a quadratic trend $a_\pi + b_\pi t + c_\pi t^2$. This adjustment concerns Bahamas, Botswana, Denmark, Finland, Guyana, Honduras, Lesotho, Paraguay, Poland, Russia, Sao Tome, Salvador and Serbia. To decide whether to include the quadratic term or not, we looked at the serial correlation of the residual term, by means of the Breusch-Godfrey Serial Correlation LM Test. A significant autocorrelation of residuals detected in the model without quadratic trend may indicate the existence of a trend in the inflation process. So, if we detected a significant autocorrelation of residuals, and if the inclusion of quadratic trend makes this autocorrelation disappear, we include the trend in the regression. It is worth to note that the inclusion of the quadratic trend has little impact on the estimated parameters $\hat{\gamma}$ and $\hat{\varphi}$, because the output gap is a de-trended series by construction. So the inclusion of quadratic trends has no consequences on the results; it only makes the residuals' autocorrelation disappear. Secondly, adjustments have also been made on the sample period. The theoretical model described by Eqs. (1) and (2) may be a good description of the monetary policy for some countries on a more recent period, but not since the early 1980s. The concept of a targeting rule is relatively recent, and few Central Banks in the world have followed such a rule since the early 1980s. For some countries included in the sample, it is obvious that the apparent inflation instability is not compatible with the inflation/output trade-off. In these countries, monetary policy was not intended to control inflation,

⁷ For Argentina and China, we use annual average consumer prices index.

⁸ For Belarus, Russia and Turkmenistan, the GDP data are available from 1992 and the inflation data from 1993; for China, the inflation data are available from 1987; for Kyrgyzstan, the GDP and inflation data are available from 1993; for Marshall Islands, the GDP data are available from 1997 and the inflation data from 2004; and for Serbia, the GDP and inflation data are available from 1998.

even partially, but to fund public spending, this policy creating hyperinflation. Some of these countries have more recently regained control of inflation, and we do take these periods of stability into

account when running the regressions. Argentina experienced instability of inflation process up to 1992. Before 1992, inflation measured with the logarithmic formulae, which underestimate inflation for high

Table 7
Individual estimations of Eq. (5).

Country	Sample period	$\hat{\pi}$	\hat{a}_π	\hat{b}_π	\hat{c}_π	$\hat{\gamma}$	$\hat{\varphi}$	LM test
Argentina	1992–2014	7.960				0.415	-0.950	1.595
		(1.736)				(0.212)	(1.109)	0.206
Austria	1981–1998	0.000				0.032	0.401	
		3.257				-0.652	0.060	2.629
Bahamas	1981–2014	(0.249)				(0.119)	(0.398)	0.104
		0.000	8.148	-0.491	0.009	0.999	0.88	4.216
Barbados	1981–2014		(0.860)	(0.109)	(0.002)	-0.064	-0.118	0.040
			0.000	0.000	0.003	0.940	0.284	3.532
Belarus	1996–2014	4.072				-0.275	0.048	0.060
		(0.555)				(0.141)	(0.304)	
Botswana	1981–2014	0.000				0.969	0.874	
		36.954	11.134	-0.067	-0.001	2.282	-2.430	3.262
China	1987–2014	(7.367)	(1.299)	(0.162)	(0.004)	(0.983)	(1.917)	0.070
		0.000	0.000	0.680	0.650	0.016	0.223	
Denmark	1981–2014					-0.132	0.174	3.497
		4.269	8.912	-0.629	0.012	-0.106	-0.217	6.079
Ecuador	1981–2014	(1.105)	(0.897)	(0.115)	(0.002)	(0.089)	(0.271)	0.013
		0.000	0.000	0.000	0.000	0.879	0.428	
Finland	1981–2014		18.858	2.641	-0.099	-0.600	4.005	8.723
			(7.843)	(1.032)	(0.027)	(0.782)	(2.283)	0.003
Guatemala	1981–2014	0.022	0.022	0.016	0.001	0.775	0.089	
		10.627	10.627	-0.798	0.016	-0.115	0.028	5.383
Guyana	1981–2014	(0.688)	0.000	0.000	0.000	(0.058)	(0.104)	0.020
		0.000	9.683			0.971	0.787	
Honduras	1981–2014					0.765	-0.183	4.053
			(1.199)			(0.311)	(1.310)	0.044
Kenya	1981–2014	0.000				0.009	0.889	
		30.546	30.546	-0.929	0.001	1.175	-0.602	6.058
Kyrgyzstan	1995–2014	(7.177)				(0.244)	(0.640)	0.013
		0.000				0.000	0.360	
Laos	1981–2014	1.852				-1.251	1.224	4.325
		(3.309)				(0.509)	(0.680)	0.037
Lesotho	1981–2014	0.580				0.989	0.082	
			10.702			-0.546	-2.140	8.061
Malaysia	1981–2014	(1.211)				(0.262)	(2.919)	0.004
		0.000				0.977	0.468	
Marshall Islands	2004–2014	11.693				1.427	-2.267	0.359
		(2.019)				(0.474)	(1.646)	0.548
Pakistan	1981–2014	0.000				0.003	0.186	
		19.037				-1.868	0.238	2.699
Paraguay	1990–2014	(4.026)				(1.698)	(2.975)	0.100
		0.000				0.860	0.936	
Poland	1991–2014		14.478	-0.260	-0.001	-0.086	0.081	1.332
			(1.653)	(0.218)	(0.006)	(0.180)	(0.822)	0.248
Russia	1993–2014		0.000	0.244	0.871	0.681	0.921	
			2.933			-0.155	-0.150	2.858
Russia	1993–2014	(0.280)				(0.049)	(0.337)	0.090
		0.000				0.998	0.658	
Russia	1993–2014	3.479				-1.119	0.754	0.631
		(1.246)				(0.961)	(1.334)	0.426
Russia	1993–2014	0.023				0.861	0.587	
		7.694				-0.598	-0.514	3.308
Russia	1993–2014	(0.473)				(0.178)	(0.447)	0.068
		0.000				0.998	0.259	
Russia	1993–2014		62.767	-4.139	0.073	0.283	0.424	0.654
			(8.977)	(0.820)	(0.017)	(0.136)	(0.391)	0.418
Russia	1993–2014	0.000				0.025	0.291	
		137.50				0.053	-0.135	0.995
Russia	1993–2014	(23.47)				(0.329)	(0.191)	0.318
		0.000				0.436	0.488	
Russia	1993–2014	635.20				-1.723	-3.733	0.459
		(79.11)				(0.473)	(2.566)	0.498
Russia	1993–2014	0.000				0.999	0.163	
			0.000	0.000	0.000			

(continued on next page)

Table 7 (continued)

Country	Sample period	$\hat{\pi}$	\hat{a}_π	\hat{b}_π	\hat{c}_π	$\hat{\gamma}$	$\hat{\varphi}$	LM test
Salvador	1981–2014		22.342	-1.004	0.010	0.541	-0.806	0.038
			(2.375)	(0.298)	(0.007)	(0.102)	0.395	0.844
Samoa	1981–2014	4.642	0.000	0.002	0.177	0.000	0.050	0.008
		(1.621)				(0.264)	(1.068)	0.926
Sao Tome	1981–2014	0.007	-1.009	3.390	-0.093	-0.465	-3.638	9.323
			(6.418)	(0.799)	(0.020)	(0.823)	(2.035)	0.002
Serbia	1999–2014		0.876	0.000	0.000	0.712	0.084	
			323.16	-20.37	0.326	0.349	-2.075	0.208
Seychelles	1981–2014	3.927	0.028	0.055	0.085	0.354	0.493	
		(1.309)				-0.228	0.519	1.399
South Africa	1981–2014	0.005				(0.196)	(1.044)	0.236
		8.941				0.872	0.622	
Tonga	1981–2014	(0.728)				-0.209	-0.626	23.70
		0.000				(0.256)	(1.086)	0.000
Turkmenistan	1998–2014	6.549				0.789	0.568	
		(0.856)				-0.055	0.434	2.042
Venezuela	1981–2014	0.000				(0.084)	(0.334)	0.153
		8.177				0.741	0.202	
		(1.084)				0.193	-0.394	0.217
		0.000				(0.064)	(0.379)	0.641
		0.000				0.004	0.316	
		25.664				-0.677	-1.052	12.16
		(2.499)				(0.358)	(1.375)	0.000
		0.000				0.966	0.450	

Note: For every parameter, we present the estimated value, the standard error (into brackets) and the probability of the test of nullity of the estimated parameter, except for $\hat{\gamma}$, for which the probability is the one associated with the unilateral test of negativity. LM test refers to the Breusch-Godfrey serial correlation LM test; the first value is the statistics of the test and the second the probability of the null hypothesis of no autocorrelation of residuals.

rates relatively to the index price growth rate, was over 60% (on the period 1980–1991). The inflation index fell from 1992 and was fairly stable since then. In Belarus, inflation has stabilized since 1996. Between 1993 and 1995, inflation was over 200% before dropping. In Kyrgyzstan inflation rate was over 200% in 1993 and 100% in 1994, before dropping in 1995. In Turkmenistan, inflation stabilized below 25% from 1998 onwards. The Polish inflation rate was unstable up to 1991. In addition, in China and in Ecuador inflation stabilized respectively from 1995 and 2002 onwards, but as there was no more female Central Bank chair from these years, we didn't shorten the sample period. Moreover, there is a lack of reliability with Paraguay's inflation data before 1990. The reported inflation rate was exactly the same (23.58702) every year from 1980 to 1989; so we excluded this period of the sample. And finally, inflation was analyzed in Austria up to 1998, as the country entered the Euro zone in 1999.

Table 7 presents the results of the individual estimations of Eq. (5). We test the hypothesis of nullity of parameters $\hat{\pi}$, \hat{a}_π , \hat{b}_π , \hat{c}_π and $\hat{\varphi}$, and we test the hypothesis of negativity of $\hat{\gamma}$ (in others words we look if $\hat{\gamma}$ is significantly positive). The results show that few countries have adopted a monetary policy compatible with the model of inflation/output trade-off. In order for the results to be consistent with the model, we have to keep in mind that $\hat{\gamma}$ has to be significantly positive (and the residuals have to be non-serially correlated). Only eight countries out of the thirty-three considered seem consistent with the model. Moreover, the Breusch-Godfrey test shows that the null hypothesis of non-autocorrelation of residuals of the regressions for these eight countries is not rejected for conservative significance level (probabilities are over 1%). The countries concerned are Argentina, Belarus, Guatemala, Guyana, Kyrgyzstan, Paraguay, Salvador and Turkmenistan. According to indicators of human development in Table 2, these countries are mostly characterized by medium human development, except for Belarus which is classified as a high human development country and Argentina which is in the very high human development category. There is no country characterized by low development in this panel. As for the nature of the organization of

the political system (Table 3), five countries are Western-style democracies and the other three are former popular democracies. There is no monarchy in the panel. None of these countries is located in Africa or in the Indian Ocean; only Belarus is a European country; others countries are located in America or in central Asia. Results of individual regressions for these eight countries are discussed below.

The estimated parameter $\hat{\gamma}$ exhibits noticeable variations from one country to another. It varies from 0.193 for Turkmenistan to 2.282 for Belarus. If $\hat{\gamma}=2$, it means that to keep the inflation rate 1% above the target, the Central Bank chair maintains the output gap at 0.5%. And if $\hat{\gamma}$ is less than 2, which is the case for most of the eight countries, the Central Bank chair agrees to let the output gap vary even more. So the estimated values of $\hat{\gamma}$ are economically significant, proving the existence of an important trade-off between inflation and output.

The constant implicit inflation targets of Argentina, Belarus, Guatemala, Kyrgyzstan and Turkmenistan are of course significant, but above all, they are high, from 7.96% for Argentina to 36.95% for Belarus. And, for three other countries (Guyana, Paraguay and Salvador), the inflation trend is decreasing over the period, but starting from a high level of inflation.

Finally, it is tempting to comment the estimated values of φ , but we have to keep in mind that the number of points in the sample characterized by $d_t=1$ is very low: 4 for Argentina, 4 for Belarus, 4 for Guatemala, 16 for Guyana, 4 for Kyrgyzstan, 2 for Paraguay, 7 for Salvador and 1 for Turkmenistan. So, we know that the standard error of the parameter is likely to be very high at an individual regression level. And effectively $\hat{\varphi}$ is not significant in any of the 8 regressions except in the case of Salvador. Nevertheless, the parameter $\hat{\varphi}$ is positive in seven out of eight cases, which may be indicative of the positivity of φ . This positivity indicates that female Central Bank chairs would be more conservative than their male counterparts. The first step consists in testing the significance of a difference between female and male Central Bank chairs in the panel model (6).

Table 8
Panel estimation of country-specific estimated parameters.

Country	Sample period	$\hat{\pi}$	\hat{a}_π	\hat{b}_π	\hat{c}_π	$\hat{\gamma}$
Argentina	1992–2014	7.841 (1.539) 0.000				0.323 (0.197) 0.051
Belarus	1996–2014	39.337 (6.596) 0.000				2.670 (0.809) 0.000
Guatemala	1981–2014	9.841 (1.064) 0.000				0.557 (0.256) 0.015
Guyana	1981–2014		26.300 (5.525) 0.000	-0.724 (0.731) 0.323	0.001 (0.019) 0.926	1.039 (0.215) 0.000
Kyrgyzstan	1995–2014	12.204 (1.809) 0.000				1.353 (0.380) 0.000
Paraguay	1990–2014		51.652 (7.056) 0.000	-3.167 (0.640) 0.000	0.054 (0.013) 0.000	0.275 (0.119) 0.015
Salvador	1981–2014		19.939 (1.640) 0.000	-0.875 (0.207) 0.000	0.011 (0.005) 0.022	0.468 (0.092) 0.000
Turkmenistan	1998–2014	8.647 (0.968) 0.000				0.189 (0.055) 0.000

Note: For every parameter, we present the estimated value, the standard error (into brackets) and the probability of the test of nullity of the estimated parameter, except for $\hat{\gamma}$, for which the probability is the one associated with the unilateral test of negativity.

4.2. Panel regression

According to the results of the previous section, we selected eight countries (Argentina, Belarus, Guatemala, Guyana, Kyrgyzstan, Paraguay, Salvador and Turkmenistan) to estimate the non-linear panel model (6). The model is estimated using a non-linear SUR method, which exploits the errors correlation of the different countries.

Table 8 presents the results relative to the country-specific estimated parameters ($\hat{\pi}_j$, $\hat{a}_{\pi j}$, $\hat{b}_{\pi j}$, $\hat{c}_{\pi j}$ and $\hat{\gamma}_j$) and Table 9 presents the results of the common estimated parameter $\hat{\rho}$.

According to Table 8, panel estimation gives similar results to those of individual regressions. The restriction induced by the common parameter and the consideration of the error correlation does not seem to alter the results.

Table 9 presents the main result of the paper: $\hat{\rho}$ is significantly different from zero, and it is negative, confirming the results of individual regressions, that female Central Bank chairs appear to put more emphasis on price stability than output stability in comparison to male Central Bank chairs. The estimated parameter $\hat{\rho}$ is even highly negative, the female Central Bank chairs being 73% less attached to the stabilization of output objective than men. Clearly, monetary policy appears to be less accommodative when conducted by female Central Bank chairs. This result of a larger degree of conservativeness associated with female Central Bank chairs is in line with previous analysis (see Bannani et al., 2015).

In fact, we can even wonder if female Central Bank chairs are interested in output stabilization, as $\hat{\rho}$ is close to -1. We decided to test $\begin{cases} H_0: \rho \leq -1 \\ H_1: \rho > -1 \end{cases}$, which is more convenient than $\begin{cases} H_0: \rho = -1 \\ H_1: \rho \neq -1 \end{cases}$ as ρ can't be less than -1, using the t-statistics $(\hat{\rho} + 1)/\text{stand. err. of } \hat{\rho}$. The value of

Table 9
Panel estimation of the common parameter ρ .

$\hat{\rho}$	Standard error of $\hat{\rho}$	Probability (test of nullity of ρ)
-0.736	0.274	0.007

the statistics is 0.936, and the probability of a standard normal variable to be more than 0.936 is 0.175, which is the probability of the test. Thus the hypothesis that female Central Bank chairs don't regard output stabilization, and are concerned only with inflation stabilization, cannot be rejected for a significance level of 10%, which assesses the importance of gender in central banking.

5. Conclusion

Comparatively to the corporate boards, the gender of the Central Bank's chair has not so far been a subject of academic work. The contribution of this study to the literature on gender and monetary policy is to provide a deep insight of the female's under-representation among Central Bank chairs over the world, and to describe the way they resolve the inflation/output trade-off relatively to their male counterparts. To this aim, we have built a unique data set compiling information about female Central bank chairs since 1949. Our sample is larger and more recent than previous studies, and its originality lies in the fact that we included developed and emerging countries. Of course, there are other available data sets but they are incomplete or display some errors (misunderstandings about persons, confusions between Central Banks and national commercial banks).

From the data compiled, we identified 56 female Central Bank chairs, i.e. a very small minority. By using various international data about socio-economic indicators (level of human development, gender gaps) and socio-political characteristics (religion, traditions, political representation, political organization, geographical location), we found that: the female Central Bank chairs appointment was not influenced by the countries' level of human development; female under-representation, as Central Bank chairs, seems to result from tradition, religion and to the inequality gap with men, which is globally prevalent in societies.

As long as Central Banks were totally dependent of politics, roughly before the 1990s, the governments showed a clear inclination to appoint male Central Bank chairs. Since the beginning of the 1990s, Central Banks have become more independent and empowered to focus on the price stability goal, and governments started to appoint, more frequently, female Central Bank chairs, albeit always in a low proportion. Perhaps this is entirely due to the fact that the international movement of institutional monetary reforms coincided with a social change for women. Another explanation may simply result from female preferences on monetary policy goals in comparison with men. Indeed, while Central Banks were given independence, women selected to chair Central Banks have a career and an academic background consistent with a preference for the price stability, which leads us to think that the appointment of women may have been the result of a political will.

As only an empirical analysis can establish how female and male Central Bank chairs differ in the conduct of monetary policy, we examined if policy preferences are influenced by gender. We developed an innovative methodology, based on an idea first coined by Diouf and Pépin (2010), which does not require estimating all the structural and preference parameters of a monetary model, but only how men and women's parameters differ.

As a preliminary, the empirical analysis of the inflation/output trade-off reveals that, among the 33 countries in the sample, only eight appear to be consistent with a model of inflation targeting (Argentina, Belarus, Guatemala, Guyana, Kyrgyzstan, Paraguay, Salvador and Turkmenistan). Preferences cannot be inferred from the other twenty-four countries, as the implemented monetary policy in these countries does not seem to result from a compromise between stabilization of inflation and output growth. A panel data analysis conducted on the eight countries, whose monetary policy is consistent with inflation targeting, shows that female Central Bank chairs put more emphasis on stabilization of inflation comparatively to their male counterparts. Such a result is in line with previous studies on a larger degree of hawkishness from female. This is explained by the fact that

female policymakers for monetary policy need to be more conservative, in their preference, in order to acquire/reinforce a reputation (Wilson, 2014; Bennani et al., 2015). They are 73% less attached to the objective of output stabilization than men, which reveals they have a high degree of aversion to inflation i.e. they are conservative in the sense of Rogoff (1985). Actually, female Central Bank chairs appear so hawk according to our results we cannot even reject the hypothesis that they are only concerned with inflation stabilization. This strong conservatism may be a factor explaining their appointment to the Central Bank chair, as the central banker's conservatism has been advocated, on the basis of Rogoff's work, as a way to gain in credibility and reputation. To some extent, this attachment to the ultimate monetary policy goal, reflected by a high degree of conservatism, can be interpreted as a sign of a greater ability to resist political pressures, and hence of independence in the conduct of monetary policy.

Nevertheless, we have to be cautious with the interpretation of these empirical results, because they are based on the empirical analysis of only eight countries which are mostly in the medium human development category. It will be interesting to repeat the estimation conducted in this paper within a few years, when more data about countries in the very high human development category are available.

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