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Three Essays on the Transmission of Monetary Policy in the Euro Area

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Résumé

Après Septembre 2008, à cause du gel du marché interbancaire, d'un manque de liquidité, d'une perte de confiance et des difficultés des institutions financières, la transmission de la politique monétaire au sein de la zone euro a été sévèrement altérée. Dans ce contexte exceptionnel, la Banque Centrale Européenne (BCE) a dû avoir recours à des politiques monétaires non-conventionnelles. En considérant, au sein de la zone euro, à la fois les contraintes imposées à la banque centrale et la fragmentation des marchés financiers, l'objectif de cette thèse empirique est d'évaluer les canaux de transmission des politiques monétaires conventionnelles et non-conventionnelles de la BCE et leurs effets sur les marchés financiers et sur l'économie.

Les comportements de prêts des banques étant liés à leurs coûts de financement, le premier essai se focalise sur le canal de transmission des prêts bancaires. Il étudie l'évolution des activités de prêts d'institutions financières européennes sur le marché des prêts syndiqués et leur réaction aux politiques conventionnelles et non-conventionnelles de la BCE. De plus, la communication de la banque centrale revêt une importance toute particulière dans une union monétaire avec différents, en termes de situation économique et de culture, états membres. Les deuxième et troisième essais de cette thèse se concentrent sur le canal des signaux de politique monétaire. Le deuxième essai se focalise sur la communication durant les conférences de presse mensuelles ainsi que ses effets sur la prévisibilité des décisions de politique monétaire et sur les rendements et la volatilité des marchés financiers. Le dernier essai se concentre exclusivement sur l'utilisation du guidage des taux d'intérêt futurs, une communication non-conventionnelle de la banque centrale informant les marchés du niveau futur des taux d'intérêt de court-terme. Il étudie l'efficacité de cette annonce et sa capacité à influencer les prévisions de taux d'intérêt faites par les acteurs de marché.

Mot(s)-clé(s) : politique monétaire, instruments non-conventionnels, Banque Centrale Européenne, canal des prêts bancaires, canal des signaux, analyse de séries temporelles, communication des banques centrales.

Abstract

After September 2008, due to a frozen interbank market, shortage of liquidity, loss of confidence, and collapsing financial institutions, the monetary policy transmission in the euro area was severely impaired. Under thus exceptional circumstances, the European Central Bank (ECB) had to turn to non-standard monetary policy measures. Considering, in the euro area, the constrained range of actions and fragmented financial markets, the objective of this empirical thesis is to assess the transmission channels of ECB standard and non-standard monetary policies and their effects on both financial markets and the economy.

As banks' lending behaviors are related to their financing costs, the first essay focuses on bank lending channel. It studies the evolution of lending activities of European financial institutions on the syndicated loan market and its reaction to the ECB standard and non-standard policies. The communication of the central bank is of utmost importance in a monetary union with heterogeneous, in terms of economic situations and cultures, countries. The second and third essays of this thesis study the signaling channel of monetary policy. The second essay focuses on the communication during monthly press conferences and their effects on the predictability of monetary policy decisions and on financial markets returns and volatility. The last essay concentrates exclusively on the use of *forward guidance* on interest rate, a non-standard central bank communication providing information on future short-term interest rates. It discusses its effectiveness and ability to lower market participants expected interest rates.

Keywords : monetary policy, non-standard instruments, European Central Bank, transmission channels, bank lending channel, signaling channel, time series analysis, central bank communication.

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Introduction Générale

"Bien que de nombreux macroéconomistes en professent peu d'incertitude, la profession dans son ensemble n'a pas de réponse claire à la question de la taille et de la nature des effets de la politique monétaire sur l'activité globale." Sims (1992)

Contexte de la thèse

Moins de 10 ans après sa création en 1999, la Banque Centrale Européenne (BCE), ainsi que d'autres banques centrales, ont lutté lors du choc financier commencé en 2007. La faillite de Lehman Brothers, le 15 septembre 2008, suivie le lendemain des difficultés d'AIG ont poussé la finance mondiale dans une crise qu'Alan Greenspan a qualifiée de "tsunami du siècle". [a]

Après ce premier choc, les gouvernements de la zone euro ont utilisé les dépenses publiques pour soutenir à la fois la croissance économique et les institutions financières encore en difficulté. [b] Sur fond de dette publique croissante, les marchés financiers ont commencé à remettre en question la viabilité financière de plusieurs pays. La Grèce, en particulier, a attiré l'attention après une première révision de sa dette publique fin 2009. Elle a été rapidement suivie dans les turbulences par l'Irlande et le Portugal. Ce

a. Octobre 2008, Audition devant le Congrès américain.

b. Voir Ureche-Rangau & Burietz (2013) pour la liste des interventions publiques des pays de la zone euro et du Royaume-Uni.

deuxième choc marque le début de la crise de la dette souveraine dans la zone euro, crise caractérisée par une faible croissance économique, une faible inflation et une instabilité financière.

Dans des *circonstances normales*, les banques centrales contrôlent l'offre de monnaie par les instruments classiques : opérations d'*open market*, facilités permanentes et réserves obligatoires. Elles fixent l'objectif de taux d'intérêt interbancaire à un jour et adaptent en conséquence la quantité de liquidité allouée au cours des opérations d'*open market*. Réagissant aux tensions dans le système financier, la BCE a diminué son principal taux d'intérêt entre octobre 2008 et mai 2009 pour atteindre son plus bas historique. Cependant, après septembre 2008, en raison d'un marché interbancaire gelé, d'une pénurie de liquidités, d'une perte de confiance et de l'effondrement des institutions financières, la transmission de la politique monétaire dans la zone euro a été gravement altérée. Dans ces *circonstances exceptionnelles* de troubles économiques et financiers, la BCE a dû se tourner vers des mesures de politique monétaire non-conventionnelles. La banque centrale a assuré une offre illimitée de liquidité aux institutions financières avec, pour toutes ses opérations de refinancement, un taux fixe, la totalité des soumissions étant servies. [c] Cette mesure marque l'introduction d'instruments de politique monétaire non-conventionnels dans la zone euro. La mise en oeuvre de plusieurs programmes a augmenté la taille du bilan de la BCE de plus de 700 milliards entre 2008 et 2010. Parallèlement, l'extension de la gamme de garanties acceptées pour ses opérations a modifié la composition de son bilan vers des actifs plus risqués. Réagissant aux tensions sur le marché des dettes souveraines et aux difficultés des banques, la BCE a intensifié, en 2010, son utilisation des politiques non-conventionnelles. La *forward guidance* sur les taux d'intérêt, divulguée en juillet 2013, illustre, pour la première fois dans la zone euro, l'utilisation de la communication comme instrument de politique monétaire non-conventionnel.

Le cadre institutionnel unique de la BCE pose des défis importants à la conduite de la

c. Fixed Rate tender with Full Allotment.

politique monétaire. Tout d'abord, la zone euro, composée de 11 États membres lors de sa création le 1er janvier 1999, regroupe désormais 19 États, tous membres de l'Union Européenne. C'est la plus grande union monétaire en population et en nombre d'États. Pour garantir une mise en œuvre équitable de la politique monétaire, l'article 123 du Traité sur le fonctionnement de l'Union européenne interdit le financement monétaire direct de la dette publique et l'accès privilégié au financement. Une augmentation de la base monétaire «classique» par l'achat d'obligations d'État est donc impossible. Deuxièmement, la fragmentation des marchés financiers de la zone euro s'est intensifiée au cours des deux périodes de stress, autour de la chute de Lehman Brother et pendant la crise de la dette souveraine. Elle peut être définie comme une situation dans laquelle les coûts de financement des agents économiques sont déterminés par les segments de marché et le pays d'origine d'un emprunteur plutôt que par ses fondamentaux sous-jacents. Cette fragmentation a gravement compromis la transmission de la politique monétaire, car les taux d'intérêt appliqués sur les prêts bancaires ne s'expliquaient pas seulement par les taux de politique monétaire, mais également par leurs homologues souverains. [d]

Tenant compte de la gamme limitée d'actions et de marchés financiers fragmentés, l'objectif de cette thèse empirique est d'évaluer les canaux de transmission des politiques monétaires conventionnelles et non-conventionnelles de la BCE et leurs effets sur les marchés financiers et sur l'économie. En raison de la fragmentation financière, les institutions monétaires et financières réagissent de manière asymétrique aux décisions des banques centrales en fonction de leur pays d'origine. Comme les décisions des banques sur l'émission de prêts bancaires sont liées à leurs coûts de financement, la canal de transmission de la politique monétaire par les prêts bancaires est un important mécanisme de transmission des décisions de politique monétaire dans l'union monétaire. Le premier chapitre de cette thèse porte sur ce mécanisme. Il étudie l'évolution des activités de 15 institutions financières européennes sur le marché des prêts syndiqués et les

d. Voir Coeuré, 2014 pour une discussion.

réactions aux politiques conventionnelles et non-conventionnelles utilisées par la BCE. Conçue comme une banque centrale transparente et responsable, la communication de la BCE se doit d'informer le public de ses décisions et des processus qui y amènent. Cette communication est de la plus haute importance dans une union monétaire avec des pays hétérogènes, en termes de situations économiques et de cultures. Lors de conférences de presse régulières, [e] la BCE transmet aux participants du marché son point de vue sur les perspectives économiques et détaille ses décisions de politique monétaire. Le deuxième et le troisième chapitre de cette thèse étudient le canal des signaux de la politique monétaire. Le deuxième essai se concentre sur la communication des décisions de politique monétaire lors des conférences de presse mensuelles ainsi que sur leurs effets sur la prévisibilité des décisions de politique monétaire et sur les rendements et la volatilité des marchés financiers. Le dernier essai se concentre exclusivement sur l'utilisation d'une *forward guidance* sur le taux d'intérêt en juillet 2013, une communication non-conventionnelle de la banque centrale fournissant des informations sur les futurs taux d'intérêt à court terme. Cet essai étudie l'efficacité de cette communication et sa capacité à baisser les taux d'intérêt attendus par les acteurs du marché.

Le reste de cette introduction est organisé comme suit : la section suivante introduit le lecteur aux principaux concepts et définitions relatifs à cette thèse. Elle se concentre sur les canaux de transmission de la politique monétaire, puis détaille les différentes formes de politiques monétaires non-conventionnelles. La dernière section présente les trois essais et leur contribution aux littératures financières et économiques.

e. À partir de janvier 2015, la BCE a réduit la fréquence de ses réunions du Conseil d'administration de quatre semaines à six semaines.

Concepts et définitions

La politique monétaire est le processus par lequel l'autorité monétaire d'un pays, banque centrale ou caisse d'émission monétaire, contrôle l'offre de monnaie et régule le taux d'inflation pour assurer la stabilité des prix et générer de la confiance dans la monnaie. Depuis sa création en 1999, la BCE utilise un régime de ciblage d'inflation.[f] Son objectif est défini dans le Traité sur le fonctionnement de l'Union européenne, par l'article 127 (1) : "L'objectif principal du Système européen de banques centrales est de maintenir la stabilité des prix". La BCE cible explicitement "un taux d'inflation inférieur, mais proche de 2% à moyen terme", l'inflation étant mesurée par l'indice harmonisé des prix à la consommation. Pour atteindre son objectif, la banque centrale contrôle l'offre de monnaie à l'aide du taux d'intérêt de court terme. Les relations entre les taux de court terme, les agrégats économiques et les objectifs de la politique monétaire (stabilité des prix pour la BCE) sont détaillés par les mécanismes de transmission de la politique monétaire (Mishkin, 1995). Toutefois, dans des *circonstances exceptionnelles*, les changements de taux de politique à court terme peuvent être insuffisants pour atteindre l'objectif de la banque centrale (Smaghi, 2009). Deux situations peuvent nécessiter l'utilisation de politique non-conventionnelles. Tout d'abord, un choc économique peut exiger que les taux d'intérêt nominaux soient proches de zéro. Si la situation économique exige une stimulation monétaire supplémentaire, la banque centrale, contrainte par borne inférieure limitant les taux d'intérêt nominaux à zéro, ne pourra pas baisser son taux directeur. Deuxièmement, les mécanismes de transmission peuvent être altérés. Un changement du taux d'intérêt à court terme peut ne pas affecter les conditions de crédit des gouvernements, entreprises ou ménages. Pour surmonter cette difficulté, les banques centrales devront utiliser des instruments influençant l'économie sans passer par le marché interbancaire.

Cette section présente une brève revue de la littérature sur les mécanismes de transmis-

f. Voir Svensson (1999), Svensson (2010) et Woodford (2012a) parmi d'autres pour plus de détails sur le ciblage de l'inflation.

sion de la politique monétaire. Dans un second temps, elle présente les différents types de politiques non-conventionnelles.

Canaux de transmission de la politique monétaire

La théorie économique différencie cinq canaux de transmission de la politique monétaire : le taux d'intérêt, le taux de change, le prix des actifs, le canal du crédit (décomposé en canal du bilan et des prêts bancaires), et le canal des signaux.
Le premier canal de transmission d'une décision de politique monétaire à la production économique et au niveau des prix passe par le taux d'intérêt. Dans le modèle IS/LM développé par Hicks (1937), explication mathématique de la théorie Keynes (1936), une politique monétaire restrictive entraîne une augmentation des taux d'intérêt nominaux et réels, augmentant les coûts d'emprunt et du capital. [g] Les coûts (prix du capital) augmentant, les investissements diminueront. La demande globale diminuera donc, entrainant une diminution de la production nationale et du niveau des prix. Apportant des preuves empiriques du canal du taux d'intérêt, Mishkin (1981) montre que la croissance monétaire réduit les taux d'intérêt réels entre 1931 à 1979 aux États-Unis. Taylor (1995) quantifie les changements de la production réelle en réponse aux changements de la politique monétaire. En mettant l'accent sur la zone euro, des études de Smets & Wouters (2003) ainsi que Angeloni et al. (2003) démontrent l'importance du canal de taux d'intérêt pour la transmission de la politique monétaire.

Le mécanisme de transmission de la politique monétaire par le taux de change est expliqué dans le modèle Keynesian IS/LM en économie ouverte développé par Mundell (1963) et Fleming (1962). Dornbusch (1976) étend ce modèle en mettant l'accent sur l'effet à long terme de la politique monétaire. Selon la parité des taux d'intérêt, une politique monétaire nationale restrictive augmente le taux d'intérêt réel au-dessus de

g. Le capital est défini par les investissements à long terme des entreprises et les achats de maisons des ménages et la consommation de biens durables (voir Calza et al. (2013) pour une étude de l'impact de la politique monétaire sur le financement du logement dans les économies développées).

sa contrepartie étrangère. En régime de change flottant, pour équilibrer les entrées de capitaux, la monnaie nationale devrait s'apprécier. Le coût des biens domestiques en devises étrangères augmentant, les exportations nettes diminuent. Cela s'accompagne également d'une diminution du niveau des revenus et des prix. En régime de change fixe, Obstfeld & Rogoff (1995) décrivent ce mécanisme de transmission comme inefficace [h] :

> *La tentative du gouvernement d'augmenter la masse monétaire échoue, car ses acquisitions d'obligations nationales sont compensées par ses pertes en réserves de change. Et un gouvernement engagé dans une régime de change fixe n'a pas d'autre choix que de permettre ces pertes de réserve : s'il refusait de racheter l'excédent de monnaie, la monnaie locale se déprécierait.*

À l'aide d'un modèle d'équilibre étalonné pour la zone euro, Smets & Wouters (2003) illustrent l'appréciation du taux de change réel suite aux chocs de politique monétaire. Cette appréciation est suivie d'une diminution des exportations nettes. Campa & Goldberg (2005), étudiant tous les pays de l'OCDE entre 1980 et 2002, fournissent des preuves empiriques de la relation entre taux de change et prix des importations.

Le canal du prix des actifs repose sur deux théories développées au début des années 70, le ratio q de Tobin (1969) et le modèle de consommation à vie de Modigliani. Le q de Tobin est la relation entre la valeur boursière d'une entreprise et le coût de remplacement de son capital physique. Lorsque ce ratio est élevé, les investissements sont peu coûteux par rapport aux valeurs de marché des entreprises. Elles ont donc tendance à émettre des actions pour financer leurs projets de long terme. D'autre part, lorsque le ratio q est faible, pour augmenter leur capital, les entreprises envisagent des fusions ou des acquisitions. Une politique monétaire restrictive diminue les prix des obligations et augmente les cours des actions. La théorie keynésienne explique cette relation par l'attractivité relative des obligations par rapport aux actions alors que les monétaristes

h. Voir l'"Impossible Trinité" ou Obstfeld & Taylor (2007) "Trilemma" : une nation ne peut pas avoir en même temps un régime de change fixe, une mobilité parfaite du capital et une politique monétaire indépendante.

l'attribuent à la diminution de la demande des stocks et à une diminution des flux de trésorerie attendus des entreprises. Par conséquent, une politique monétaire restrictive diminuera les prix des actifs et diminuera le q de Tobin. Les investissements sont moins élevés, les entreprises étant dans l'impossibilité d'émettre des actions à un prix élevé. Finalement, le coût des investissements augmente, réduisant leur nombre et la croissance économique. La deuxième théorie expliquant le canal du prix des actifs est basée sur le modèle de consommation à vie de Ando & Modigliani (1963) et Modigliani (1971). La consommation d'un individu au cours de sa vie s'explique par son capital humain (dotation), son capital réel et sa richesse financière. Une politique monétaire restrictive entraînera une diminution des prix des actifs, puis une diminution de la richesse des ménages. [i] On observera donc une diminution de la consommation intertemporelle ainsi que de la production nationale. Bien que les liens entre la politique monétaire et les prix des actifs soient largement prouvés dans la littérature[j], Goodhart & Hofmann (2000) et Bernanke & Gertler (2001), entre autres, soulignent que les banques centrales ne devraient pas cibler les prix des actifs pour définir leur position monétaire.

Le canal de crédit décrit l'effet de la politique monétaire sur l'offre de crédit des institutions financières aux agents économiques. Selon Bernanke & Gertler (1995), cette transmisison peut être décomposée en deux sous-canaux différents : le canal de prêt bancaire et le canal du bilan des banques. [k] Le principal défi de cette littérature est de différencier une variation de l'offre de crédit d'une modification de la demande de crédit qui peuvent se produire de manière concomitante (Bernanke et al. (1996)).
En raison d'une asymétrie d'information et des problèmes de sélection adverse entre les

i. Meltzer (1995) souligne l'importance non seulement des prix des actions, mais aussi des prix des terrains et d'autres biens durables.

j. Voir Bordo & Landon-Lane (2013) et Galí (2014) pour une littérature récente, et Bekaert et al. (2013) pour un focus l'incertitude des marchés boursiers.

k. Van den Heuvel et al. (2002) considère un troisième mécanisme : le canal du capital des banques. Étant donné que les variations du capital de la banque affectent ses exigences de fonds propres fondées sur le risque des Accords de Bâle, et parce que les banques sont assujetties au risque de taux d'intérêt, un changement des taux directeurs influencera les prêts des banques faiblement capitalisées (Gambacorta & Mistrulli, 2004).

prêteurs et les emprunteurs, les banques sont un intermédiaire indispensable entre les fournisseurs de liquidité et les gestionnaires de projets d'investissement. Cet argument est particulièrement vrai pour les petites entreprises qui ne peuvent pas accéder directement aux marchés financiers. Une politique monétaire restrictive entraînera une diminution des dépôts bancaires et, par la suite, des prêts bancaires en raison des besoins en réserves (Bernanke & Blinder, 1988). À mesure que les prêts bancaires diminuent, les investissements et la production nationale devraient diminuer. Kashyap & Stein (1995) et Kashyap & Stein (2000), travaillant sur les banques individuelles, classent les institutions financières américaines en fonction de leur actif. Leurs études empiriques soutiennent l'existence du canal des prêts bancaires. Il est particulièrement important pour les petites banques disposant de bilans moins liquides, une politique monétaire restrictive conduisant alors à une diminution des activités de prêt. Kashyap et al. (1997) fournissent une revue de la littérature des études empiriques dans la zone Euro pour soutenir l'existence de ce canal, en accord avec Kishan & Opiela (2000), Altunbas et al. (2002) et Disyatat (2011), parmi d'autres.

Le canal des bilans se concentre sur la valeur nette des entreprises. Dans le cas des entreprises à faible valeur nette, le prêteur s'inquiète de la possibilité d'une sélection adverse et d'un risque moral (Stein, 1998). Ces deux problèmes tendent à diminuer les prêts émis, et comme une politique monétaire restrictive entraîne une baisse du prix des actifs, elle entraînera également une diminution de la valeur nette des entreprises, ce qui réduira d'autant plus les investissements. Une modification de la politique monétaire, influant sur les prêts bancaires et les flux de trésorerie des ménages, impactera également le marché du logement et l'achat de biens durables des ménages (Bernanke & Gertler, 1995). Même si les primes moyennes[1] des prêts n'augmentent pas, en raison d'une *fuite vers les actifs de qualité*, l'offre de crédit continue de diminuer (Bernanke et al. (1996)). Les deux sous-chaînes impliquent également un rééquilibrage des portefeuilles de prêts bancaires, vers des prêts à court terme, et vers des entreprises de taille plus importantes

l. La prime correspond au taux d'intérêt supplémentaire payé par une firme. Elle s'additionne au taux de référence.

et plus sûres. La difficulté principale dans les estimations empiriques est la distinction entre ces deux canaux du crédit distincts mais proches. Même si la littérature fournit de nombreuses preuves empiriques de l'existence du canal de crédit et de son importance pour les décisions de politique monétaire (voir, entre autres, Bernanke (2007) pour un discours), une identification claire des deux chaînes nécessite plus d'investigation (Jiménez et al., 2012).

Comme les attentes sont un facteur clé des décisions économiques des agents, les signaux (sous la forme d'informations) envoyés par la banque centrale au public peuvent les influencer. Ces attentes concernent les futures décisions de politique monétaire, la rareté relative d'actifs, leurs risques et leurs liquidités (Borio & Disyatat, 2010). L'influence de la communication sur les anticipations des acteurs du marché est analysée dans le canal de signalisation, également nommé canal des attentes dans la terminologie utilisée par la littérature étudiant les interventions des banques centrales sur le marché des devises (Mussa, 1981; Sarno & Taylor, 2001). Dans leur article renommé, Blinder et al. (2008) traitent des différentes formes de communications des banques centrales et de leurs effets empiriques sur les marchés financiers, les attentes, et sur l'économie. La banque centrale informe le public de ses intentions par des conférences de presse, des discours, des notes ou d'autres formes de communication. Andersson et al. (2006) examinent les effets de la communication de la Riksbank suédoise sur la structure par terme du taux d'intérêt et trouve que toutes les formes de communication attendues et inattendues affectent les taux d'intérêt à court terme. [m] Bauer & Rudebusch (2014), ainsi que Christensen & Rudebusch (2012), mettent en évidence l'importance du canal de signalisation pour expliquer l'abaissement des taux d'intérêt à long terme après les annonces du programme d'achats d'actif à grande échelle (*Large-Scale Asset Purchases*, LSAP) de la Réserve Fédérale.

m. Fleming & Remolona (1999) a précédemment montré la modification la structure par terme du taux d'intérêt du fait de la publication de données macroéconomiques.

Pour influencer l'offre de monnaie dans l'économie réelle, le point de départ des canaux de transmission, les banques centrales utilisent les taux d'intérêt à court terme. Une politique monétaire restrictive (expansionniste) est mise en œuvre en augmentant (diminuant) les taux courts. Pour la mise en oeuvre de telles politiques, les banques centrales interagissent avec les institutions monétaires et financières (IMF) grâce à leurs opérations de marché ouvertes (OMO), fournisseuses de liquidité. Alors que la banque centrale peut influer directement sur les taux d'intérêt interbancaires à court terme, les IMF ajustent les taux d'intérêt à plus long terme au coût des liquidités de court terme, influençant ainsi le coût des prêts aux entreprises et aux ménages. Pour exécuter sa politique monétaire, la BCE utilise quatre formes d'OMO (ECB, 2006). Les opérations principales de refinancement sont des transactions inversées hebdomadaires avec une échéance d'une semaine. Elles signalent au marché la position de la politique monétaire. Les opérations de refinancement à long terme sont également des opérations inversées, mais généralement d'une échéance de trois mois. Ils se déroulent à une fréquence mensuelle en fournissant de la liquidité à plus long terme. Les deux derniers OMO sont des opérations de réglage fin, soit des transactions inversées ou directes utilisées pour lisser les fluctuations de liquidité inattendues, soit des opérations structurelles, permettant d'ajuster la position structurelle de l'Eurosysteme sur le secteur financier.

Alors que les IMF peuvent obtenir des liquidités auprès de la banque centrale, celles-ci sont également échangées entre banques sur le marché interbancaire. Il s'agit d'un marché de gré à gré au jour le jour où une IMF peut emprunter ou prêter des liquidités de court terme à des échéances entre une nuit et un mois pour répondre aux besoins réglementaires (réserves). Le gel du marché bancaire interbancaire, débuté en août 2007 avec la décision de BNP Paribas d'arrêter les retraits pour ses hedge funds de prêts hypothécaires puis, amplifié avec la faillite de Lehman Brothers,[n] a gravement altéré la transmission de la politique monétaire (Drudi et al., 2012).

Avec des IMF craignant le manque de solvabilité des contreparties et les risques de

n. Voir Vento & La Ganga (2010) pour une description du fonctionnement du marché interbancaire pendant la crise financière.

défaut, la liquidité a disparu du marché interbancaire. Au lieu de financer l'économie réelle ou d'autre IMF dans le besoin, celles-ci ont retenu les fonds obtenus en tant que réserves à la facilité de dépôt de la BCE (Acharya & Merrouche, 2012). Les IMF étaient disposées à recevoir une rémunération plus faible de leurs liquidités excédentaires plutôt que de prêter à d'autres institutions perçues comme risquées. Comme les instruments conventionnels n'ont pas réussi à restaurer le fonctionnement du marché interbancaire ou les canaux de transmission de la politique monétaire, la BCE a dû recourir à des instruments non-conventionnels.

Politiques monétaires non-conventionnelles

En théorie, lorsque (i) les taux d'intérêt nominaux sont proches ou à borne inférieure de zéro (*zero lower bound*, ZLB), (ii) l'économie est dans une trappe de liquidité [o] (Krugman, 1999), ou (iii) les mécanismes de transmission sont compromis, un stimulus supplémentaire de la politique monétaire nécessite alors l'utilisation de mesures non-conventionnelles. Les banques centrales peuvent utiliser trois instruments non- conventionnels pour abaisser les taux d'intérêt à long terme lorsqu'ils sont proches de la ZLB (Clouse et al., 2003; Bernanke & Reinhart, 2004) : s'engager à maintenir dans le futur un taux d'intérêt bas, changer la composition du bilan de la banque centrale, et augmenter la taille du bilan de la banque centrale.

Tout d'abord, pour abaisser le taux d'intérêt à long terme, la banque centrale peut influencer les attentes des acteurs de marché sur les futurs taux d'intérêt nominaux de court terme (Svensson, 2003; Eggertsson & Woodford, 2003). Cette approche s'appuie sur la communication de la banque centrale. Lorsque le taux est proche de la ZLB, et afin de lutter contre la déflation, la banque centrale peut s'engager à une longue période de faible taux d'intérêt nominaux de court terme en utilisant le canal de transmission de

o. Une trappe de liquidité est définie comme un état de l'économie dans lequel une augmentation de l'offre de monnaie n'a aucun effet sur les variables économiques.

la signalisation. Ce type de guidage est décrit comme "odysséen"[p] par Campbell et al. (2012), par opposition à un guidage sans engagement "delphique."[q] En conséquence, la banque centrale, afin de changer les attentes, doit renforcer sa réputation de combattant de la déflation. Ce message contredit l'objectif de la banque centrale (maintenir la stabilité des prix) en créant un problème d'incohérence temporelle. Eggertsson (2006) décrit donc cet outil comme un engagement à être irresponsable. Traitant de la politique de la Banque du Japon (BoJ) au début des années 2000, Bernanke et al. (2004), Baba et al. (2005) et Ugai (2007) témoignent de l'efficacité des engagements de la banque centrale dans l'abaissement des taux d'intérêt souverains à long terme.

Deuxièmement, les politiques d'assouplissement qualitatif sont liées au bilan de la banque centrale. Elles impliquent un changement de sa composition, principalement vers des actifs plus risqués. Les banques centrales acceptent traditionnellement seulement des collatéraux de haute qualité (classés AAA) pour leurs opérations. Mais avec une incertitude financière accrue, les banques centrales ont accepté pendant la crise des actifs plus risqués, éliminant ainsi certains risques du bilan des banques, en utilisant un assouplissement qualitatif *indirect* (Smaghi, 2009). En achetant et en vendant certains titres, dans un marché financier incomplet et avec frictions, la banque centrale peut affecter son prix (ou son rendement), sa prime de risque et de liquidité (Bernanke & Reinhart, 2004). De plus, les agents économiques qui vendent les titres maintenant acceptés à la banque centrale auront des soldes monétaires plus importants et réaffecteront alors leurs portefeuilles conduisant à des changements de prix relatifs (Friedman & Schwartz, 1963). Cependant, Woodford (2012b) contredit l'utilisation de l'assouplissement qualitatif, arguant que son efficacité ne s'explique que par les signaux envoyés au marché relatifs à de futures politiques monétaires accommodantes. En décembre 2011, la BCE a réduit le niveau de notation pour certains titres adossés à des actifs (*asset-backed securities*) afin de les inclure dans les garanties éligibles. Pour modifier la composition de son bilan, une

p. Comme Ulysse demandant à être attaché au mât par ses hommes pour entendre la chanson des sirènes, la banque centrale se lie à un comportement donné.

q. En ligne avec les oracles obscures et vagues de la Pythie de Delphes.

banque centrale peut également *directement* acheter des actifs plus risqués au cours de leurs achats directs. Dans le LSAP, la Réserve Fédérale a acheté non seulement les titres américains les mieux notés, mais aussi des titres de créances hypothécaires garantis par les agences Fannie Mae et Freddie Mac alors en grande difficulté.

Enfin, la banque centrale peut utiliser son bilan pour orienter les taux d'intérêt à court et long terme avec une expansion de la taille du bilan, généralement appelé assouplissement quantitatif (QE, (Bernanke & Reinhart, 2004)). Dans sa forme *directe*, la banque centrale augmente la taille de son bilan grâce à l'achat direct d'actifs financiers tels que des obligations d'État. La banque centrale augmente ses prêts aux banques en échange de garanties dans la forme *indirecte* (Smaghi (2009)). Alors que la BoJ dans les années 2000 et la Banque d'Angleterre en 2008 ont utilisé un assouplissement quantitatif, la Réserve Fédérale et les programmes de la BCE[r] prennent la forme de politique d'assouplissement du crédit. Borio & Disyatat (2010) définissent les politiques d'assouplissement du crédit comme des opérations ciblant des segments spécifiques de la dette privée ou du marché des valeurs mobilières, tandis que l'assouplissement quantitatif se focalise uniquement sur l'augmentation de la taille du bilan sans tenir compte du type de titres achetés. Le LSAP de la Réserve Fédérale, le CBPP de la BCE, ou les programmes d'achat d'ABS de la BCE sont des exemples de politiques d'assouplissement du crédit. La Facilité d'Achat d'Actifs (*Asset Purchases Facility*) de la Banque d'Angleterre, mise en œuvre à partir de janvier 2009 en tant que programme d'assouplissement du crédit, a été transformée en mars 2009 en un programme traditionnel d'assouplissement quantitatif visant à accroître la base monétaire. Borio & Disyatat (2010) étiquette l'achat de titres du secteur public, tels que le programme d'achat du secteur public de la BCE ou l'achat par la Fed de bons du Trésor à long terme annoncés en mars 2009 via le LSAP, comme de la quasi-gestion de la dette.

r. Pour la BCE, une forme pure de QE est utilisée depuis 2015 avec le Programme d'achat du secteur public.

La littérature empirique fournit, grâce à l'étude de différentes politiques, un large aperçu des effets de l'assouplissement quantitatif sur (i) les prix des actifs ou (ii) les agrégats macroéconomiques. Premièrement, Gagnon et al. (2011) expliquent la diminution du rendement des bons du Trésor américain à 10 ans, suite de l'annonce du LSAP par la Fed, [s] par des changements dans le portefeuille de prêts des banques. D'Amico & King (2013) différencient un effet *stock*, mouvement le long des courbes de demande de bon du Trésor, et un effet *flow*, réponse des prix aux opérations d'achat en cours, afin d'expliquer l'abaissement des rendements américains. Krishnamurthy & Vissing-Jorgensen (2011) accordent une attention particulière à l'effet du QE de la Fed sur les rendements des obligations non souveraines. Ils testent plusieurs canaux de transmission et soulignent l'importance du canal de signalisation et de la réduction de la prime de sécurité. Sur la Banque d'Angleterre, Joyce et al. (2011) étudient le programme d'assouplissement quantitatif lancé en mars 2009 et, conformément à Gagnon et al. (2011), rapportent une diminution des rendements des obligations souveraines à long terme du Royaume-Uni suite aux annonces d'assouplissement quantitatif. Christensen & Rudebusch (2012) comparent les programmes de la Fed et de la BoE. Alors que le LSAP de la Fed a influencé les attentes des participants sur le marché des taux d'intérêt futurs à court terme, le QE de la BoE a réduit la prime de terme, diminuant les taux à long terme. Ils expliquent ces deux effets distincts de l'assouplissement quantitatif par des différences dans les communications des banques centrales et dans la structure des marchés financiers. En regardant les politiques non-conventionnelles de la BCE avant le début de la crise de la dette souveraine, Fratzscher et al. (2016) montrent que les indices boursiers ont été positivement influencés par les mesures dans la zone euro. Les rendements souverains ont également diminué pour l'Italie, l'Espagne. Deuxièmement, en analysant les politiques de la BoJ entre mars 2001 et 2006, Ugai (2007) examine les études empiriques des effets macroéconomiques du QE au Japon. Il conclut que même si certaines études attestent d'une modification du portefeuille de prêts des banques, les effets proviennent principalement

s. Voir Bhattarai & Neely (2016) pour une enquête sur les effets des politiques non-conventionnelles de FOMC.

de la signalisation de ces politiques. Weale & Wieladek (2016) estiment que les politiques non-conventionnelles de la Fed ont augmenté le PIB réel de 0,62% et l'inflation de 0,58% par le rééquilibrage du portefeuille public et une diminution de l'incertitude financière. Pour la zone euro, Boeckx et al. (2017) trouvent des résultats similaires avec à la fois une augmentation de la production et des prix à la consommation. Cependant, la production des pays de la zone euro plus touchés par la crise financière, ou ayant un secteur bancaire plus faible, a tendance à moins bénéficier des politiques monétaires d'augmentation de la taille du bilan.

Objectifs et contributions de la thèse

L'objectif de cette thèse empirique est d'évaluer les canaux de transmission des politiques conventionnelles et non-conventionnelles mises en œuvre depuis 2008 par la BCE. Elle se concentre sur deux canaux distincts particulièrement pertinents pour la politique monétaire de la zone euro. Tout d'abord, parce que les coûts de financement des banques diffèrent selon leur pays d'origine ou leur structure, le canal du crédit bancaire et son efficacité peuvent influencer les décisions de la banque centrale dans une union monétaire. Le premier chapitre de cette thèse se concentre sur ce mécanisme. Deuxièmement, pour fournir une information équivalente à tous les pays, la BCE accorde une attention particulière à sa communication et aux signaux envoyés au public. Le deuxième et troisième chapitre de cette thèse étudient le canal de signalisation de la politique monétaire de la BCE. Cette section détaille les trois essais composant cette thèse avec une introduction à la question de recherche, un résumé de la méthodologie, des données et des résultats principaux.

Dans le premier essai "*The bank lending channel from the European syndicated loan market perspective*", nous, avec Aurore Burietz, étudions l'effet des politiques monétaires conventionnelles et non-conventionnelles de la BCE sur les prêts des banques entre 2004

et 2014. En utilisant 37 000 prêts syndiqués fournis par 15 institutions financières de la zone euro, nous estimons l'influence des politiques monétaires sur les activités de prêt des banques, nommée canal du prêt bancaire. Nous soutenons que les politiques non-conventionnelles influent sur les opérations de financement à court terme des institutions financières. Une banque moins dépendante de ses emprunts à court terme prêtera davantage sur le marché des prêts syndiqués. Sur la base d'une analyse transversale avec des effets fixes par prêteur, nous expliquons les montants des prêts par un ensemble de critères microéconomiques et par les politiques monétaires. Nous contrôlons des caractéristiques de l'emprunteur grâce à son industrie, sa cote de crédit et son emplacement (être situé dans le même pays que le prêteur peut suggérer un biais domestique). Nous prenons en considération les stratégies spécifiques de la banque qui peuvent affecter les prêts à une entreprise. Nous incluons plusieurs autres contrôles détaillés dans le chapitre, tels que les caractéristiques du prêt avec sa maturité, *all-in spread*, le type et s'il est sécurisé. Nous prenons également en compte les conditions économiques en utilisant le PIB et la demande de crédit via la *Bank Lending Survey* de la BCE. D'un côté, nous trouvons que les banques qui se financent via des emprunts à court terme sont plus contraintes dans leurs activités de prêt. De l'autre côté, les banques avec des niveaux élevés de dépôts de clients accordent des prêts syndiqués plus importants. Dans la deuxième partie de l'essai, nous étudions comment la capitalisation de la banque (mesurée avec le ratio du capital, définie par les capitaux propres ordinaires d'une banque sur son actif total) influe sur ses activités de prêt. Nos résultats témoignent de l'existence d'un canal de prêt bancaire. Les politiques de la BCE non-conventionnelles réduisent avec succès les contraintes de financement des banques, alors que les mesures conventionnelles sont inefficaces. La politique monétaire accommodante de la BCE facilite l'accès des banques à d'autres sources de financement, ce qui réduit les contraintes imposées par un niveau élevé d'emprunts à court terme. Nous montrons que les mesures non-conventionnelles appuient l'offre de crédit avec un impact positif sur les montants des prêts, mais aussi que cet impact positif est plus fort pour les banques étant plus faiblement capitalisées.

Nos résultats sont robustes à un contrôle des valeurs aberrantes et à l'utilisation d'effets fixes pour l'emprunteur. Ce chapitre contribue à la littérature existante sur le canal du prêt bancaire en étudiant pour la première fois, à notre connaissance, toutes les politiques non-conventionnelles de la BCE et leurs effets sur les institutions financières de la zone euro. En outre, notre analyse comprend un ensemble de critères microéconomiques généralement absents des recherches sur les canaux de transmission de la politique monétaire.

Dans le deuxième essai, "*The signaling channel : a new measure of the ECB communication*", nous, avec Thomas Renault, étudions la communication de la BCE et le canal de signalisation. Pour une banque centrale crédible, les agents anticipent la mise en œuvre des politiques monétaires et ajustent leur comportement en conséquence (ainsi que les prix des actifs et les taux d'intérêt) juste après l'annonce et avant sa mise en œuvre. Cependant, pour étudier la communication de la banque centrale en finance traditionnellement quantitative, les chercheurs doivent quantifier le contenu qualitatif des discours ou des conférences de presse. La première partie de cet article introduit une nouvelle approche pour mesurer le contenu des conférences de presse de la BCE en identifiant les phrases liées à deux thématiques : (i) perspectives économiques et (ii) décisions de politique monétaire. Grâce à une classification manuelle des 7700 phrases des déclarations introductives entre 2006 et 2014, nous calculons pour chaque groupe de mots sa probabilité d'appartenir à l'une des deux thématiques avec une inclinaison donnée (positive, neutre ou négative). Ensuite, pour chaque conférence de presse, nous agrégeons les probabilités des groupes de mots en un score unique spécifique à chaque sujet. Dans la deuxième partie de l'essai, nous comparons notre nouvelle mesure à deux méthodes existantes en utilisant le dictionnaire de Loughran & McDonald (2011) et la liste de mots de Apel & Blix-Grimaldi (2012). En utilisant une règle proposée par Taylor (1993), nous déterminons la prévisibilité des futures décisions de politique monétaire avec un modèle probit ordonné. Nous considérons soit les changements du taux directeur, soit,

de manière jointe, les changements des taux directeurs et les annonces de politiques non-conventionnelles comme mesures des décisions de politique monétaire. Ensuite, nous étudions la prévisibilité des rendements des marchés financiers (Eurostoxx 50) et leur volatilité (Vstoxx) les jours qui suivent une conférence de presse. Notre nouvelle mesure reflète mieux la communication non-conventionnelle de la BCE, en particulier suite à la crise de la dette souveraine en 2011. Compte tenu d'une règle de Taylor avec des variables prospectives, notre indicateur de la communication de la BCE améliore la compréhension des décisions de politique monétaire contemporaines. En comparant les $Pseudo - R^2$, il modifie la prévisibilité des futures décisions de politique monétaire de 7,5 à 15,1 points lorsque la communication est mesurée avec le dictionnaire de Loughran & McDonald (2011), et de 6,5 à 11,7 points lorsque la communication est mesurée avec la liste de mots d'Apel & Blix-Grimaldi (2012). Nous constatons également que les anticipations d'inflation expliquent de manière significative les décisions futures en matière de politique monétaire. En mettant l'accent sur les prix des actifs, nous ne trouvons aucune prévisibilité des cours des actions le jour suivant d'une conférence de presse, mais notre mesure des perspectives économiques et de la politique monétaire explique, avec une significativité de respectivement 5% et 10%, la volatilité de l'Eurostoxx du jour suivant. Les communications accommodantes tendent à prédire une volatilité le jour suivant plus faible alors qu'une perspective économique positive diminue la volatilité des marchés boursiers. Ce chapitre contribue à la littérature existante en fournissant une mesure spécifique et accessible au public du contenu de la conférence de presse de la BCE pour la période 2008-2014. Cette mesure, pour la première fois, considère les communications de politique monétaire non-conventionnelle ainsi que les probabilités associées aux groupes de mots. Nous montrons que cette approche améliore considérablement les mesures actuelles du contenu ainsi que la prévisibilité des décisions de politique monétaire et la volatilité des marchés boursiers le jour suivant la conférence de presse.

Alors que le deuxième essai considère toutes les conférences de presse de la BCE, le

troisième chapitre "*The effects of the ECB's Forward Guidance on overnight index swaps*" se concentre sur l'utilisation d'une *forward guidance*. La communication, non conventionnelle pour la BCE, a été transmise lors de la conférence de presse du 4 juillet 2013 : "*The Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time.*"[t] Pour estimer l'effet de cet engagement de la banque centrale à maintenir des taux d'intérêt nominaux à des niveaux bas, nous utilisons les *overnight index swaps* (OIS). Étant donné que la jambe variable du swap est le taux d'intérêt interbancaire de la zone euro (EONIA), les OIS mesurent les attentes des agents économiques relatives aux futurs taux directeurs avec des échéances comprises entre 2 mois et 10 ans. Pour quantifier l'influence du guidage, il faut séparer le contenu macroéconomique de la nouvelle de l'effet lié à l'engagement de la banque centrale. Pour ce faire, nous modélisons les variations quotidiennes des taux OIS avec un ARMAX (1,1). Nous contrôlons pour l'effet lié à l'information macroéconomique au travers des anticipations d'inflation de moyen terme. Nous considérons également comme une variable indépendante les remboursements des LTRO, car la diminution de la liquidité sur le marché interbancaire pourrait affecter les anticipations de taux d'intérêt. Nous prenons également en compte d'autres décisions de politique monétaire annoncées par la BCE et les publications macroéconomiques de la zone euro et des États-Unis. Nous quantifions l'effet de la *forward guidance* et sa «ferme» réitération de janvier 2014 avec une étude d'événements. Les rendements anormaux sont obtenus à partir des prévisions du modèle ARAMX (1,1) décrit ci-dessus. Nos résultats suggèrent que les conditions de liquidité affectent de manière significative les taux OIS pour les échéances de court terme (2 à 6 mois), tandis que les échéances à plus long terme (2 à 10 ans) s'expliquent par les anticipations d'inflation. Une diminution de la liquidité du marché et une augmentation des anticipations d'inflation ont toutes deux tendances à augmenter les taux OIS pour les échéances données. Les annonces de remboursements des LTRO ont également considérablement augmenté les attentes du marché en matière de taux directeurs futurs. La *forward guidance* a eu

t. La BCE ne fournissant une traduction officielle des conférences de presse que depuis Janvier 2015, nous avons décidé de garder la communication dans sa version originale.

un effet, lié à l'engagement de la banque centrale, négatif sur les échéances entre dix mois et trois ans, indépendamment de l'effet lié aux mauvaises nouvelles macroéconomiques. La valorisation, par les participants au marché, du guidage au travers des taux OIS implique que, le jour de la *forward guidance*, les taux de politique étaient déjà attendus à des niveaux bas pendant six mois. Ce chapitre contribue à la littérature existante en fournissant, à notre connaissance, la première estimation quantitative de la *forward guidance* de la BCE sur les anticipations de taux d'intérêt. Nous estimons également la vision du marché sur la durée de " *extended period of time "* de taux bas. De manière empirique, ce chapitre fournit également une nouvelle modélisation des taux OIS en tenant compte des conditions de liquidité de la zone euro.

General introduction

"Though many macroeconomists would profess little uncertainty about it, the profession as a whole has no clear answer to the question of the size and nature of the effects of monetary policy upon aggregate activity." Sims (1992)

Context of the thesis

Less than 10 years after its creation in 1999, the European Central Bank (ECB), along with other central banks, struggled in the wake of the financial shock in started in 2007. The bankruptcy of Lehman Brothers on September 15, 2008, followed by AIG's difficulties the next day dove the financial world into a crisis that Alan Greenspan aptly described as a "once in a century credit tsunami." [a]

After this initial shock, euro area governments used public spending to support both economic growth and the still struggling financial institutions. [b] Against the backdrop of increasing public debt, financial markets started to question several countries' financial sustainability. Greece, in particular, attracted considerable attention after a first revision of its public debt at the end of 2009. It was quickly followed in the turmoil by Ireland and Portugal. This second shock started the sovereign debt crisis in the euro area cha-

a. October 2008, Audition in front of the US Congress.

b. See Ureche-Rangau & Burietz (2013) for a list of public interventions in the euro area and United Kingdoms.

racterized by low economic growth, low inflation, and financial instability.
Under *normal circumstances*, central banks control the supply of money through conventional instruments : open market operations, permanent facilities, and reserve requirements. They set the target for the interbank overnight interest rate and adapt accordingly the quantity of liquidity alloted during open market operations. Reacting to the tensions in the financial system, the ECB decreased its main interest rate between October 2008 and May 2009 to reach the lowest level in its history. However, after September 2008, due to a frozen interbank market, shortage of liquidity, loss of confidence, and collapsing financial institutions, the monetary policy transmission in the euro area was severely impaired. Under thus *exceptional circumstances* of financial and economic turmoil, the ECB had to turn to non-standard monetary policy measures. The central bank ensured an unlimited supply of liquidity to financial institutions throughout, for all its refinancing operations, Fixed Rate tender procedures with Full Allotment (FRFA). It marks the introduction of unconventional monetary policy instruments in the euro area. The implementation of several programs increased the size of the ECB balance sheet by more than 700 billions between 2008 and 2010. At the same time, the extension of the range of collateral accepted for its operations altered the composition of its balance sheet toward riskier assets. Reacting to tensions in the sovereign debt market and to banks' difficulties, the ECB intensified its use of unconventional balance sheet policies in 2010. The *forward guidance* on interest rates disclosed in July 2013 illustrates, for the first time in the euro area, the use of communication as a non-standard monetary policy instrument.

The unique institutional framework of the ECB raises important challenges to the conduct of monetary policy. First, the euro area regrouped 11 members states at its creation on January 1st 1999 and is now composed of 19 states, all part of the European Union. It is the largest monetary union in number of states and population. To guarantee a fair implementation of monetary policy among countries, Article 123 of the Treaty on the Functioning of the European Union prohibits the direct monetary financing of public

debt and privileged access to funding. It restricts a "classical" increase of money supply through the purchase of government bonds. Second, the fragmentation of the euro area financial markets was intensified during the two periods of distress, around the fall of Lehman Brother and during the sovereign debt crisis. Financial fragmentation can be defined as a situation in which financing costs of economic agents are determined by both market segments and the country of origin of a borrower rather than its underlying fundamentals. This fragmentation seriously impaired the transmission of monetary policy as interest rates charged on bank loans were not only related to policy rates but also to their sovereign counterparts. [c]

Considering a constrained range of actions and fragmented financial markets, the objective of this empirical thesis is to assess the transmission channels of ECB standard and non-standard monetary policies and their effects on both financial markets and the economy. Because of the financial fragmentation, monetary and financial institutions react asymmetrically to central banks policy decisions depending on their country of origin. As banks lending behaviors are related to their financing costs, the bank lending channel is an important transmission mechanism of monetary policy decisions in the monetary union. The first essay of this thesis focuses on this mechanism. It studies the evolution of lending activities of 15 European financial institutions on the syndicated loan market and its reaction to the standard and non-standard policies used by the ECB.

Designed as a transparent and accountable central bank, the communication of the ECB explains to the public both its decisions and the processes explaining them. This communication is of utmost importance in a monetary union with heterogeneous countries, in terms of economic situations and cultures. Through regular press conferences, [d] the ECB provides market participants its view on the economic outlook and details its monetary policy decisions. The second and third essays of this thesis study the signaling

c. See (Coeuré, 2014) for a discussion.

d. Starting from January 2015, the ECB reduced the frequency of its Governing Council meetings from four weeks to six weeks.

channel of monetary policy. The second essay focuses on the communication of monetary policy decisions during monthly press conferences and their effects on the predictability of monetary policy decisions and on financial markets returns and volatility. The last essay concentrates exclusively on the use of *forward guidance* on interest rate in July 2013, a non-standard central bank communication providing information on future short-term interest rates. It discusses the effectiveness of such communication and its ability to lower market participants expected interest rates.

The remainder of this introduction is organized as follow : the next section introduces the reader to the main concepts and definitions relevant to this thesis. It focuses on the transmission channels of monetary policy and then details the different forms of unconventional monetary instruments. The last section presents the three essays and their contribution to financial and economic literatures.

Concepts and Definitions

The monetary policy is the process by which the monetary authority of a country, a the central bank or a currency board, controls the supply of money and regulates the inflation rate to ensure price stability and generate trust in the currency. Since its creation in 1999, the ECB uses an inflation targeting framework. [e] Its objective is defined in the Treaty on the Functioning of the European Union, Article 127 (1) : "The primary objective of the European System of Central Banks shall be to maintain price stability." The central bank explicitly targets "inflation rates below, but close to, 2% over the medium term" where inflation is measured through the Harmonised Index of Consumer Prices. To reach its objective, the central bank controls the supply of money using short term interest rates. The relations between short term policy rates, economic aggregates,

e. See Svensson (1999), Svensson (2010), and Woodford (2012a) among others for more details on inflation targeting.

and monetary policy objectives (price stability for the ECB) is explained by the transmission mechanisms of monetary policy (Mishkin, 1995). However, under *exceptional circumstances*, changes of short term policy rates may be insufficient to achieve the central bank objective (Smaghi, 2009). Two situations may require the use of non-standard policies. First, the economic shock may require the nominal interest rates to be close to zero. If the economic situation still requires an additional monetary stimulus, the central bank, constrained by the zero lower bound, will not be able to decrease its main interest rate. Second, the transmission mechanisms can be impaired. Changes of short term policy rate may not successfully influence the supply of money to governments, firms or households. To overcome this difficulty, central banks can resort to non-standard policies.

This section presents a brief literature on the transmission mechanisms of monetary policy. Then it introduces the different types of unconventional policies.

Transmission channels of Monetary Policy

The economic theory differentiates five channels for monetary policy transmission : the interest rate, the exchange rate, the asset pricing, the credit channel decomposed into balance sheet and bank lending, and the signaling channel.

The first transmission channel of a monetray policy decision to an economy output and price level goes through the interest rate. In the IS/LM model developed by Hicks (1937) used as a mathematical explanation of Keynes (1936) theory, a contractionary monetary policy leads to an increase in both nominal and real interest rates, increasing in costs of borrowing and capital.[f] As costs (or prices of capital) increase, investment will decrease. Then the aggregate demand decreases, and both the national output and price level decrease. As empirical evidence of the interest rate channel, Mishkin (1981) shows

f. Capital is defined as firms' long-term investments and households' houses purchases and consumption of durable goods (see Calza et al. (2013) for a recent focus on the impact of monetary policy on housing finance in developed economies).

how money growth reduced real interest rates for the period from 1931 to 1979 in the United-States. Taylor (1995) quantifies with an empirical model the changes in real output in response to shifts in monetary policy. Focusing on the euro area, studies from Smets & Wouters (2003) and Angeloni et al. (2003), demonstrate the importance of the interest rate channel for monetary policy transmission.

The exchange rate transmission mechanism of monetary policy is explained in the open-economy Keynesian IS/LM model developed by Mundell (1963) and Fleming (1962). Dornbusch (1976) extends the model by focusing on the long-term effect of the monetary policy. According to the interest rate parity, a domestic contractionary monetary policy increases the real interest rate above its foreign counterpart. Under a floating exchange rate, to balance capital inflow, the domestic currency should appreciate. because the cost of domestic goods in foreign currencies increases, and the net exports decline. This is also accompanied by a decrease in the income and price level. Under a fixed exchange rate, Obstfeld & Rogoff (1995) describes this transmission mechanism as ineffective[g] :

> *The government's attempt to increase the money supply fails, because its acquisitions of domestic bonds are exactly offset by its losses of foreign exchange reserves. And a government committed to a fixed rate has no choice but to allow these reserve losses : if it refused to buy back the excess supply of money, the home currency would depreciate.*

Using an equilibrium model calibrated for the euro area, Smets & Wouters (2003) illustrate the appreciation of the real exchange rate following monetary policy shocks. This appreciation is followed by a decrease in net exports. Campa & Goldberg (2005), studying all OECD countries between 1980 and 2002, provide empirical evidence of the relation between exchanges rates and imports prices.

g. See the "Impossible Trinity" or Obstfeld & Taylor (2007) "Trilemma" : a nation cannot have at the same time a fixed exchange rate, a perfect capital mobility, and an independent monetary policy.

The asset price channel is based on two theories developed in the early 70s, Tobin q and the Modigliani life-time consumption model. Tobin (1969) q ratio is the relation between the stock market value of a firm and the replacement cost of the physical capital of this firm. When this ratio is high, investments are cheap compared to the market values of the firms. Companies tend to issue equities to finance their long-term project. On the other hand, when the q ratio is low, to increase their capital, firms will consider mergers or acquisitions. A contractionary monetary policy decreases bond prices and increases stock prices. The Keynesian theory explains this relation through the relative attractiveness of bonds compared to stocks whereas monetarists attribute it to the decrease in the demand of stocks and a decrease in the expected firms cash flow. Therefore a contractionary monetary policy will decrease asset' prices and decrease Tobin q. Investments are lower as firms are unable to issue stocks at a high price ; thus, the cost of investments increases. The second theory explaining the asset price channel is based on Ando & Modigliani (1963) and Modigliani life-time consumption model (1971). The consumption of an individual over his life time is explained by his human capital (endowment), his real capital, and his financial wealth. A contractionary monetary policy will lead to a decrease in asset prices and then a decrease in household wealth. [h] It leads to a decrease in inter-temporal consumption along with the national output. While the links between monetary policy and asset prices are widely proved in the literature [i], Goodhart & Hofmann (2000) and Bernanke & Gertler (2001) (among others) emphasize that central banks should not target asset prices to define their monetary stance.

The credit channel describes the effect of monetary policy on the financial institution credit supply to economic agents. According to Bernanke & Gertler (1995), the supply of credit can be decomposed into two different sub-channels : the bank lending chan-

h. Meltzer (1995) emphasizes the importance not only of stock prices but also of land prices, and other durable goods.

i. See Bordo & Landon-Lane (2013) and Galí (2014) for a recent literature, and Bekaert et al. (2013) for a focus on stock markets uncertainty.

nel and the balance sheet channel.[j] A key challenge of this literature is to differentiate a change in the supply of credit from a change in the demand of credit that may also occur concomitantly (Bernanke et al., 1996).

Because of asymmetric information and adverse selection problems between lenders and borrowers, banks are a useful intermediate between liquidity providers and investment project managers. This argument is particularly true for small firms that cannot directly access financial markets. A tight monetary policy will lead to a decrease in bank deposits and, subsequently in bank loans because of reserve requirements (Bernanke & Blinder, 1988). As bank loans decrease, both investments and national output are likely to decrease. Kashyap & Stein (1995) and Kashyap & Stein (2000), working at an individual bank level, categorized US financial institutions based on their asset size. They find evidence of the bank lending channel ; it is particularly important for small banks with less liquid balance sheets, a restrictive monetary policy leading to a decrease of lending activities. Kashyap et al. (1997) survey empirical studies in the euro area to support the existence of this channel, in line with Kishan & Opiela (2000), Altunbas et al. (2002), and Disyatat (2011) among others. The balance sheet channel focuses on the net worth of firms. In the case of low net worth firms, a lender becomes concerned about possible adverse selection and moral hazard (Stein, 1998). These two problems tend to decrease lending, and as a contractionary monetary policy leads to a decrease in asset prices, it will also lead to a decrease in the net worth of firms, further depleting investments. As a change in the monetary policy impacts banks lendings and households cash flow, it also influences housing markets and purchases of durable goods by households (Bernanke & Gertler, 1995). Even if the average loan spreads do not increase, because of a *flight to quality*, the supply of credit continues to decrease (Bernanke et al., 1996). Both subchannels also imply a re-balancing of banks' loan portfolios toward short-term lending and loans to larger and safer firms.

j. Van den Heuvel et al. (2002) considers a third mechanism inside the credit channel : the bank capital channel. As variations of a bank capital affect its risk-based capital requirements from Basle Accord, and because banks are subject to interest rate risks, a change of monetary policy rates will influence lending from banks with low capital ((Gambacorta & Mistrulli, 2004))

A main problem in empirical estimates is distinguishing between the two different but close credit channels. Even if the literature provides ample empirical evidence of the existence of the credit channels and its importance to monetary policy decisions (see, among others, Bernanke, 2007), a clear identification of the two channels calls for more investigation (see Jiménez et al., 2012).

As expectations are a key driver of agents' economic decisions, signals (in the form of information) sent by the central bank to the public can affect their expectations. These expectations concern future monetary policy decisions, relative scarcities of assets, their risk, and their liquidity profiles (Borio & Disyatat, 2010). The influence of communication on market participants' anticipations is analyzed in the signaling channel or expectation channel in line with the terminology used in the Central Banks foreign exchange intervention literature (Mussa, 1981; Sarno & Taylor, 2001). In their seminal paper, Blinder et al. (2008) overview both the forms of central banks communication and empirical evidences of its ability to affect financial markets, expectations, and macroeconomic variables. The central bank informs the public of its intentions through press conferences, speeches, notes or other forms of communication. Andersson et al. (2006) examine the effects of Swedish Riksank's communication on the interest rate term structure and find that all forms of expected and unexpected communication affect short-term interest rates. [k] Bauer & Rudebusch (2014), along with Christensen & Rudebusch (2012), highlight the importance of the signaling channel to explain the lowering of long-term interest rates after the Federal Reserve Large Scale Assets Purchases (LSAP) announcements.

To affect the supply of money to the real economy, the starting points of the transmission channels, central banks use short-term interest rates. A contractionnary (expansionnary) monetary policy is implemented by increasing (decreasing) short-term interest rates. To

k. Fleming & Remolona (1999) previously showed the change in the term structure in relation to macroeconomic releases.

implement such policies, central banks interact with monetary and financial institutions (MFI) through their liquidity-providing open market operations (OMO). While the central bank can directly affect short-term interbank interest rates, MFI adjust longer term interest rates to the cost of short-term liquidities, thus influencing lendings to firms and households. To execute its monetary policy, the ECB uses four forms of OMO (ECB, 2006). The main refinancing operations (MRO) are weekly reverse transactions with a maturity of one week. They signal to the market the monetary policy stance. The long term refinancing operations are also reverse transactions but typically with a maturity of three months. They take place at a monthly frequency as longer-term liquidity providing transactions. The two last OMO are fine-tuning operations, either reverse or outright transactions used to smooth unexpected liquidity fluctuations, and structural operations, used to adjust the eurosyste'sm structural position against the financial sector. While MFI can obtain liquidity from the central bank, it can also be traded among banks in the interbank market. It is an overnight over-the-counter market where MFI can borrow or lend short-term liquidities with maturities between one night and one month to meet their regulatory needs (reserves). The freeze of the overnight interbank bank market, which started in August 2007 with BNP Paribas' decision to stop withdrawals for its subprime mortgage hedge funds and expanded with the bankruptcy of Lehman Brothers,[1] severely impaired the transmission of the monetary policy (Drudi et al., 2012). With MFI fearing counterparty solvency and default risks, liquidity disappeared from the interbank market. Instead of funding the real economy or other MFI in need, MFI retained the funds obtained as reserves at the ECB deposit facility (Acharya & Merrouche, 2012). They were willing to receive a lower interest rate on their excess liquidities rather than lend to other institutions perceived as risky. As conventional instruments were not able to successfully restore the interbank market functioning or the transmission channels of the monetary policy, the ECB had to resort to unconventional instruments.

1. See Vento & La Ganga (2010) for a description of the functionning of the interbank market during the financial crisis.

Unconventional monetary policies

In theory, when (i) nominal interest rates are close or at the zero lower bound (ZLB), (ii) the economy is in a liquidity trap[m] (Krugman, 1999), (iii) transmission mechanisms are impaired, an additional monetary policy stimulus requires the use of unconventional measures. Central banks can use three non-standard instruments to lower long-term interest rates when close to the ZLB (Clouse et al., 2003; Bernanke & Reinhart, 2004) : commit to low interest rate in the future, change the composition of the central bank balance sheet, or increase the size of the central bank balance sheet.

First, to lower long-term interest rate, the central bank can influence market participants' expectations of future nominal short-term interest rates (Svensson, 2003; Eggertsson & Woodford, 2003). This approach makes use of the central bank communication. When close to the ZLB and in order to fight deflation, the central bank can commit to a long period of low nominal short-term interest rate using the signaling transmission channel. This type of guidance is called "Odyssean[n]" by Campbell et al. (2012), as opposed to a no-commitment "Delphic[o]" guidance. Hence, the central bank, in order to shift expectations, has to strengthen its reputation as a deflation fighter. This message contradicts the central bank objective (maintain price stability) by creating a time inconsistency problem, bringing Eggertsson (2006) to describe this policy as a commitment to being irresponsible. Focusing on the Bank of Japan (BoJ) policy in the early 2000s, Bernanke et al. (2004), Baba et al. (2005) and Ugai (2007) provide evidence of the effectiveness of central bank commitments in lowering long-term interest rates.

m. A liquidity trap is defined as a state of the economy at which an increase in the supply of money has no effect on economic variables

n. As Ulysses tied to the mast by his men to hear the Siren's song, the central bank ties itself to a given behavior.

o. In line with the Oracle of Delphi ambiguous statements.

Second, qualitative easing policies are related to the central bank balance sheet. It implies a change of its composition, mainly toward riskier assets. Central banks traditionally accept only high-quality (rated AAA) collaterals for their operations. But with increased financial uncertainty, central banks accepted during the crisis riskier assets thus removing some risk from banks balance sheets, using *indirect* qualitative easing (Smaghi, 2009). By buying and selling certain securities, in an incomplete and with friction financial market, the central bank can affect its price (or yield), risk and liquidity premiums (Bernanke & Reinhart, 2004). Also, economic agents selling the now accepted securities to the central bank will have larger money balances and will then re-allocate their portfolios leading to changes in relative prices (Friedman & Schwartz, 1963). However, Woodford (2012b) contradicts the use of qualitative easing, arguing that its effectiveness comes only from the signals sent to market participants on future accommodative monetary policies. In December 2011, the ECB reduced the rating threshold for certain asset-backed securities to include them as eligible collaterals. To change the composition of its balance sheet, a central bank can also *directly* buy riskier assets during their outright purchases. In the LSAP, the Federal Reserve purchased not only top-rated US treasuries but also agency-guaranteed (from Fannie Mae and Freddie Mac) mortgage back securities.

Finally, the central bank can use its balance sheet to steer short- and long-term interest rates with an expansion of the size of the balance sheet, usually called quantitative easing (QE, Bernanke & Reinhart, 2004). In a *direct* quantitative easing, the central bank increases the size of its balance sheet through the direct purchase of financial assets such as government bonds. The central bank increases its lending to banks in exchange for collateral in the *indirect* form (Smaghi, 2009). While the BoJ in the 2000s and the Bank of England in 2008 used quantitative easing, the Federal Reserve and the ECB programs[p] are in fact credit easing policies. Borio & Disyatat (2010) define credit poli-

p. For the ECB, a pure form of QE has been in use since 2015 with the Public Sector Purchase Programme.

cies as operations targeting specific segments of the private debt and securities market while quantitative easing only focuses on increasing the size of the balance sheet without considering the type of securities purchased. The Federal Reserve LSAP or the ECB CBPP, or ABS programs are examples of credit easing policies. The Bank of England Asset Purchases Facility, implemented in January 2009 as a credit easing program, was transformed in March 2009 into a traditional quantitative easing program with the objective to increase the monetary base. Borio & Disyatat (2010) label the purchase of public sector securities, such as the ECB Public Sector Purchase Programme or the Fed purchase of long-term Treasuries announced in March 2009 through the LSAP, as quasi-debt management.

The empirical literature provides, through the study of different policies, a wide overview of the effects of quantitative easing on either (i) asset prices or (ii) macroeconomic aggregates. First, Gagnon et al. (2011) explains the decrease of the 10-y treasury bill yield following the Fed [q] LSAP announcement through the changes in the banks' loan portflio. D'Amico & King (2013) differentiate a *stock* effect, movements along Treasury demand curves, and a *flow* effect, response of prices to the ongoing purchase operations,to explain the lowering of US yields. Krishnamurthy & Vissing-Jorgensen (2011) pay a specific attention to the effect of the Federal reserve QE on non-sovereign bonds yields. They test several channels of transmission and underline the importance of both the signaling channel and the safety premium's reduction. On the Bank of England, Joyce et al. (2011) study the quantitative easing program started in March 2009 and, in line with Gagnon et al. (2011), report a decrease of UK long-term government yields following quantitative easing announcements. Christensen & Rudebusch (2012) compare the Fed and BoE programs. While the Fed LSAP influenced market participants' expectations of future short-term interest rates, the BoE's QE reduced the term premiums, thus decreasing long-term rates. They explain the un-similar effects of quantitative easing

q. See Bhattarai & Neely (2016) for a survey of the effects of the FOMC unconventional policies.

through differences in communications from the central banks and the financial market structure. Looking at the ECB non-standard policies before the beginning of the sovereign debt crisis, Fratzscher et al. (2016) shows that equity indices were positively impacted by the measures in the euro area. Sovereign yields also decreased for Italy, Spain. Second, analyzing policies of the BoJ between March 2001 to 2006, Ugai (2007) reviews empirical studies on the macroeconomic effects of QE in Japan. He concludes that even if some studies attest to a change in the banks' loan portfolio, the effects result mainly from the signaling of such policies. Weale & Wieladek (2016) estimate that the Fed unconventional policies increased real GDP by 0.62% and inflation by 0.58% through the public portfolio rebalancing and a decrease of financial uncertainty. For the euro area, Boeckx et al. (2017) finds similar with both an increase of output and consumer prices. However, outputs of euro area countries more impacted by the financial crisis, or with a weaker banking sector, tend to face smaller positive effects from balance sheet policies.

Objectives and Contributions of the Thesis

The objective of this empirical thesis is to assess the transmission channels of ECB standard and non-standard policies implemented since 2008. It focuses on two distinct channels particularly relevant to the euro area monetary policy. First, because banks financing costs differ, according to their country of origin or structure, the bank lending channel and its effectiveness can influence the central bank decisions in a monetary union. The first essay of this thesis focuses on this mechanism. Second, to provide equal information to all countries, the ECB pays a very specific attention to its communication and to the signals sent to the public. The second and third essays of this thesis study the signaling channel of the ECB monetary policy. The section details the three essays composing this dissertation with an introduction to the research question, a summary of

the methodology, data, and main results.

In the first essay "The bank lending channel from the European syndicated loan market perspective," we, with Aurore Burietz, study the effect of the ECB's standard and non-standard monetary policies on banks' lending between 2004 and 2014. Using 37000 syndicated loans provided by 15 euro area financial institutions, we estimate the influence of monetary policies on banks' lending activities or the bank lending channel. We argue that non-standard policies influence financial institution short-term financing operations. A bank less dependent on its short-term borrowing will lend more in the syndicated loan market. On the basis of a cross-section analysis with lender fixed effects, we explain loan amounts with a set of microeconomic criteria and monetary policies. We control for the borrower characteristics through its industry, credit rating, and its location (being located in the same country as the lender suggests possible home bias). We also take into consideration the bank specific strategies that possibly affect lending to a given company. We include several other controls detailed in the chapter such as loan characteristics with its maturity, all-in-spread, type and if it is secured. We also take into consideration controls for economic conditions using the GDP and credit demand from the quarterly Bank Lending Survey. On one side, we find that banks that use short-term borrowing as a source of funds are more constrained in their lending activities. On the other side, banks with high levels of customer deposits grant larger syndicated loans. In the second part of the essay, we study how the capitalization of the bank (measured with the capital ratio, defined as a bank's common equity to total assets) influences lending activities. Our results provide evidence of the existence of the bank lending channel. Non-standard ECB policies successfully reduce banks' funding constraints, while standard measures are ineffective. The accommodating ECB monetary policy facilitates banks' access to alternative sources of funds, reducing the constraints imposed by a high level of short-term borrowing. We show that non-standard measures support credit supply with a positive impact on loan amounts, but also that this positive

impact is stronger for banks with less capital. Our results are robust to a control for outliers and to the use of borrower fixed-effects. This chapter contributes to the existing literature on the bank lending channel by, to the best of our knowledge, studying for the first time all unconventional ECB policies and their effects on euro area financial institutions. Also, our analysis includes a set of microeconomic criteria generally absent from articles on the monetary policy transmission channels.

In the second essay, "The signaling channel : a new measure of the ECB communication," we, with Thomas Renault, study the ECB communication and the signaling channel. For a credible central bank, market participants will anticipate the implementation of monetary policies and adjust their behavior accordingly (and so will asset prices and interest rates) right after the announcement and before its implementation. However, to study the central bank communication in finance using, traditionally quantitative methods, researchers have to quantify the qualitative content of speeches or press conferences. The first part of this chapter introduces a new approach to measuring the content of ECB press conferences by identifying sentences related to the economic outlook and monetary policy decisions (topics). Through a manual classification of the introductory statement's 7700 sentences between 2006 and 2014, we calculate for each group of words its probability to belong to one of the two topics with a given inclination (positive, neutral, or negative). Then for each press conference, we aggregate the group of word probabilities to a unique score for each topic. In the second part of the essay, we compare our new measure to two existing methods using the Loughran & McDonald (2011) dictionary and the Apel & Blix-Grimaldi (2012) word list. Using a rule proposed by Taylor (1993), we determine the predictability of future monetary policy decisions with an ordered probit model. We consider either changes to the interest rates or both changes to interest rates and announcements of non-standard policies as measures of monetary policy decisions. Then we study the predictability of financial market reactions (Eurostoxx 50) and their volatility (Vstoxx) on the days following a press conference. Our new

measure better captures ECB's non-standard communication, especially following the sovereign debt crisis in 2011. Considering a Taylor rule with forward looking variables, our indicator of ECB communication improves the understanding of contemporaneous monetary policy decisions. Comparing $Pseudo - R^2$, it improves the predictability of future monetary policy decisions when communication is measured with the Loughran & McDonald (2011) dictionary by 7.5 to 15.1 points and by 6.5 to 11.7 points when communication is measured with the Apel & Blix-Grimaldi (2012) word list. We also find that inflation expectations significantly explain future monetary policy decisions. Focusing on asset prices, we do not find any predictability of stock prices on the day following a press conference but our measure of economic outlook and monetary policy explain, at 5% and 10% respectively, the next day's Eurostoxx volatility. Dovish communications tend to predict a lower next day volatility while a positive economic outlook decreases stock markets' volatility. This chapter contributes to the existing literature by providing a specific and publicly available measure of the ECB's press conference content for the period 2008-2014. This measure, for the first time, considers non-standard policy communication and group of words probabilities. We show that this approach significantly improves both the existing measures of content and the predictability of monetary policy decisions and next-day stock market volatility.

While the second article considers all ECB press conferences, the third essay "The effects of the ECB's Forward Guidance on overnight index swaps" focuses on the use of *forward guidance*. The following unconventional communication for ECB was shared during the press conference on July 4, 2013. : "*The Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time.*" To estimate the effect of this commitment from the central bank to maintain nominal interest rates at low levels, we use overnight index swaps (OIS). As the variable leg of the swap is the euro area interbank overnight interest rate (EONIA), they measure economic agents' expectations of policy rates with maturities between 2 months and 10 years. To quan-

tify the influence of the guidance, one has to disentangle the macroeconomic content of the news from its central bank commitment effect. To do this, we model the daily variations of OIS rates with an ARMAX(1,1). We control for the macroeconomic news effect through medium-term inflation expectations. We also consider as an independent variable the LTRO repayments, as the decreasing liquidity in the interbank market might affect interest rate expectations. We also take into consideration other monetary policy decisions announced by the ECB and macroeconomic news from both the euro area and the United States. We quantify the effect of the forward guidance and its "firm" reiteration of January 2014 with an event-study. Abnormal returns are obtained from forecasts of ARAMX(1,1) model detailed above. Our results suggest that liquidity conditions significantly affect OIS rates for short-term maturities (2 to 6 months) while longer term maturities (2 to 10 years) are driven by inflation expectations. A decrease in market liquidity and an increase in inflation expectations both tend to increase OIS rates for the given maturities. Annoucements of LTRO repayments also significantly increased market expectations of future policy rates. The forward guidance had a negative commitment effect on maturities between ten months and three years, independent of the effect of negative macroeconomic news. Market participants' pricing of the forward guidance on OIS rates implies that on the day of the forward guidance, policy rates were already expected to remain low for six months. The *extended* period of time could then be estimated to last until June 2016. This essay contributes to the existing literature by providing, to the best of our knowledge, the first quantitative estimate of ECB's forward guidance on interest rate expectations. We also assess market participants' view on the length of the " *extended period of time"* of low policy rates. Empirically, this essay also provides a novel modeling of daily OIS rates taking into consideration the euro area market liquidity conditions.

1

The bank lending channel : a European syndicated loan market perspective

This paper is a joint work with A. Burietz.

Abstract

This paper provides new empirical evidence on the bank lending transmission channel of monetary policy during the 2008 financial crisis. Using an original dataset on Euro Area syndicated loans between 2005 and 2013, we focus our attention on 7 major banks and try to explain their lending behaviour in the syndicated loan market. Using a fixed effect panel, we show a significant influence of the ECB key rate changes on banks' short term borrowings. We argue that excess liquidities in the money market weakened the importance of customer deposits in the banks' loan allotments process. Moreover, unconventional measures (proxied by the central bank balance sheet) are reducing banks' short term borrowing constraints only between 2008 and 2010 hence facilitating the credit supply of syndicated loans.

Keywords : Bank lending channel, credit supply, syndicated loan, financial crisis

JEL classification : E52, F34, G21

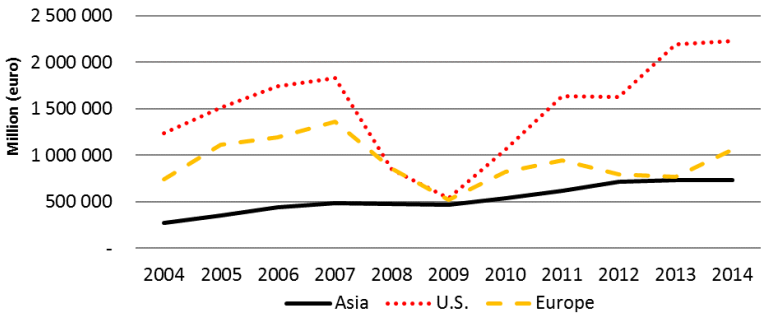
1.1. Introduction

"The recent credit crisis has reminded us of the crucial role performed by banks in supplying lending to the economy, especially in a situation of serious financial distress"

Gambacorta & Marques-Ibanez (2011)

In 2008, Lehman Brothers' bankruptcy filing triggered one of the most significant financial crises in banking history, deeply affecting the syndicated loan market. Figure 1 illustrates the collapse of the issuance volume of syndicated loans before and during the financial crisis in the three major syndicated loan markets. It has decreased by 60% from the crisis' peak in 2007 (3.68 trillion euros, see Figure 1.1).

Figure 1.1. – Issuance Volume in the Major Syndicated Loan Markets



Source : LPC Dealscan database and authors' calculations.

The syndicated loan market is a major source of external finance for firms and represents more than one third of all international corporate financing, including money-market instruments, bonds, and equities Gadanecz (2004).[a] A large body of literature explores the impact of the financial crisis on the syndicated loan market.[b] Ivashina &

a. A syndicated loan is a hybrid of a bank loan and public debt, gathering together commercial banks and other financial institutions, and implying both monitoring and underwriting activities (Dennis & Mullineaux (2000),Chaudhry & Kleimeier (2015)).

b. In an extensive study, Kleimeier et al. (2013) analyse the impact of roughly 200 global financial crises on the geographical repartition of cross-border loans from 1995 to 2008. By distinguishing between banking, currency, and twin crises, the authors highlight significant differences among the types of crises, with stronger effects from twin financial turmoil.

Scharfstein (2010) focus on the U.S. banking sector and highlight how the banking panic set off a disruption in syndicated bank lending, combined with a run on lines of credit granted before the crisis, totaling $26.8 billion. This run affected banks' balance sheets, damaging their liquidity position and reducing new-loan origination to large corporations. In a larger perspective, Cerutti et al. (2015) explore the evolution and drivers of cross-border bank-loan exposures from 1995 to 2012 for a panel of 26 lender countries and 76 borrower countries. First, the authors find that the 2008 financial crisis significantly impacted the syndicated loan market, with a reduction in cross-border exposures (Haas & Van Horen, 2012). In line with Ivashina & Scharfstein (2010), they highlight a disruption in the issuance volume of new loans associated with higher stocks of syndicated loans on banks' balance sheets due to significant drawdowns on existing lines of credit. Second, Cerutti et al. (2015) provide support to the home-bias hypothesis, defined as the increase in the proportion of domestic loans in banks' portfolios from the effect of geographical proximity easing credit-risk assessments (Epstein, 2001). Giannetti & Laeven (2012) provide evidence that this home bias is further amplified during periods of financial turmoil. The confidence crisis, combined with an increase in uncertainty, makes banks reluctant to lend money abroad. They would rather allocate more resources to domestic markets. This lending behaviour then contributes to the transmission of the financial crisis to the international level.

Acharya & Steffen (2013) show that during the subprime crisis, large settlement banks in the U.K. started hoarding liquidity for precautionary purposes due to a rise in their funding risk. Amid the magnitude of the financial shock and the increasing pressures on the banking industry, central banks intervened to reduce strains in financial markets and provide credit institutions with financial support. [c] The goal of this paper is to assess the impact of the accommodating monetary policy implemented by the European Central Bank (ECB) on the syndicated loan market. More precisely, we estimate the effects of

c. Fawley & Neely (2013) provide a precise description of the quantitative easing programmes implemented by the Federal Reserve (Fed), the Bank of England (BoE), the ECB, and the Bank of Japan (BOJ).

standard and non-standard measures of ECB monetary policy on the issuance volume of syndicated loans (bank lending channel) and assess whether these policies managed to support syndicated bank lending.

We contribute to the debate on the effectiveness of the bank lending channel (Bernanke & Blinder, 1988; Bernanke & Gertler, 1995) by investigating whether the ECB's accommodating monetary policy contributed to mitigating the disruption in the issuance volume of syndicated loans.[d] Peek & Rosengren (2012) emphasise the importance of understanding the role of credit institutions in monetary policy transmission. The authors show that the development of new non-standard measures triggered a shift in the objective of monetary policy, requiring a re-assessment of its bank lending transmission channel. Adelino & Ferreira (2016) explain that the decrease in bank lending was due to reduced access to wholesale funding and to an increase in the cost of funding, reinforcing the importance of studying this channel.

Like Gambacorta & Marques-Ibanez (2011), as well as the other papers quoted previously, we investigate the transmission mechanism of monetary policy (both standard and non-standard measures) and its impact on bank lending. However, in contrast to Gambacorta and Marques-Ibanez, we focus on the syndicated loan market. Although this approach addresses a specific category of credit, it provides new insights on the effectiveness of the bank lending channel on a market – insights that are far from anecdotal. To the best of our knowledge, this is the first work that explores the impact of the overall ECB monetary policy on the syndicated loan market, one of the major sources of international finance for corporations. We hypothesise that the operations implemented by the ECB supported syndicated bank lending, reducing the impact of the 2008 financial crisis. By providing credit institutions with funds, the ECB alleviated the constraints on banks' balance sheets, providing them with more flexibility to allocate resources.

d. J.C. Trichet speech (11/23/2009) : 'These 'non-standard' measures started in October 2008 and were designed to... enable banks to continue their lending to households and firms'.

To test our hypothesis empirically, we estimate a cross-section regression for a sample of 15 European banking groups between 2004 and 2014. We analyse the potential effects of several monetary policy instruments (i.e. the interest rate and non-standard ECB policies) on syndicated bank lending through their impact on banks' short-term borrowing. We pay particular attention to the microeconomic foundations of bank lending activities by using loan-specific data, rather than overall lending aggregates (Popov & Van Horen, 2015).

Overall, we find that a higher level of deposits strengthened bank lending activities, while short-term borrowing acted as a constraint on banks, reducing syndicated-loan volume. We also provide evidence that only non-standard measures of the ECB's accommodating monetary policy alleviated this constraint, facilitating banks' access to funds. More precisely, policies affecting the size of the ECB balance sheet were more effective than interest-rate instruments in providing banks with sufficient funds to compensate for a decrease in their deposit stocks, resulting in an increase in loan size. This relationship is particularly strong for weakly capitalised banks, which are more sensitive to monetary and macroeconomic shocks.

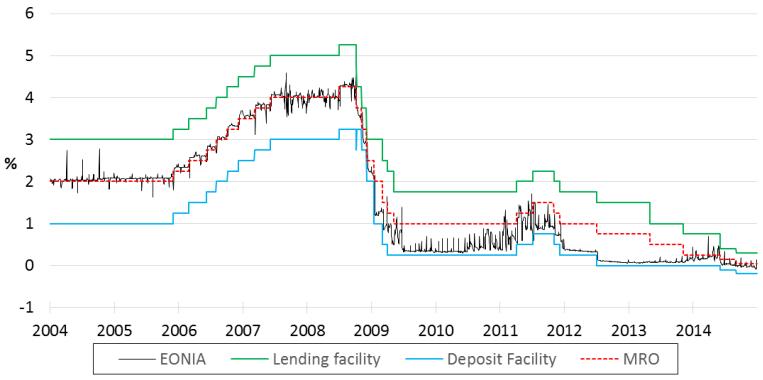
Our findings confirm the existence and the effectiveness of the bank lending channel over the recent period for the syndicated loan market. The innovation is the nature of the instruments that are found to be effective in the transmission of monetary policy. After the Lehman collapse, the ECB successfully alleviated the impact of the 2008 crisis, hence limiting the consequences for the real economy, with the ultimate recipient being the borrowing companies. This result remains valid when we consider banks' specific loan-attribution process and resist several robustness checks.
The remainder of this paper is organised as follows. The first section describes the monetary policy implemented by the ECB and is followed by Section 2 which presents our methodology. Section 3 describes our data, while section 4 provides descriptive statis-

tics. Section 5 investigates whether the measures of ECB's monetary policy contributed to supporting syndicated bank lending through a reduction in credit institutions' funding constraints. Section 6 analyses the importance of banks' size for the bank lending channel. Section 7 is dedicated to robustness checks, and Section 8 concludes the paper.

1.2. ECB Monetary Policy

Typically, the ECB targets short-term interest rates to conduct monetary policy, i.e. buy or sell short-term debt securities. The two main instruments used by the ECB are the Main Refinancing Operations (MROs), with a maturity of two weeks, and the Longer-Term Refinancing Operations (LTROs), with a maturity of three months. Both measures direct lending of predetermined amounts sold at auctions to credit institutions against eligible collateral. One month after the collapse of Lehman Brothers, the ECB implemented the Fixed-Rate, Full Allotment programme (FRFA) to address the deterioration of financial conditions. In addition, the ECB adjusted its standard policy to fulfill the terms of all MROs and LTROs at the main refinancing rate. From October 2008 to May 2009, this rate decreased by 325 basis points (from 4.25% to 1%) as illustrated in Figure 1.2.

Figure 1.2. – ECB Monetary Policy : Standard Measures



Source : ECB, EONIA stands for Euro Overnight Index Average.

However, in 2009, concerns over counter-party risk remained significant, disturbing the operations of European interbank markets (Drudi et al., 2012). With short-term interest rates approaching the zero lower bound, the ECB adopted non-standard measures to reduce financial distress and stimulate the economy. These measures contributed to increasing the monetary base and mainly consisted of lending and asset-purchase programmes targeting the main players in the European economy, i.e. the banks. [e]

On May 7, 2009, the ECB extended the maturity of its LTROs to 12 months, satisfying credit institutions' demand for longer maturities. In addition, the ECB announced the Covered Bond Purchase Programme (CBPP), aiming at purchasing euro-denominated covered bonds for a predetermined amount equal to 60 billion euros over 14 months, i.e. until June 30, 2010. This programme contributed to alleviating the maturity constraints that credit institutions faced when lending long and borrowing short, generally through on-demand deposits. The CBPP became an important source of funding for European banks.

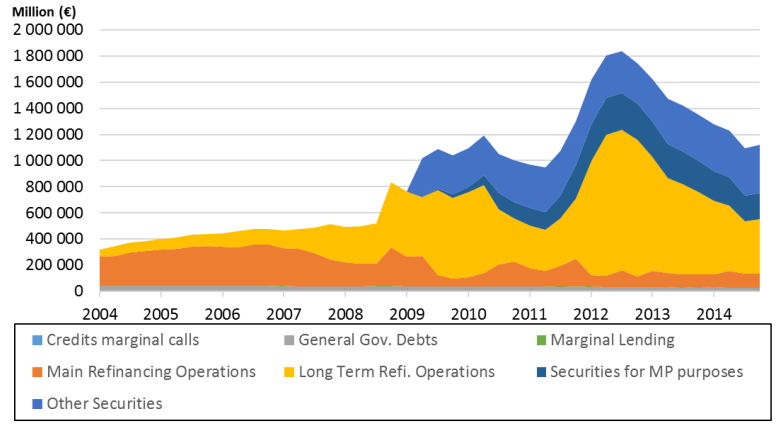
Nevertheless, during the financial crisis of 2008, tax revenues decreased and economic growth slowed down, exacerbating budget and debt problems. In 2010, European credit institutions holding substantial amounts of sovereign debt had to face new difficulties linked to the sovereign-debt crisis occurring in the monetary union. On May 10, 2010, the ECB announced its Securities Market Programme (SMP) [f] with a two-fold objective : with the ability to purchase government debt on the secondary market, the ECB aimed to ensure liquidity and restore an appropriate transmission mechanism for monetary policy. Unfortunately, the European sovereign-debt crisis continued to plague European interbank markets, and the ECB had to intervene with additional measures in

e. Fawley & Neely (2013) highlight a significant difference between the programmes implemented by the ECB and the BOJ, and those implemented by the Fed and the BOE. The difference lies in the reality that the economies of Europe and Japan are more bank-oriented, while those of the U.S. and U.K. are more bond-oriented.

f. On September 6, 2012, the ECB replaced the SMP with the Outright Monetary Transactions programme to address the lack of an enforcement mechanism to receive support.

2011 to restore confidence. On October 6, 2011, a second CBPP was set up for 40 billion euros. In addition, on December 8, 2011, the ECB announced an extension of the LTROs' maturity, up to 36 months. As a result, the size of the ECB balance sheet significantly increased between 2008 and 2009, as shown in Figure 1.3 below.

Figure 1.3. – ECB Balance Sheet : Relevant Assets



Source : ECB.

All of these measures carried out by the ECB may have potentially affected the economy through several transmission channels (Mishkin, 1996). As banks are credit- constrained, the bank lending channel is effective when the monetary policy affects credit institutions' external finance premium, subsequently altering credit availability in the economy (Stein, 1998; Gan, 2007; Disyatat, 2011 among others).[g] Gambacorta & Marques-Ibanez (2011) provide evidence of a significant impact from the monetary policy before and during the lending crisis. However, the authors argue that banks' reactions are not homogenous and depend on banks' capital levels, as well as their use of new and innovative tools, such as securitization. In line with this analysis, several papers (Angeloni et al., 2003; Gambacorta, 2005 among others) investigate how the relationship between

g. Considering the credit channel in general, Kishan & Opiela (2000) highlight the importance of distinguishing between the bank lending channel and the borrower net-worth channel. They argue that the former depends on banks' asset volume and capital.

monetary policy and the level of deposits can disturb bank lending activities. Gambacorta (2005) studies a sample of Italian banks and shows that a tightening monetary policy leads to a decrease in deposits and loans afterward, with the effect being more significant in smaller banks unable to raise uninsured funds. We contribute to the debate on the effectiveness of the bank lending channel (Bernanke & Blinder, 1988; Bernanke & Gertler, 1995) by investigating whether the ECB's accommodating monetary policy contributes to mitigating the disruption in the issuance volume of syndicated loans.

1.3. Method

Following a financial shock like that of the collapse of Lehman Brothers, credit institutions may experience higher funding constraints, resulting in a contraction in syndicated bank lending. Our objective is to estimate to what extent standard measures (proxied by the Euro Overnight Index Average, EONIA) and non-standard measures (proxied by the size of the balance sheet) implemented by the ECB mitigated the impact of the 2008 financial crisis by supporting lending in the syndicated loan market.

Our methodology is based on the analysis developed by Kashyap & Stein (2000). The authors use a two-step analysis to study the bank lending channel in the U.S. between 1976 and 1993.[h] Cetorelli & Goldberg (2012) replicate this methodology to investigate the effectiveness of monetary policy when banks experience a liquidity shock like that of the financial crisis of 2007-2009. In our analysis, we start with the same model, but our approach differs in several ways. First, we group the two steps from Kashyap & Stein (2000) analysis into a one-step regression to limit the influence of first-step estimation uncertainty over the second one. We hypothesise that the ECB's accommodating measures will impact syndicated bank lending only indirectly through a reduction in banks'

h. In their model, they first regress the total volume of loans on the structure of banks' balance sheets using the ratio of securities and federal funds sold to total assets as a proxy. In a second step, they regress the previously obtained coefficient for the structure of banks' balance sheets on different monetary policy indicators, including the federal funds rate.

funding constraints (Kashyap & Stein, 2000). As such, we include these monetary-policy measures in our model through their interaction with banks' funding constraints, distinguishing between standard and non-standard monetary policy tools, and controlling for time effects with year dummies. Secondly, our model is based on a cross-sectional analysis.

In addition, we contribute to the literature on syndicated loans by considering all credit institutions that are part of the syndicate. In the syndicated loan market, a syndicate is divided into two distinct groups of lenders, depending on their roles. The lead arrangers are responsible for structuring, administering, and monitoring loans, while the participants behave as investors and provide funds. Contrary to the literature, our analysis is not limited to loans provided by lead arrangers, as we consider each bank's proper decision to lend. As such, even if the bank is only a participant, it still has the choice to invest or not at the beginning of the syndication process, and this decision may also be influenced by the implementation of monetary policy. However, we control for lead arrangers in our model.

Finally, we include new variables that better account for each bank's balance sheet or that may influence bank-lending decisions such as a bank's level of customer deposits. These variables provide precise descriptions of banks' funding constraints.

As a result, we model the amount of each syndicated loan j provided by bank i as follows :

$$Amount_{ij} = \alpha_1 + Lender\ constraints_i + \alpha_2 \times \Delta EONIA_j + \alpha_3 \times Controls_{ij} + \epsilon_{ij} \tag{1.1}$$

$$Lender\ constraints_i = \alpha_4 \times CD_i + STB_i \times (\theta_1 + \theta_2 MP_j) \tag{1.2}$$

where $Amount_{ij}$ stands for the amount of loan j provided by credit institution i. The lender constraints depend on the level of customer deposits at credit institution i, i.e. CD_i (Jiménez & Ongena, 2012 among others) ; the funding constraints of this credit

institution i, STB_i, proxied by the level of its quarterly short-term borrowings (Ivashina & Scharfstein, 2010) ; and on the interaction between this funding constraint and monetary policy. The latter, i.e. MP_j, contains two variables, i.e. $\Delta EONIA_j$ (Jiménez et al., 2014 among others) and the size of the ECB balance sheet (Gambacorta & Marques-Ibanez, 2011), which account for standard and non-standard policies, respectively. The variable representing the size of the ECB balance sheet contains not only the MROs, as the ECB decided to fulfill all of these operations at a fixed rate after the Lehman collapse, but also the LTROs, which benefited from an extension in their maturity and the securities held for monetary purposes through the different programmes as previously described (e.g., CBPP, SMP, etc.). However, this variable may be biased by the presence of the MROs, which are considered to be standard measures before the crisis and the FRFA implementation. This second variable is then representative of the monetary-policy stance and contains both standard and non-standard measures. As a robustness check, we built a more restrictive variable, called $non - standard$, in which we remove these MROs to be more focused on non-standard policies implemented by the ECB. In the following estimations, we always test our model for both proxies. Moreover, in the main equation, we also include $\Delta EONIA_j$ as the variation of the EONIA because it represents the traditional interest-rate channel that may directly affect lending activities.

$Controls_{ij}$ is a matrix of our control variables. In our analysis, we consider the characteristics of the loan, i.e. its all-in spread, maturity, whether the loan is secured, its type, and seasonal effects. We also control for the characteristics of the borrower, i.e. its industry and the risks associated with this industry[i], the borrower's credit rating when the loan is issued,[j] and whether the borrower is located in the same country as the lender.

i. The industry risk may affect a bank's portfolio of loans, especially during a crisis, when investors become risk-averse. We compute a Value-at-Risk (VaR) per industry to control for this risk using industry indices produced by Datastream. Then we manually match the industry of the borrower with these indices to associate one VaR per loan.

j. DealScan provides credit ratings produced by the three leading U.S. credit-rating agencies (CRAs), i.e. Standard & Poor's, Moody's and Fitch. These ratings are automatically reported in the database when they exist. In our sample, we consider for each loan the rating each time it is provided by one of the three CRAs. For rated loans with more than one rating, we apply the 'worst of 2 and median of 3

The latter allows us to account for the home-bias hypothesis. According to the literature, the financial situation of the lender may impact its lending activities. As such, our model contains the change in the lender's Tier 1 ratio, the country of the lender, and a dummy variable reflecting whether the lender is the lead arranger. We also consider the lender's strategy in terms of industry portfolio diversification. A bank may develop expertise in one specific industry from often lending to companies in this industry. As such, the bank can save on information through gathering and monitoring costs. However, the risk of this 'focus' strategy (Acharya et al., 2006) is a lack of diversification, which may sometimes push banks to lend more to companies in other industries. Finally, we integrate in our analysis the relationship between the lender and the borrower, as well as the macroeconomic context (i.e. the change in the eurozone's Gross Domestic Product (GDP), the banks' anticipations of credit demand based on the question number 9 in the bank lending survey (BLS) [k] quarterly provided by the ECB (Del Giovane et al., 2011), and four dummy variables for the crisis period between 2008 and 2011 to control for this financial institution crisis, the intervention of the ECB, and the state aid received by banks.

In line with Gambacorta (2005), who provides evidence of an asymmetric transmission of monetary policy across Italian banks, we run the model using a cross-section estimation method per loan and per credit institution, rather than per country. We perform our regressions with robust standard errors and lender-fixed effects as a result of the Hausman (1978) test. As previously stated, we hypothesise that monetary-policy measures, i.e. the $\Delta EONIA_j$, and the size of the ECB balance sheet impact syndicated bank lending through banks' short-term borrowing. If the monetary policy is accommo-

ratings' rule (Bongaerts et al., 2012). We then categorise borrowers as investment-grade, junk-grade, or unrated. In the regression, we use the group of unrated loans as the reference.

k. The main objective of the BLS is to provide the ECB's Governing Council with information regarding the financing conditions in the eurozone, using questionnaires sent out to banks and enterprises to gauge their opinions about the market appetite for loans. In our model, we use the information related to the answers to question 9 ('Please indicate how you expect demand for loans or credit lines to enterprises to change at your bank over the next three months [apart from normal seasonal fluctuations]'). We consider the quarterly variation of the overall category, i.e. all loans (short- and long-term) to all companies (small, medium, and large), and we include the balance of opinions in our model (always between -100 and +100).

dating (or tight), the interest rate will decrease (or increase). As such, banks will borrow at a lower (or higher) cost resulting in a higher (or lower) capacity to lend. We expect that banks with a higher level of customer deposits will be less affected by a change in monetary policy. They should be able to provide larger loans before requiring the use of costly external financing sources. However, a rise in the level of short-term borrowing may force banks to slow down their lending activities. As such, an accommodating monetary policy, either through a decrease in the EONIA or an expansion of the size of the ECB balance sheet, should facilitate banks' access to credit by reducing their funding constraints.

1.4. Data

This paper focuses on the monetary policy implemented by the ECB.[l] Our analysis, therefore, considers all of the credit institutions that can benefit from the open market operations of the ECB. According to European Directive 2000/12/EC (European Parliament – March 20, 2000), 'a 'credit institution' shall mean an undertaking whose business is to receive deposits or other repayable funds from the public and to grant credits for its own account'. The ECB establishes a list of Monetary Financial Institutions (MFIs) that fall within the scope of this definition.[m] From this list, we select only credit institutions that must satisfy the reserve requirement. We came up with a list of 5,294 MFIs. To run our analysis on a quarterly basis, we restrict our sample to MFIs for which we have access to financial information and which are active in the syndicated loan market. Our final sample contains 86 credit institutions located in 10 eurozone countries (Austria, Belgium, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, and Spain).

l. We do not extend our analysis to other central banks, such as the Fed, as they have different monetary-policy objectives and measures.

m. MFIs are defined by the ECB as 'central banks, resident credit institutions as defined in community law, and other resident financial institutions whose business is to receive deposits and/or close substitutes for deposits from entities other than MFIs and, for their own account (at least in economic terms), to grant credit and/or make investments in securities. Money market funds are also classified as MFIs'. (Regulation (EC) No. 25/2009 – ECB/2008/32). On February 29, 2016, this list contained 7,959 MFIs. The list is updated on a monthly basis.

We collect financial data from banks using Bloomberg, and we complete our series with information from banks' balance sheets. In our study, we consider the quarter when the loan is issued to determine the relevant bank's financials. The ECB provides data on monetary-policy instruments. Our set of variables includes two main monetary-policy instruments, i.e. the change in the EONIA for standard measures of monetary policy and the size of the ECB balance sheet for non-standard instruments. As previously described, we run robustness checks using an alternative measure of non-standard policies based on a more restrictive definition of what is non-standard and which includes only LTROs and securities held for monetary-policy purposes. All of these variables are taken with a quarter lag to consider the delay in the transmission of monetary policy.

In addition, we use the LPC DealScan database to get data on syndicated loans, provided by each MFI. In LPC DealScan, we obtain all of the loans' characteristics and the industries involved, as well as the credit rating and nationality of the borrower, while the industry risk is computed using data from Datastream. LPC DealScan also provides access to the nationality of the MFI, the MFI's role in the syndicate, its strategy in terms of industry specialization, its relationship with the borrower and the bank allocation, i.e. how much each MFI has invested per loan. Finally, the GDP and the results of the bank lending survey are extracted from Eurostat and the ECB website, respectively.

To investigate the effect of the ECB measures on syndicated bank lending, we run our baseline analysis from January 2004 to December 2014. For the sake of our study, we group the 86 MFIs under the names of their parents for which we have financial information on a quarterly basis. Our final sample contains 19,866 unique loans provided by 15 banking groups to 6,873 borrowing companies between 2004 and 2014.

1.5. Descriptive Statistics

Table 1.1 provides the definition and the descriptive statistics of each variable included in our analysis. Table 1.2 presents the 15 banking groups included in our sample. In

this table, we report the countries in which these banking groups have MFIs involved in syndicated loans, as well as descriptive statistics for each banking group over the whole time period. On average, both the number and the amount of loans decrease when the bank gets smaller, while the loan spread and its maturity are similar across the three categories of banks. The levels of customer deposits and the levels of short-term borrowing at the banks are positively related to their levels of total assets.

Table 1.3 displays the description of our sample in terms of geographical repartition of the borrowers, the type, the objective, and the maturity of the loans. This table highlights that the 15 banking groups lend to companies that are mainly located either in Western Europe or North America, with the two regions representing more than 80% of our sample. Our objective is to study lending behaviour of banks active in the international syndicated loan market. As such, we do not limit our analysis to a sample of European borrowers. Instead, we control for the geographical location of borrowers in our estimates. Regarding the most common loan characteristics, term loans and lines of credit dominate the sample and are used mainly to finance general corporate functions, LBOs, and takeovers, with more than 50% of the loans maturing in one to five years.

1.6. Baseline Results

We started estimating our model with only the variables of interest, i.e. lender constraints (i.e. CD_i and STB_i), in addition to the loan all-in spread and the $\Delta EONIA_j$ to determine whether and how they impact loan amounts. Table 1.4 reports the results of this simplified model for five different specifications. In Model 1, we do not include monetary-policy instruments to assess the stand-alone influence of lender constraints on bank lending activities. In Models 2, 3, and 4, we introduce each instrument separately to assess the impact of the EONIA variation, the size of the ECB balance sheet, and the non-standard ECB operations, respectively, on loan amounts indirectly through short-term borrowing. As such, we can understand the influence of these instruments

Table 1.1. – Descriptive Statistics

Variable	Definition	Unit	Average	St. Dev.
	Dependent Variable			
$Amount_{ij}$	The amount of loan provided by credit institution taken as a logarithm	Million €	44.84	110.61
	Lender constraints			
CD_i	The level of customer deposits of credit institution taken as a logarithm on a quarterly basis	Million €	310,423.50	182,619.40
STB_i	The level of short-term borrowings of credit institution taken as a logarithm on a quarterly basis	Million €	146,970.10	74,994.38
	MP_j : Monetary policy instruments			
	The variation of the quarterly EONIA taken with one lag	Bps	0.00	0.39
Balance sheet	The logarithm of the ECB quarterly balance sheet taken with one lag and equal to total assets minus general government debt denominated in €, marginal lending facility, credits related to marginal calls and other securities	Billion €	690,840.80	322,601.70
Non-standard	The logarithm of the value of ECB unconventional policies taken with one lag (i.e. the sum of LTROs and securities purchased for monetary policy purposes from the quarterly balance sheet assets)	Billion €	487,409.60	387,292.50
	Loan characteristics			
All-in spread	Sum of the loan spread (i.e. the difference between the rate of the loan and its benchmark rate) and the total fees	Bps	203.06	161.03
Maturity	The logarithm of the loan's maturity	Month	61.38	43.84
Secured	equal to one when the loan is secured	Dummy	0.41	0.49
Revolver loan	equal to one when the loan is a revolver loan (with a maturity lower than 1 year)	Dummy	0.00	0.06
	equal to one when the loan is a revolver loan (with a maturity higher than 1 year)	Dummy	0.36	0.48
Term loan	equal to one when the loan is a term loan	Dummy	0.33	0.47
Seasonal effect	equal to one when the loan is issued during the fourth quarter of the year	Dummy	0.27	0.44
	Borrower characteristics			
Industry	equal to one when the borrower belongs to one of the 4 main economic sectors, i.e. manufacturing	Dummy	0.31	0.46
	equal to one when the borrower belongs to one of the 4 main economic sectors, i.e. finance	Dummy	0.15	0.35
	equal to one when the borrower belongs to one of the 4 main economic sectors, i.e. services	Dummy	0.12	0.32
	equal to one when the borrower belongs to one of the 4 main economic sectors, i.e. transports	Dummy	0.10	0.30
Industry risk	Value-at-Risk of the industry	%	-0.02	0.01
Credit rating	equal to one if the borrower is investment grade	Dummy	0.17	0.37
	equal to one if the borrower is junk grade	Dummy	0.07	0.26
	equal to one if the borrower is unrated	Dummy	0.71	0.46
Domestic	equal to one when the borrower has the same nationality as the lender	Dummy	0.23	0.42
	Lender characteristics			
DT1	Quarterly change in the Tier 1 ratio of the lender taken with one lag	%	0.11	1.26
Country	equal to one if the subsidiary is located in Austria	Dummy	0.02	0.15
	equal to one if the subsidiary is located in Belgium	Dummy	0.06	0.24
	equal to one if the subsidiary is located in France	Dummy	0.00	0.01
	equal to one if the subsidiary is located in Germany	Dummy	0.35	0.48
	equal to one if the subsidiary is located in Greece	Dummy	0.01	0.08
	equal to one if the subsidiary is located in Ireland	Dummy	0.00	0.03
	equal to one if the subsidiary is located in Italy	Dummy	0.18	0.39
	equal to one if the subsidiary is located in Luxembourg	Dummy	0.00	0.05
	equal to one if the subsidiary is located in Netherlands	Dummy	0.15	0.36
	equal to one if the subsidiary is located in Spain	Dummy	0.20	0.40
Lead	equal to one when the lender is the lead arranger	Dummy	0.56	0.50
Strategy	The logarithm of the total amount lent by the credit institution to the industry of the borrower associated with the loan the year before	Million €	1,450.98	1,986.20
	Lender-Borrower relationship			
Relation (1Y)	equal to one when the lender has already lent to the borrower during the previous year	Dummy	0.16	0.36
	Macroeconomic environment			
DGDP	Quarterly change in the Eurozone GDP taken with one lag	Million €	1.22	1.89
BLS	Banks' anticipations of credit demand based on question 9 of the bank lending survey	Numerical	-1.25	10.56
Years	equal to one when the loan is issued in 2008	Dummy	0.08	0.26
	equal to one when the loan is issued in 2009	Dummy	0.05	0.22
	equal to one when the loan is issued in 2010	Dummy	0.08	0.28
	equal to one when the loan is issued in 2011	Dummy	0.10	0.30

Table 1.2. – Sample of banking groups

Banking Group	*Countries*	*Nb. loans*	$Amount_{ij}$	*All-in Spread*	*Maturity*	*Total Assets*	CD_i	STB_i
Deutsche bank	GE/LU	8,825	71.02	239.81	55.49	1,667,439	453,251	189,531
ING	BE/FR/GE/IR/ IT/LU/NL	5,787	36.73	244.33	61.72	1,171,419	488,228	186,068
Santander SA	BE/SP	2,194	62.27	190.86	69.17	1,011,695	430,971	154,217
Unicredit bank	IT/LU	3,344	41.35	221.50	64.39	825,23	373,461	181,191
Commerzbank	GE/IT/SP	5,47	38.92	175.00	54.15	636,243	190,569	181,297
Intesa Sanpaolo	IT	2,338	46.15	146.21	55.90	541,617	223,111	96,715
BBVA	FR/IT/SP	3,409	45.56	160.58	72.56	510,76	224,379	125,121
KBC bank NV	BE/IR	2,213	22.16	176.09	62.30	302,981	133,895	66,463
BMPS	IT	478	16.43	145.05	49.99	192,743	92,154	47,437
Erste bank	AU/LU	1,024	16.35	178.13	52.64	191,567	103,527	17,034
Banco Populare Espanol	SP	491	23.47	227.31	60.32	116,336	50,614	27,043
Sabadell SA	SP	703	20.57	188.56	78.73	96,115	47,557	17,158
Alpha Bank AE	GR	187	16.50	150.26	33.91	57,905	32,451	13,602
Bankinter	SP	342	14.38	274.77	65.39	50,043	17,942	13,601
Banca Popolare di Milano	IT	175	27.14	193.90	67.20	46,473	21,08	8,477

Notes : This table provides descriptive statistics of the 15 banking groups included in our sample. BBVA stands for Banco Bilbao Vizcaya Argentaria and BMPS for Banca Monte dei Paschi di Siena. The countries are Austria (AU), Belgium (BE), France (FR), Germany (GE), Greece (GR), Ireland (IR), Italy (IT), Luxembourg (LU), Netherlands (NL), and Spain (SP). Number of loans represents the sum of all loans in which the banking group has participated. Average loan characteristics (i.e. amount expressed in millions of euro, spread expressed in basis points, maturity expressed in months) and quarterly averages of the financial characteristics of each banking group (i.e. total assets, customer deposits, and short-term borrowing, all expressed in millions of euros) are computed for the 2004-2014 period.

Table 1.3. – Sample of loans

	Numbers		*Amounts*	
Borrowers' region				
Africa	161	1%	65,148.62	1%
Asia Pacific	1,468	7%	465,367.42	5%
Eastern Europe/Russia	1,38	7%	379,307.05	4%
Latin America/Caribbean	697	4%	250,356.31	3%
Middle East	288	1%	172,672.37	2%
USA/Canada	7,266	37%	3,855,236.82	43%
Western Europe	8,606	43%	3,829,908.52	42%
Loan type				
Revolver ($< 1Y$)	72	0%	25,480.05	0%
Revolver ($> 1Y$)	6,895	35%	3,719,424.23	41%
Term loan	10,084	51%	3,612,903.75	40%
Others	2,815	14%	1,660,189.07	19%
Loan objective				
General purposes	9,387	47%	4,984,473.86	55%
Leverage Buy-out (LBO)	2,577	13%	505,854.71	6%
Takeover	1,123	6%	1,298,157.58	14%
Project finance	1,235	6%	313,245.09	3%
Recapitalization	799	4%	119,711.58	1%
Working capital	879	4%	387,250.26	4%
Acquisition	791	4%	426,521.04	5%
Commercial Paper backup	226	1%	271,600.41	3%
Others	2,849	14%	711,182.58	8%
Loan maturity				
Short-Term ($< 1Y$)	2,378	12%	1,591,635.07	18%
Medium-Term ($1Y - 5Y$)	10,337	52%	5,303,281.46	59%
Long-Term ($> 5Y$)	7,151	36%	2,123,080.58	24%

Notes : This table provides descriptive statistics of the sample of loans. The amount is expressed in millions of euros. The first panel provides the split of borrowers according to their geographical region. The second, third, and fourth panels describe the sample of loans in terms of loan type, loan objective, and loan maturity respectively.

on syndicated bank lending. Finally, in Model 5, we measure how the ECB monetary policy as a whole influences syndicated loan amounts by considering both standard and non-standard instruments. In the five different specifications, we find a positive and significant coefficient for customer deposits (CD_i), while the coefficient for short-term borrowings (STB_i) is negative and significant. In line with Kashyap et al. (2002) , we show that banks with high levels of customer deposits grant larger syndicated loans. On the contrary, banks that use short-term borrowing as a source of funds are more constrained in their lending activities. Moreover, the relationship between the loan spread and the loan amount is negative and significant, i.e. a higher (or lower) spread is associated with a lower (or higher) amount, as highlighted by Angbazo et al. (1998) and Carey & Nini (2007). The authors show that larger loans benefit from lower spreads. These conclusions remain valid in the full model.

Introducing the standard measures of ECB monetary policy, both the stand-alone coefficient of the $\Delta EONIA_j$ and the coefficient of the interaction term between the $\Delta EONIA_j$ and the short-term borrowings STB_i are not statistically significant, highlighting a null effect in standard measures of ECB monetary policy on banks' funding constraints (Model 2 – EONIA). In Models 3 and 4, we focus on the size of the ECB balance sheet and the non-standard policies, respectively. We assume that these two variables only indirectly affect syndicated bank lending through banks' short-term borrowings, compared with standard measures. In both models, the coefficient of the interaction term is positive and significant. These results, combined with the negative coefficient on STB_i, support the hypothesis that non-standard measures implemented by the ECB contribute to mitigating lender funding constraints. In Table 1.5 we compute the marginal effect of both the size of the balance sheet and the non-standard policies on bank lending behaviour for different levels of short-term borrowing.

The marginal effect of these two monetary-policy measures is positive for all levels of banks' short-term borrowing, showing that the tools implemented by the ECB support the supply of syndicated bank lending. In addition, we observe that this relationship

Table 1.4. – Baseline models

Variables	(1) Base Model	(2) EONIA	(3) Balance sheet	(4) Non-standard	(5) MP
Lender constraints					
CD_i	0.481***	0.481***	0.245***	0.121***	0.244***
STB_i	-0.088***	-0.088***	-0.352***	-0.216***	-0.353***
Monetary policy instruments					
$\Delta EONIA_j$		0.120	0.075***	0.096***	-0.040
STB_i*$\Delta EONIA_j$		-0.010			0.010
STB_i*Balance sheet			0.023***		0.023***
STB_i*Non-standard				0.014***	
Loan characteristics					
All-in spread	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
Observations	36,979	36,979	36,979	36,979	36,979
Other controls	No	No	No	No	No
Lender country	No	No	No	No	No
Year dummies	No	No	No	No	No
Lender FE	Yes	Yes	Yes	Yes	Yes
R^2	0.135	0.135	0.139	0.142	0.139

Notes : The dependent variable is the loan amount granted by each MFI included in the sample and taken as a logarithm. We run a cross-section regression of the 15 banking groups with robust standard errors. The table displays five different specifications : a Base model without any monetary policy instruments, an EONIA model with standard measures of the monetary policy, a Balance Sheet model with non-standard measures of the monetary policy proxied by the size of the ECB balance sheet, a Non-Standard model acting as a robustness check on the Balance Sheet model considering a more restrictive definition of non-standard measures than the size of the ECB balance sheet, and an MP model in which we include both standard and non-standard measures using the change in EONIA and the size of the ECB balance sheet, respectively. All regressions are run with a constant term. Table 1 provides the description of the variables. ***, **, * significant at 1%, 5%, and 10%, respectively.

Table 1.5. – Marginal effect of the size of the ECB balance sheet and the non-standard policies

STB_i		(3) Balance sheet	(4) Non-standard
Minimum	5.37	0.124	0.075
Maximum	12.97	0.298	0.182
Mean	10.89	0.250	0.152
Median	10.75	0.247	0.151

Notes : This table provides the marginal effect of the non-standard measures implemented by the ECB. STB_i are expressed in logarithms. We get the minimum, maximum, mean, and median of STB_i over the full sample of the 15 banking groups for the entire period under study. For each level of STB_i, we compute the marginal effect of the balance sheet and the non-standard policies by multiplying these values with the significant coefficient of the interaction term.

is more economically significant for high levels of STB_i. We conclude that the non-standard ECB instruments set up after the collapse of Lehman Brothers, contributing to the significant increase in the size of the ECB balance sheet, facilitate banks' access to funds, with this effect being even more significant for more constrained banks. As such, these credit institutions are more able to support their lending activities, alleviating the impact of the 2008 financial crisis. This is in line with the results of Model 5. In this specification, we consider ECB monetary policy as a whole (with interaction between STB_i and $\Delta EONIA_j$, and the size of the ECB balance sheet). In the former case, the coefficient is not significant, while in the second case, the coefficient is positive and significant, at a 1% confidence level. We then argue that non-standard measures are more effective than standard ones in providing banks with sufficient funds to compensate for a decrease in their deposit reserves. These results confirm the existence and effectiveness of the bank lending channel over the recent period for the syndicated loan market.
In Table 1.6 below, we run the same models with additional controls for the characteristics of the loan, borrower, lender, lender-borrower relationship, and macroeconomic environment. These additional variables allow us not only to better consider credit institutions' lending process and improve the fitting of our model (R^2 from 0.13 without controls to 0.27), but also to confirm our previous results and reinforce our conclusions.

Banks with a high level of customer deposits and/or a low level of short-term borrowing provide borrowers with larger loans. Both coefficients are economically and statistically significant at the 1% confidence level. This result corroborates Ivashina and Scharfstein's (2010) conclusions. The authors show that during the financial crisis, the decrease in new syndicated loans was exacerbated at banks with less-stable sources of funds (i.e. with a larger proportion of short-term debt, compared with insured deposits). Haas & Van Horen (2012) also highlight a contraction in lending supply after the Lehman collapse that is more significant for banks with more funding constraints. When raising funds is more expensive, banks tend to be more reluctant to grant credit, especially during financial crises. In this particular context, a central bank may intervene

Table 1.6. – Full models

Variables	(1) Base Model	(2) EONIA	(3) Balance sheet	(4) Non-standard	(5) MP
Lender constraints					
CD_i	0.226***	0.226***	0.098***	0.033	0.098***
STB_i	-0.058***	-0.056***	-0.278***	-0.183***	-0.277***
Monetary policy instruments					
$\Delta EONIA_j$	0.132***	0.402	0.145***	0.147***	0.274
STB_i*$\Delta EONIA_j$		-0.023			-0.011
STB_i*Bal. sheet			0.017***		0.017***
STB_i*N.-stand.				0.011***	
Loan characteristics					
All-in spread	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
Maturity	0.137***	0.137***	0.140***	0.143***	0.140***
Secured	-0.238***	-0.238***	-0.236***	-0.236***	-0.236***
Revolver ($< 1Y$)	0.015	0.014	0.016	0.016	0.015
Revolver ($> 1Y$)	-0.179***	-0.179***	-0.185***	-0.190***	-0.185***
Term loan	-0.157***	-0.157***	-0.159***	-0.162***	-0.159***
Seasonal effect	0.072***	0.072***	0.079***	0.070***	0.079***
Borrower characteristics					
Sector Manuf	-0.105***	-0.104***	-0.103***	-0.103***	-0.103***
Sector Finance	-0.621***	-0.621***	-0.621***	-0.620***	-0.621***
Sector Services	0.051**	0.051**	0.049**	0.049**	0.049**
Sector Transports	0.025	0.025	0.025	0.027	0.025
Industry Risk	-8.723***	-8.718***	-6.623***	-6.623***	-6.631***
Investment grade	0.795***	0.795***	0.794***	0.793***	0.794***
Junk grade	0.258***	0.258***	0.255***	0.253***	0.255***
Domestic	-0.398***	-0.398***	-0.397***	-0.392***	-0.397***
Lender characteristics					
$\Delta T1$	0.000	0.000	0.001	0.001	0.001
Lead	0.327***	0.327***	0.318***	0.312***	0.318***
Strategy	0.181***	0.181***	0.180***	0.179***	0.180***
Lender-Borrower Relationship					
Relation. (1Y)	0.223***	0.223***	0.227***	0.230***	0.227***
Macroeconomic environment					
ΔGDP	-0.023***	-0.023***	0.008	0.019**	0.008
BLS	-0.002***	-0.002***	-0.002**	-0.001*	-0.002**
Observations	35,850	35,850	35,850	35,850	35,850
Lender country	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes
R^2	0.274	0.274	0.275	0.276	0.275

Notes : We run a cross-section regression of the 15 banking groups with robust standard errors. The table displays five different specifications : a Base model without any monetary policy instruments, an EONIA model with standard measures of the monetary policy, a Balance Sheet model with non-standard measures of the monetary policy proxied by the size of the ECB balance sheet, a Non-Standard model run as a robustness check of the Balance Sheet model considering a more restrictive definition of non-standard measures than the size of the ECB balance sheet, and an MP model in which we include both standard and non-standard measures using the change in EONIA and the size of the ECB balance sheet, respectively. All regressions are run with a constant term. Table 1 provides the description of the variables. ***, **, * are significant at 1%, 5%, and 10%, respectively.

to alleviate these constraints, supporting the credit supply and limiting the impact of a crisis on the real economy.

As such, our previous conclusions on the bank lending channel and the transmission of monetary policy through banks' short-term borrowing remain unchanged. The accommodating ECB monetary policy significantly impacted banks' lending activities by cutting down their funding constraints, with the effect being fully driven by non-standard measures. These results highlight the critical need for the ECB to develop new, non-standard measures to overcome the limits of standard measures during crises. The ECB had to intervene with additional major measures in 2008 to limit the spread of the crisis to the real economy. As such, our analysis underlines how the ECB's non-standard measures enabled banks to maintain credit supplies with the ultimate recipient being the borrowing parties.

In this model, we also control for a set of variables notably related to the characteristics of each loan, and our results are in line with the literature. We show that larger loans are characterised by lower all-in spread and higher maturity (Angbazo et al., 1998; Carey & Nini, 2007). Banks tend to decrease their investment in syndicated loans when a loan is secured, as it implies a higher level of the borrower's credit risk. Berger and Udell (1990) study the relationship between collateral and credit risk. They argue that highly risky borrowers/loans are associated with collateral. This positive link between credit risk and secured loans relies on banks' ability to assess borrowers' credit risk. If this risk is observable, only a restrictive sample of risky borrowers will pledge collateral. Loan type also has a significant influence on loan amounts, with banks decreasing their investments in revolving loans with a maturity higher than a year, and on term loans. Finally, the amount increases when the loan is issued during the fourth quarter of the year.

When considering the industry of the borrower, banks granted smaller loans to manufacturing and financial sectors over the period under study, while the service industry benefitted from larger loans. Consistently, when the industry risk increases, the loan

amount decreases. In addition, a good credit rating helps the borrowing company secure a larger loan, especially if the company rates in the investment-grade range (from AAA to BBB-), as the information asymmetry, as well as the credit risk, are lower. However, we found that domestic borrowers are granted loans of lower amounts than foreign borrowers. This result seems inconsistent with the literature that shows evidence of a flight-to-home effect, with banks lending more to domestic companies. Cerutti et al. (2015) show that information asymmetries are significant drivers of cross-border loans. The greater the geographical distance between lenders and the borrower, the lower the size of this type of loan. Epstein (2001) argues that banks are less likely to grant credit when they are less able to assess borrowers' credit risk. This risk aversion increases with the distance between the lender and the borrower. These conclusions drawn from the literature may be mitigating in the international syndicated loan market, where banks group together in a syndicate to lend to one company sharing both risk and expertise. The characteristics of the lender also have a significant impact on the amount invested. First, lead lenders grant loans of larger amounts than other lenders. Sufi (2007) emphasises the role of information asymmetry between lenders and borrowers, on the composition of the syndicate, and on amounts invested by lenders. He shows that lead lenders retain a larger proportion of the loan amount when the information asymmetry is more significant due to reputational issues and more intense efforts provided in screening and monitoring processes. Second, the coefficient related to the specialty of lenders in terms of industry is positive and significant at the 1% confidence level, supporting the 'focus strategy' hypothesis. When they are used to lend to a specific industry, banks develop expertise in the industry's characteristics and its cycles, investing in research and monitoring efforts (Acharya et al., 2006). As such, they become more willing to lend to companies that belong to the particular industry.

In line with the literature, the relationship variable highlights a positive and significant coefficient indicating that banks issue larger loans to borrowers who already have taken out loans with them in the past. In addition, banks experience higher costs when lending

to a company for the first time compared with other companies with whom they already have done business. Regarding the macroeconomic environment, results on the change in GDP are mixed while we observe a lower average loan amount when banks anticipate an increase in the demand for credit.

1.7. Weakly vs. Strongly Capitalised Banks

According to Gambacorta & Marques-Ibanez (2011) and Jiménez & Ongena (2012) among others, shocks to financial and monetary conditions do not have the same impact on banks, depending on their level of capital and liquidity. Gambacorta and Marques-Ibanez (2011) show that weakly capitalised banks with a higher dependence on market funding reduced credit availability more significantly than other banks during the financial crisis that began in 2008. In addition, Jiménez et al. (2014) highlight greater vulnerability at banks with low capital or liquidity when monetary and macroeconomic conditions worsen. Facing an increase in short-term interest rates or a decrease in GDP, these weakly capitalised banks grant fewer loans than strongly capitalised banks, thereby worsening the credit crunch. Overall, these studies find that the composition and strength of banks' balance sheets play a significant role in the transmission channel of monetary policy. As such, assessing the effectiveness of monetary-policy transmission through the bank lending channel requires a deeper analysis of these fluctuations between weakly and strongly capitalised banks. In the previous section, we show that non-standard measures implemented by the ECB following the collapse of Lehman Brothers contribute to alleviating banks' funding constraints, ultimately supporting credit availability. We now want to investigate further the extent to which these conclusions depend on the strength of banks' balance sheets.

In line with the literature, we sort the 15 banking groups in our sample according to their level of capital ratio, defined as a bank's common equity to total assets. To rank these

banking groups, we compute the average capital ratio over the pre-crisis period from 2004 until the Lehman collapse in 2008. As such, we identify banks that were weakly (or strongly) capitalised before the crisis, and we assess how the financial and monetary shocks affect the two subgroups of banks. To clearly distinguish between weakly and strongly capitalised banks, we focus the analysis on banks that are below the bottom tercile and above the top tercile, respectively. Each of the two subgroups contains five banks, with the lowest and the highest pre-crisis capital ratios respectively. We run the cross-section regressions for each subgroup separately.

Given our database, we are confident that this analysis will allow us to make good inferences on how monetary-policy tools impact credit supply, depending on the level of each bank's capital. According to the literature, we expect the bank lending channel to be more effective for weakly capitalised banks, which are more vulnerable to wide swings in monetary conditions. Results are provided in Tables 1.7 and 1.8.

We show that both subgroups of banks adopt the same lending behaviour, depending on their funding constraints, also in line with previous conclusions. Having more deposits (or less short-term borrowing) significantly increases the loan amounts provided to borrowers. The results differ between the two groups when considering the implementation of monetary policy. Standard measures have an impact on strongly capitalised banks that is statistically significant, though not significant for weakly capitalised banks, in both the models 2 and 5. However, given that both the coefficient on the change in EONIA and the coefficient on the interaction between the latter and each bank's level of short-term borrowings are significant, when one computes the marginal effect of standard measures on loan amount, the economic impact is close to zero, especially for high levels of short-term debt. As such, we conclude that standard measures are not effective in supporting credit supply for syndicated loans.

On the contrary, and in line with previous results, non-standard accommodating measures are more effective than standard ones, especially when dealing with weakly capita-

Table 1.7. – Weakly vs. strongly capitalised banks : Model (1) to (3)

Variables	(1) Base Model		(2) EONIA		(3) Balance sheet	
	Weak	Strong	Weak	Strong	Weak	Strong
			Lender constraints			
CD_i	0.325***	0.440***	0.325***	0.387***	0.121**	0.384***
STB_i	-0.108***	-0.174***	-0.109***	-0.119***	-0.331***	-0.295**
			Monetary policy instruments			
$\Delta EONIA_j$	0.113***	0.113	-0.038	1.815***	0.128***	0.118
STB_i * $\Delta EONIA_j$			0.013	-0.162**		
STB_i*Bal. sheet					0.017***	0.009
STB_i*Non-stand.						
Observations	20,744	3,822	20,744	3,822	20,744	3,822
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Lender country	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes	Yes
R	0.238	0.386	0.238	0.387	0.239	0.386

Notes : We run a cross-section regression with robust standard errors of 10 banking groups sorted out as weakly (or strongly) capitalised banks because they have the lowest (or highest) capital ratio (defined as common equity to total assets). The table displays five different specifications, i.e. a Base model without any monetary policy instruments, an EONIA model with standard measures of the monetary policy, a Balance Sheet model with non-standard measures of the monetary policy proxied by the size of the ECB balance sheet, a Non-Standard model run as a robustness check of the Balance Sheet model considering a more restrictive definition of non-standard measures than the size of the ECB balance sheet, and an MP model in which we include both standard and non-standard measures using the change in EONIA and the size of the ECB balance sheet, respectively. The five different specifications are run separately for each of the two subgroups of banks. All regressions are run with a constant term. Table 1 provides the description of the variables. ***, **, * are significant at 1%, 5%, and 10%, respectively.

Table 1.8. – Weakly vs. strongly capitalised banks : Model (4) and (5)

Variables	(4) Non-standard		(5) MP	
	Weak	Strong	Weak	Strong
	Lender constraints			
CD_i	0.031	0.288***	0.093	0.339***
STB_i	-0.224***	-0.325***	-0.341***	-0.226*
	Monetary policy instruments			
$\Delta EONIA_j$	0.131***	0.122	-0.037	1.792**
STB_i * $\Delta EONIA_j$			0.012	-0.159**
STB_i*Bal. sheet			0.017***	0.008
STB_i*Non-stand.	0.011***	0.012***		
Observations	20,744	3,822	20,744	3,822
Other controls	Yes	Yes	Yes	Yes
Lender country	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes
R	0.239	0.387	0.239	0.387

Notes : We run a cross-section regression with robust standard errors of 10 banking groups sorted out as weakly (or strongly) capitalised banks because they have the lowest (or highest) capital ratio (defined as common equity to total assets). The table displays five different specifications, i.e. a Base model without any monetary policy instruments, an EONIA model with standard measures of the monetary policy, a Balance Sheet model with non-standard measures of the monetary policy proxied by the size of the ECB balance sheet, a Non-Standard model run as a robustness check of the Balance Sheet model considering a more restrictive definition of non-standard measures than the size of the ECB balance sheet, and an MP model in which we include both standard and non-standard measures using the change in EONIA and the size of the ECB balance sheet, respectively. The five different specifications are run separately for each of the two subgroups of banks. All regressions are run with a constant term. Table 1 provides the description of the variables. ***, **, * are significant at 1%, 5%, and 10%, respectively.

lised banks. As stated above, these banks are more sensitive to monetary shifts, and our results confirm this hypothesis. The two proxies, i.e. the size of the ECB balance sheet and the more restrictive variable of non-standard measures, display a positive and significant coefficient, while only the latter is significant for strongly capitalised banks. As such, we show not only that non-standard measures support credit supply with a positive impact on loan amounts, but also that this positive impact is stronger for banks with less capital. We conclude that the accommodating monetary policy implemented by the ECB after the Lehman collapse contributed to a significant reduction in funding constraints at weakly capitalised banks, leaving them better able to support credit supply. The conclusions on control variables remain strictly identical to the previous analysis.

1.8. Robustness Checks

In the section below, we run two additional tests to assess the robustness of our results.

1.8.1. No influence from outliers

For the first robustness check, we remove the outliers from our sample to ensure that they do not influence our results. We define an outlier as a loan with an amount (taken as a natural logarithm) lower (or higher) than the first (or ninth) decile. Table 1.9 displays the results of the cross-section regressions run on this restricted sample. Our conclusions are strictly identical.

1.8.2. Adjusting for credit demand using borrower fixed effects

In the second robustness check, we aim at ensuring that we correctly control for credit demand in our main regressions using an alternative approach based on the introduction of borrower fixed effects. The main advantage of this approach is to better take into

Table 1.9. – Results without outliers

Variables	(1) Base Model	(2) EONIA	(3) Balance sheet	(4) Non-standard	(5) MP
Lender constraints					
CD_i	0.210***	0.210***	0.114***	0.077***	0.114***
STB_i	-0.049***	-0.049***	-0.214***	-0.136***	-0.216***
Monetary policy instruments					
$\Delta EONIA_j$	0.026	0.025	0.033*	0.033*	-0.116
STB_i*$\Delta EONIA_j$		0.000			0.013
STB_i*Balance sheet			0.013***		0.013***
STB_i*Non-standard				0.008***	
Observations	28,699	28,699	28,699	28,699	28,699
Other controls	Yes	Yes	Yes	Yes	Yes
Lender country	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes
R^2	0.199	0.199	0.201	0.202	0.201

Notes : We run a cross-section regression of the 15 banking groups with robust standard errors and remove the outliers. An outlier is defined as a loan with an amount (taken as a natural logarithm) lower (or higher) than the first (or ninth) decile. The table displays five different specifications : a Base model without any monetary policy instruments, an EONIA model with standard measures of the monetary policy, a Balance Sheet model with non-standard measures of the monetary policy proxied by the size of the ECB balance sheet, a Non-Standard model run as a robustness check of the Balance Sheet model considering a more restrictive definition of non-standard measures than the size of the ECB balance sheet, and an MP model in which we include both standard and non-standard measures using the change in EONIA and the size of the ECB balance sheet, respectively. All regressions are run with a constant term. Table 1 provides the description of the variables. ***, **, * are significant at 1%, 5%, and 10%, respectively.

account all of the characteristics of the borrowing companies. However, the drawback is the reduction in the size of our sample as we focus the analysis only on companies that have at least two loans, one before and one during the crisis, granted by at least two different banks. Given the size of our sample, we consider this analysis a good robustness check of our main test, in line with the literature attempts to better distinguish between credit supply and credit demand (Khwaja & Mian, 2008, among others). Table 1.10 presents the results.

The coefficients for lender constraints share similarities with coefficients in previous analyses. The slight change is that either customer deposits have a positive and significant coefficient or short-term borrowing has a negative and significant coefficient. No regression contains the two significant coefficients at the same time. Despite this small difference, the conclusions remain similar, i.e. a bank relying more on customer deposits than on short-term borrowing provides loans in larger amounts. The conclusions regarding the impact of monetary policy remain strictly identical. Non-standard measures are more effective than standard measures in supporting the credit supply of syndicated loans by reducing banks' funding constraints.

1.9. Conclusion

The objective of this paper is to assess whether and how the monetary policy implemented by the ECB manages to alleviate the impact of the 2008 financial crisis on syndicated bank lending. The innovation of this paper relies on our investigation of the role played by both standard and non-standard measures on banks' credit supplies. Following the Lehman collapse, the ECB, as well as other central banks globally, had to implement new tools to overcome the limits of standard measures to address the severity of the financial crisis. This new development at unprecedented levels requires a reassessment of the bank lending channel as a transmission mechanism for monetary

Table 1.10. – Full models with borrower*time fixed effects

Variables	(1) Base Model	(2) EONIA	(3) Balance sheet	(4) Non-standard	(5) MP
Lender constraints					
CD_i	0.187***	0.188***	0.042	0.002	0.046
STB_i	0.010	0.010	-0.254***	-0.113***	-0.248***
Monetary policy instruments					
$\Delta EONIA_j$	0.198***	0.989**	0.219***	0.217***	0.859**
STB_i*$\Delta EONIA_j$		-0.067*			-0.054
STB_i*Balance sheet			0.021***		0.020***
STB_i*Non-standard				0.012***	
Observations	12,569	12,569	12,569	12,569	12,569
Other controls	Yes	Yes	Yes	Yes	Yes
Lender country	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes
R^2	0.658	0.658	0.659	0.660	0.659

Notes : We run a cross-section regression of the 15 banking groups with robust standard errors and remove the outliers. An outlier is defined as a loan with an amount (taken as a natural logarithm) lower (or higher) than the first (or ninth) decile. The table displays five different specifications : a Base model without any monetary policy instruments, an EONIA model with standard measures of the monetary policy, a Balance Sheet model with non-standard measures of the monetary policy proxied by the size of the ECB balance sheet, a Non-Standard model run as a robustness check of the Balance Sheet model considering a more restrictive definition of non-standard measures than the size of the ECB balance sheet, and an MP model in which we include both standard and non-standard measures using the change in EONIA and the size of the ECB balance sheet, respectively. All regressions are run with a constant term. Table 1 provides the description of the variables. ***, **, * are significant at 1%, 5%, and 10%, respectively.

policy.

To answer these questions, we run an empirical analysis on syndicated loan amounts provided by a sample of 15 European banking groups between 2004 and 2014. The use of six different databases allows us to integrate the precise characteristics of all players involved with banking transactions into our data and conclusions. We show that customers' deposits are an important driver of bank lending activities in this specific market, as an increase in quarterly deposits leads to higher lending amounts. On the contrary, banks with a higher level of short-term borrowing will provide smaller loans.

Considering the transmission of ECB monetary policy, our empirical analysis of the syndicated loan market provides evidence of the existence of the bank lending channel. Non-standard ECB policies successfully reduce these funding constraints, while standard measures are ineffective. The innovative, accommodating ECB monetary policy facilitates banks' access to alternative sources of funds, reducing the constraints imposed by a high level of short-term borrowing. On average, the instruments used by the ECB seem to play a significant role in reducing the constraints on financial markets, supporting credit supply for syndicated loans.

These results contribute to the debate on the effectiveness of such unforeseen measures. We argue that these measures limited the spillover effects of the 2008 financial crisis into the real economy by supporting bank lending activities. A further extension of this paper would involve deepening the analysis per sub-period, with more detailed data on ECB open-market operations to better understand the mechanisms of each instrument in monetary policy.

2

The signaling channel : a new measure of the ECB communication

This paper is a joint work with T. Renault.

Abstract

We develop a field-specific dictionary to measure the stance of the European Central Bank monetary policy (dovish, neutral, hawkish) and the state of the Eurozone economy (positive, neutral, negative) through the content of ECB press conferences. In contrast with traditional textual analysis, we propose a novel approach using term-weighting and contiguous sequence of words (n-grams) to better capture the subtlety of central bank communication. We find that quantifying ECB communication using our field-specific weighted lexicon help predicting future ECB monetary decision when considering an augmented Taylor rule. Regarding European stock market volatility, we find that market are more (less) volatile on the day following a conference with a negative (positive) tone about the euro area economic outlook. Our indicators significantly outperform a textual classification based on the Loughran-McDonald or Apel-Blix-Grimaldi dictionaries and a media-based measure of economic policy uncertainty.

Keywords : ECB, textual analysis, monetary policy, stock market volatility, interest rates

JEL classification : E43, E52, G12

2.1. Introduction

> *"What matters for transparency is therefore clarity as well as openness. For a new and supranational institution like the ECB, it is particularly important that it sends clear and coherent messages to the markets and the wider public."*
>
> Otmar Issing (Executive Board Member of the ECB) - 1999

In recent years, central banks have moved towards greater transparency (Geraats, 2002) in terms of objectives, procedures, rationales, models, and data. Central banks now reveal more information to the public by (i) describing the strategy that guides policy decisions, (ii) explaining current policy decisions, (iii) interpreting economic conditions and giving views on future economic outlook, and (iv) making statements about future policy (Woodford, 2005). In this regard, central bank communication has become a key instrument in the central bankers' toolbox, particularly during periods of high uncertainty or when the interest rates reach the zero lower bound (Filardo & Hofmann, 2014). By managing expectations, communication may improve the predictability of monetary policy and reduce volatility in financial markets (see Blinder et al., 2008, for a survey, and Sturm & De Haan, 2011, among others).

Since its creation in 1998, the European Central Bank (ECB) has placed a strong focus on transparency, using various channels of communication to send "clear and coherent messages to the markets and the wider public." While interviews, speeches, press releases (and more recently webcasts and tweets) have developed over time, the main channel of communication used by the ECB is the press conference held after the Government Council meeting. Every six weeks,[a] the President and the Vice President of the ECB explain their monetary policy decision and answer questions from journalists during a press conference. While every word pronounced by central banks officials is closely scrutinized by decision makers and market participants, converting qualitative content into quantitative indicators remains a challenge for researchers.

a. ECB adjusted the schedule of meetings from a four-week cycle prior to 2015 to a six-week cycle from now on.

Building on previous works from textual analysis, we propose a new methodology to quantify ECB communication. Manually classifying all sentences in all ECB press conferences between January 2006 and December 2014, we develop a field-specific lexicon to measure the stance of the ECB monetary policy (dovish, neutral, hawkish) and the Governing Council views on the Eurozone economic outlook (positive, neutral, negative). Using a term-weighting approach, we compute a monetary policy indicator and an economic outlook indicator by analyzing words and group of words appearing in each introductory statement. Then, we assess if our indicators contain value-relevant information, not already measured by alternative quantification from the literature, about future monetary policy decisions or future European stock market returns and volatility.

We find that quantifying ECB communication using a field-specific weighted lexicon helps in predicting future ECB monetary decisions and market volatility. A dovish (hawkish) textual content about monetary policy and a negative (positive) economic outlook both predict a dovish (restrictive) decision at the next ECB meeting. A dovish (hawkish) monetary policy and a positive (negative) economic outlook both predict a decrease (increase) in market volatility the day after the ECB statement. We also provide evidence showing that traditional approaches using equal-weighted single word lists such as the Loughran & McDonald (2011) financial dictionary (LM hereafter) and the Apel & Blix-Grimaldi (2012) central banking dictionary fail to capture the forward-looking content of the ECB introductory statement. We believe that researchers interested in quantifying central bank communication should pay specific attention to the methodology used to derive quantitative indicators from qualitative textual content. To encourage further research in this area and enhance replicability, all data used in this paper are available online. [b]

Our paper is organized as follows. In Section 2.2, we review the literature on the quantification of central bank communication and its influence on the predictability of monetary policy and financial markets. Section 2.3 details the data and describes how we

b. http://www.cbcomindex.com

create quantitative indicators of monetary policy and economic outlook from textual ECB statements. Section 2.4 reports our methodology and empirical findings about future monetary policy decisions. Section 2.5 reports our methodology and empirical findings on market volatility and market returns. Section 2.6 presents robustness checks. Finally, Section 2.7 concludes the paper.

2.2. Related Literature

This article relates to three strands of the literature on central bank communication : (i) its quantification through textual analysis, (ii) its influence on the predictability of monetary policy, and (iii) its impact on asset prices and market volatility.

Regarding the quantification of central bank communication, two main methods have been used in the literature. [c] First, central bank communication can be coded manually, following the narrative approach of monetary policy decisions proposed by Romer & Romer (1989). While researchers can convert communication into quantitative indicators on various topics, for example, the importance that policymakers assign to reducing inflation relative to promoting real growth (Boschen & Mills, 1995) or central bank views on exchange rate valuation (Dewachter et al., 2014), the most common classification consists of grading communication depending on monetary policy inclinations. Looking at the ECB, this approach was followed by Musard-Gies (2006) and Rosa & Verga (2007), who hand-coded each statement, according to the tone of the communication, into a discrete variable between +2 (very hawkish) and -2 (very dovish). [d] Gerlach (2007) implement a similar methodology for ECB Monthly Bulletins.

As a next step toward a better understanding of communication, and in line with the findings of Kohn et al. (2004) on the importance of central bank communication related

c. Other methods used on the literature for topics detection include unsupervised topic classification (Latent Dirichlet Allocation in Jegadeesh & Wu (2015) or Latent Semantic Analysis in Boukus & Rosenberg (2006)). Machine learning methods for sentiment analysis have also been considered by Moniz & de Jong (2014))

d. +1 (hawkish), 0 (neutral), -1 (dovish)

to economic conditions and economic outlooks, Berger et al. (2011) categorize the overall monetary policy stance on a scale from -3 (strong inclination to lower rates) to +3 (strong inclination to increase rates) using four subcategories : overall policy intention, price stability, real economy, and monetary sector. Likewise, Conrad & Lamla (2010) classify each sentence of the ECB statements into four categories (price developments, real economy, monetary aggregates, exchange rate) and three tendencies (positive, neutral, negative).

While manual classification is easy to implement, it presents several drawbacks. First, manual scoring is by definition subjective. For example, considering 62 ECB press conferences between 1999 and 2004, Carlo Rosa and Giovanni Verga (in Rosa & Verga 2007) disagree on 14 (22.58%) statements. Second, converting a document into a discrete class variable prevents from consideration of the smooth evolution of central bank communication. [e] Third, except when classified data are publicly available, the results are not easily reproducible, limiting further research and comparability.

To solve (partly) those issues, another strand of literature relies on dictionary-based and word-count approaches. The simplest example is provided by Jansen & De Haan (2007), who quantify communication regarding risks to price stability by simply counting the frequency of the word "*vigilance*" in ECB communications. A more standard approach consists of counting the number of positive and negative words in central bank communication using a pre-defined list of signed words from the Harvard IV-4 psychosociological dictionary or the LM financial dictionary. Using a bag-of-words approach as in Tetlock (2007), Jegadeesh & Wu (2015) convert FOMC meeting minutes into quantitative sentiment indicator, considering both Harvard IV and LM dictionaries. Schmeling & Wagner (2015) quantify ECB press conference by computing the ratio of negative words to total words using the LM financial dictionary. A similar methodology is used, among others, by Hansen et al. (2014), Cannon (2015), and Jansen et al. (2016).

However, given the specificity of central bank communication in terms of the content,

e. If the classification is done at the sentence level instead of the document level, nearly continuous variables can be generated by aggregating/averaging across sentiments and topics.

structure, and topics discussed, quantifying communication using a non field-specific lexicon may fail to capture all the dimensions and subtlety of central bank communication. Although the LM word lists have been increasingly popular in the latest researches, content analysis can be further improved by constructing more authoritative and extensive field-specific dictionaries (Kearney & Liu, 2014).

The second step of any quantitative analysis on central bank communication is to assess whether value-relevant "soft information" can be extracted from textual content. To address this question, the main methodology consists of adding a communication variable into traditional models (Taylor rule, asset pricing, market volatility) to analyze empirically if communication improves our understanding (or forecasts) of monetary policy or financial markets.

Regarding the predictability of future monetary policy decisions, several articles find that communication successfully conveys information not included in the available macroeconomic data. Rosa & Verga (2007) and Heinemann & Ullrich (2008) prove that including central bank communication improves the forecasts of ECB interest rate decisions from a Taylor (1993) rule model. These results hold even when forward-looking macroeconomic variables and interbank interest rates are considered (Sturm & De Haan, 2011). Analyzing foreign exchange markets, Conrad & Lamla (2010) find that the Euro currency appreciates against the US dollar in response to statements about increasing risks to price stability. Jansen & De Haan (2005) show that communication triggers an increase in volatility while Dewachter et al. (2014) provide evidence of large jumps in the exchange rate for several hours after the release. Regarding the equity market, Sadique et al. (2013) show that the Federal Reserve Beige Book tone affects stock market volatility and trading volume. At the intraday level, Jegadeesh & Wu (2015) confirm that the tone of FOMC minutes helps in predicting stock market volatility and returns. Schmeling & Wagner (2015) find that a positive (negative) tone in ECB communication is associated with an increase (decrease) in stock prices and a lower (higher) volatility.

In this paper, we depart from the existing literature by proposing a novel methodology

to quantify ECB communication. We provide evidence showing that developing a field-specific lexicon significantly improves the predictability of future monetary policy. We also prove that disentangling content related to monetary policy from content related to the economic outlook improves the forecasting of both monetary policy and financial markets.

2.3. Quantifying ECB communication

To quantify ECB communication, we propose a novel methodology. We first manually classify all sentences in all ECB introductory statement into two categories (monetary policy and economic outlook) and three inclinations (positive, neutral, and negative). Then, for each word (or group of words, n-grams hereafter) appearing in at least two ECB introductory statements, we compute the probability that this n-gram belongs to one of our two categories and three inclinations. Last, we compute the tone of each ECB statement by summing n-grams' probabilities, using a term-weighting approach.

2.3.1. Field-specific lexicon generation

Several issues exist when popular lexicons used in the finance literature, such as the Harvard IV or LM dictionary, are applied to quantify ECB communication. First, as Rosa & Verga (2007) and Berger et al. (2011) already pointed out, the ECB employs a very standardized form of communication, both in terms of structure and keywords used. Comparing words used in ECB communication over time, Amaya & Filbien (2015) document an increase in speech similarity, consistent with a standardization of communication. In this regard, applying a non-field specific lexicon may fail to capture all specificities of central bank communication. For example, in the LM dictionary,[f] the word "*downward*" is classified as negative while "*upward*" is not classified, whereas both words

f. We used the latest update of their dictionary available on Bill McDonald's website http://www3.nd.edu/ mcdonald/Word_Lists.html

are perfect opposites [g] in the ECB's introductory statements. Second, considering single words (unigrams) rather than a contiguous sequence of *n* words (n-grams) might cause improper classification of tone. For example, "lower unemployment" (May 2007) will be classified as negative using the LM dictionary due to the presence of the negative word "unemployment." Similarly, "risks to financial stability" (Sept. 2012) will be considered as positive using the LM dictionary due to the presence of the positive word "stability."

To address these limits, we generate a field-specific lexicon designed to quantify central bank communication. More precisely, we consider all sentences in all ECB introductory statements released between January 2006 and December 2014, covering 68 speeches from Jean-Claude Trichet and 38 speeches from Mario Draghi. For each of the 7,333 individual sentences, we follow a standard textual analysis methodology by (i) converting all words to lower case, removing numbers and punctuation (ii) using a Porter (1980) stemming algorithm to reduce inflected words to their word roots (e.g, "increasing" to "increas", "unemployment" to "unemploy"), and (iii) removing a set of 32 stop words (e.g, a, the, an, of, to...). Then, following Kohn et al. (2004), we classify manually all 7,333 sentences pronounced during ECB introductory statements into seven categories and inclinations : (1) monetary policy hawkish, (2) monetary policy neutral, (3) monetary policy dovish, (4) economic outlook positive, (5) economic outlook neutral, (6) economic outlook negative, and (7) none. [h] The first three categories are grouped into a topic labeled *Monetary Policy* (MP) and refer to the monetary policy decisions of the ECB Governing Council, without considering references to past decisions. [i] This topic also includes references to the short and medium term views of the

g. Two examples : "the range for real GDP growth this year has been revised upwards" (Sept. 2010) and "the ranges for real GDP growth in 2011 and 2012 have been revised downwards" (Sept. 2011).

h. Each sentence is classified into the category that matters most, even though in a few cases, a sentence may include information about monetary policy and economic outlook. For example, the sentence "Monetary developments therefore continue to require very careful monitoring, particularly against the background of improved economic conditions and continued strong property market developments in many parts of the euro area" (Jan. 2007) contains "monetary policy hawkish" information justified by an "economic outlook positive" part. In this specific example, we consider that "what matters most" is the "monetary policy hawkish" tonality.

i. For example, the sentence "The information that has become available since our last meeting has further underpinned the reasoning behind our decision to increase interest rates in [...]" appeared six times between November 2006 and August 2008. We consider this sentence as "not related to monetary

Governing council on the expected path of monetary policies (see Appendix B.1 for selected sentences). The next three categories are grouped into a topic labeled *Economic Outlook* (EC hereafter ; see Appendix B.2 for selected sentences) and focus on policy makers' descriptions of the current economic situation and their views on the future economic outlook. The last category (*None*, see Appendix B.3 for selected sentences) groups sentences not directly relevant to either monetary policy decisions or the Governing Council's economic outlook. This category also includes sentences presenting data that have already been released before ECB statements (HICP inflation, real GDP growth, monetary aggregates...) without any forward-looking statement or additional information.

For each n-gram *n* (from 1-gram to 10-grams) appearing at least twice in our sample, we count the frequency of occurrence of that n-gram in each of the seven categories defined previously, and we compute the probability that it belongs to category *c* (MP or EC) with the inclination *i* (dovish, neutral, hawkish for MP – positive, negative, neutral for EC).

$$P_n^{c,i} = \frac{number\ of\ occurrence\ {}_n^{c,i}}{total\ number\ of\ occurence\ {}_n} \tag{2.1}$$

Table 2.1 presents, for a selected sample of n-grams, the total number of occurrence (#) and the associated probabilities $P_n^{i,c}$. For example, the bigram "consumption growth" appears 22 times in our sample : 20 times (91%) in sentences classified manually as "economic outlook positive" and 2 times (9%) in sentences classified as "economic outlook negative[j]."

We define our field-specific lexicon by considering only n-grams with a probability over 0.5 in one of our six classes of interest (MP hawkish/neutral/dovish – EC positive/neutral/negative). With this exclusion, our final field-specific lexicon, denoted *n'*, is

policy nor economic outlook" as it does not convey new information to market participants.

j. "Consumption growth" was classified in "negative economic outlook" sentences during two speeches (Jan. 2010, Feb 2010) : "In addition, low capacity utilisation rates are likely to dampen investment, and unemployment in the euro area is expected to increase somewhat further, thereby lowering consumption growth." The trigram "lowering consumption growth" has a probability of 1 of being associated with a "negative economic outlook" in our lexicon, in such a way that all sentences are properly classified.

Table 2.1. – Term Frequency and Probabilities - Sample n-grams

		Monetary Policy			Economic Outlook			
n-grams	#	Dovi	Neut	Haw	Posi	Neut	Nega	None
act firm time manner ensur price stabil	15	0.0	0.0	0.93	0.0	0.0	0.0	0.06
remain present lower level extend period time	11	1.0	0.0	0.0	0.0	0.0	0.0	0.0
purchas	110	0.27	0.04	0.04	0.6	0.0	0.02	0.54
cover bond purchas	4	1.0	0.0	0.0	0.0	0.0	0.0	0.0
close readi consid all avail instrument	3	1.0	0.0	0.0	0.0	0.0	0.0	0.0
decid reduc key ecb interest rate	7	1.0	0.0	0.0	0.0	0.0	0.0	0.0
decid increas key ecb interest rate	9	0.0	0.0	1.0	0.0	0.0	0.0	0.0
decid leav key ecb interest rate unchang	22	0.0	1.0	0.0	0.0	0.0	0.0	0.0
uncertainti	178	0.01	0.01	0.00	0.18	0.10	0.59	0.09
uncertainti remain elev	15	0.0	0.0	0.0	0.66	0.13	0.2	0.0
uncertainti result turmoil financi	6	0.0	0.0	0.0	0.0	0.0	1.0	0.0
improv domest demand	8	0.0	0.0	0.0	1.0	0.0	0.0	0.0
advers	38	0.0	0.0	0.0	0.1	0.0	0.85	0.05
develop	799	0.06	0.15	0.11	0.14	0.06	0.18	0.31
world economi	39	0.0	0.0	0.0	0.46	0	0.46	0.08
advers develop world economi	8	0.0	0.0	0.0	0.0	0.0	1.0	0.0
consumpt growth	22	0.0	0.0	0.0	0.91	0.0	0.09	0.0
lower consumpt growth	2	0.0	0.0	0.0	0.0	0.0	1.0	0.0
been revis	40	0.0	0.0	0.0	0.35	0.04	0.54	0.04
been revis downward	15	0.0	0.0	0.0	0.0	0.06	0.87	0.06
been revis upward	13	0.0	0.0	0.0	0.84	0.07	0.07	0.0
been revis slightli upward	3	0.0	0.0	0.0	0.75	0.0	0.0	0.25
dampen	102	0.06	0.00	0.0	0.07	0.03	0.65	0.16
dampen underli growth momentum	9	0.0	0.0	0.0	0.0	0.0	1.0	0.0

Notes : This table shows, for a list of selected n-grams, the total number of occurrence and the probabilities $P_n^{i,c}$ associated. For example, the word "uncertainty" was pronounced 178 times during ECB introductory statement between January 2006 and December 2014, of which 105 times (59%) in sentence associated with a "negative economic outlook". The 4-grams "uncertainti result turmoil financi" was pronounces 6 times and is always associated with a negative economic outlook.

composed of 34,052 n-grams.[k]

2.3.2. Monetary Policy and Economic Outlook indicators

For a given introductory statement s, we analyze all words and groups of words pronounced by the ECB President, and we consider a term-weighted approach using our field-specific lexicon. More precisely, we define the probability for a statement s of being

k. For example, we do not consider the bigram "world economy" as it appears 39 times, of which 18 times are EC positive (46.15%), 18 times are EC negative (46.15%), and 3 times are NONE (7.7%), in such a way that it does not convey clear information about the tonality of ECB communication by itself. However, the fourgram "adverse development world economy" is included in our lexicon as it appears 100% of the time in "EC negative" sentences.

classified in the category c with the inclination i as :

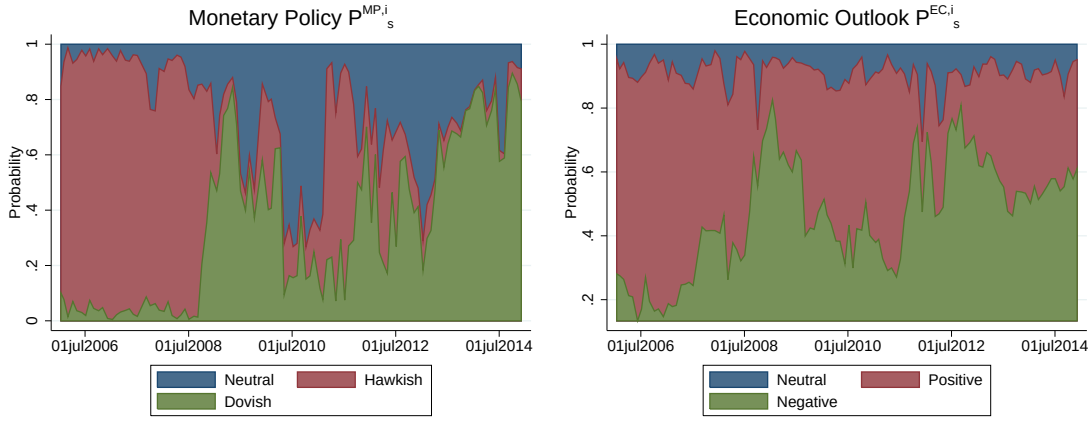
$$P_s^{c,i} = \frac{\sum_{n'=1}^{l} P_{n',s}^{c,i} * Occurrence_{n',s}}{\sum_{n'=1}^{l} P_{n',s}^{c} * Occurrence_{n',s}} \tag{2.2}$$

where l=34,052 (number of n-grams in our field-specific lexicon). For c = MP, i = *(hawkish, neutral, dovish)* and $\sum_{c=1}^{3} P_s^{MP,c} = 1$. For c = EC, i = *(positive, neutral, negative)* and $\sum_{c=1}^{3} P_s^{EC,c} = 1$. In order to improve the accuracy of our classification and to avoid multiple counting, we consider only the highest n-gram when multiple imbricated n-grams are found in a speech. [1]

Figure 2.1 shows, for all introductory statements between January 2006 and December 2014, the probabilities obtained from Equation 2.2 for our two categories of interest (Monetary Policy and Economic Outlook). Starting with the content related to monetary policy decisions and the expected path of the monetary policy stance, our indicator is closely related to the evolution of the ECB monetary policy. First, from January 2006 to September 2008, a period during which the ECB main refinancing rate increased from 2.25% to 4.25%, ECB communication about monetary policy was clearly hawkish. Then, starting in October 2008 and up to May 2010, the tone of the monetary policy became dovish. This period was associated with a large decrease in the ECB key interest rate, from 4.25% to 1%. Communication then became neutral for a few months before a strong return of hawkish communication, when the ECB started to increase its interest rate from March to September 2011. After that period, and up to the end of 2014, ECB communication became dovish, with both a decrease of the key interest rate and the implementation of various non-conventional monetary policies (long-term refinancing operations (LTRO), targeted long-term refinancing operations (TLTRO), forward guidance, ...).

1. For example, as shown previously, both "consumption growth" and "lowering consumption growth" are part of our lexicon. However, in the sentence "thereby lowering consumption growth" (January and February 2010), we will consider only probabilities associated with the trigram "lowering consumption growth" ($P^{EC,nega} = 1$) without considering probabilities associated with the bigram "consumption growth."

Figure 2.1. – Speech Probabilities for each category c and inclination i

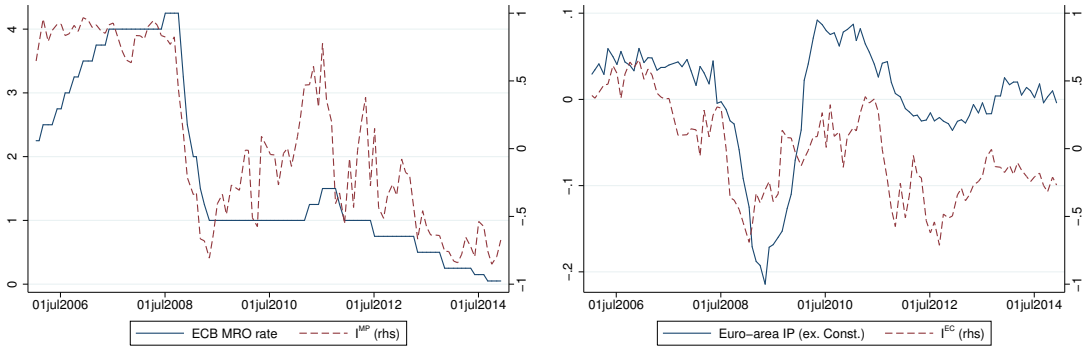


Notes : The two figures present for each category c (Monetary Policy, MP or Economic Outlook, EC), the inclinations i probabilities $P^s_{c,i}$ of ECB introductory statements s. Regarding MP, the inclinations are hawkish, neutral or dovish. For EC, the inclinations are positive, neutral or negative. For each categories, the sum of probabilities for the three inclinations is equal to one.

Regarding the economic outlook, our indicator capture both the subprime crisis and the eurozone crisis. Interestingly, the economic outlook starts deteriorating in September 2007, nearly one year before the Lehman Brothers bankruptcy, due to, amongst other things, "risk in financial markets on confidence" (Oct. 2007), "prolonged financial market volatility and re-pricing of risk on the real economy" (Nov. 2007) and "uncertainty about the potential impact on the real economy" (Dec. 2007). Regarding the eurozone crisis, the economic outlook became more and more negative starting in September 2011, characterized by a "moderation in the pace of global growth" (Sept. 2011), a "significant downward revision to forecasts" (Nov. 2011) and a "further intensification of the tensions in euro area financial markets" (Dec. 2011).

Finally, we aggregate the information content of the introductory statement into two indicators. We define two variables labeled I^{MP}_s and I^{EC}_s by computing, for each statement s, the difference between the hawkish (positive) probability $P^{MP,hawk.}_s$ ($P^{EC,posi.}_s$)

Figure 2.2. – ECB communication on Monetary Policy (I_t^{MP}) and Economic Outlook (I_t^{EC})



Notes : The two figures present the two indicators for the content of ECB Introductory statement between 2006 and 2014. The first indicator I_t^{MP} assesses the inclination of monetary policy decisions and is plotted with the ECB main refinancing rate. The second indicator I_t^{EC} captures the inclination of the Governing Council view on the economic outlook of the euro area and is plotted with the euro area industrial production excluding construction.

and the dovish (negative) probability $P_s^{MP,dovi.}$ ($P_s^{EC,nega.}$) :

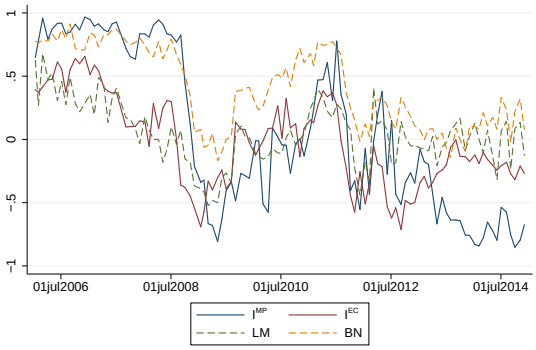
$$(I_s^{MP}, I_s^{EC}) = \begin{cases} I_s^{MP} = P_s^{MP,hawk.} - P_s^{MP,dovi.}, I_s^{MP} \in [-1,1] \\ I_s^{EC} = P_s^{EC,posi.} - P_s^{EC,nega.}, I_s^{EC} \in [-1,1] \end{cases} \tag{2.3}$$

Figure 2.2 displays the evolution of I_t^{MP} compared to the ECB Main Refinancing Operation rate (MRR) and the evolution of I_t^{EC} with the euro area industrial production (excluding construction).

2.3.3. Comparison with alternative measures of tone

We relate our new indicators to two alternative measures for the content of the ECB introductory statements. First, using the LM dictionary, we compute, for a given statement s, the tone LM_s as the difference between the number of positive and negative words in the introductory statement divided by the total number of words identified. By construction, $LM_s \in [-1, +1]$ and is equal to 0 for a neutral speech. A positive (negative) value of LM_s represents a statement with a relatively positive (negative) wording. Second, in line with Apel & Blix-Grimaldi (2012), Bennani & Neuenkirch (2017) divided a list of

Figure 2.3. – Different measures for the content of ECB introductory statements



Notes : The figure presents the two indicators I_t^{MP} and I_t^{EC} with two alternative measures for the content of ECB introductory statements. The alternative measures are calculated using either the Loughran & McDonald (2011) dictionnary for LM or the Bennani & Neuenkirch (2017) list of words for BN.

monetary policy-relevant keywords into dovish or hawkish categories. With their classification adjusted for the content of introductory statements, we use a similar calculation for LM_s to assess the monetary inclination of the introductory statement. This measure is labeled BN_s. Figure 2.3 displays these two alternative measures with our new indicators. Table 2.2 provides the pairwise correlation coefficients and their significance level. For the overall sample, the correlations are elevated (between 0.70 and 0.88) and significant at the 1% confidence level. The measure LM_s captures more efficiently the information content related to the economic outlook while BN_s, following Bennani & Neuenkirch (2017) objective, successfully measures the monetary policy content of the introductory statements. However, starting mid-2011, the two alternative measures fail to consider negative communications following the sovereign debt crisis and the dovish tone, in line with the non-standard policies that have been implemented, such as the three-year LTRO, the forward guidance, and the TLTRO. Between June 2011 and December 2014, the correlations between the different measures range from 0.35 to 0.66 but are still significant at the 1% or 5% confidence levels.

Table 2.2. – Pearson correlations for the content of ECB introductory statements

	Full Sample (106 obs.)				June 2011 to Dec. 2014 (43 obs.)			
	I_t^{EC}	I_t^{MP}	LM_t	BN_s	I_t^{EC}	I_t^{MP}	LM_t	BN_s
I_t^{EC}	1				1			
I_t^{MP}	0.712***	1			0.174	1		
LM_t	0.702***	0.610***	1		0.448***	0.351**	1	
BN_s	0.805***	0.884***	0.719***	1	0.380**	0.661***	0.592***	1

Note : Superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

2.4. Explaining and forecasting ECB monetary policy decisions

2.4.1. Methodology

To assess the relation between the information content of the introductory statements and monetary policy decisions, we test empirically the explanatory power of our two indicators (I_t^{MP} and I_t^{EC}) compared to LM_t and BN_t on both contemporaneous and future monetary policy decisions. More precisely, we consider the following Equation :

$$ECB_t = \alpha + \beta_1 I_t^{MP} + \beta_2 I_t^{EC} + \rho ECB_{t-1} + \epsilon_t \tag{2.4}$$

where ECB_t is the ECB monetary policy decision at time t, I_t^{MP} and I_t^{EC} are our indicators of communication, α is a constant, and ϵ_t is an error term. We include the lagged decision ECB_{t-1} to control for the smoothing of monetary policy. In a forward-looking approach, Equation 2.4 is rewritten as :

$$ECB_{t+m} = \alpha + \beta_1 I_t^{MP} + \beta_2 I_t^{EC} + \rho ECB_t + \epsilon_t \tag{2.5}$$

with $m = 1$ for the next Governing Council monetary policy decision and $m = 2$ the two-period-ahead decision. To control for available economic information at the time of the introductory statement, we consider a forward-looking Taylor (1993) monetary policy rule (Orphanides, 2001) with contemporaneous and forward-looking measures of inflation and output gap as in Jansen & De Haan (2009) :

$$ECB_t = \alpha + \beta_1 I_t^{MP} + \beta_2 I_t^{EC} + \gamma_1(\pi_t - \pi^*) + \gamma_2(y_t - y^*) + \gamma_3\, \pi_t^e + \gamma_4\, y_t^e + \rho ECB_{t-1} + \epsilon_t \tag{2.6}$$

$$ECB_{t+m} = \alpha + \beta_1 I_t^{MP} + \beta_2 I_t^{EC} + \gamma_1(\pi_t - \pi^*) + \gamma_2(y_t - y^*) + \gamma_3\, \pi_t^e + \gamma_4\, y_t^e + \rho ECB_t + \epsilon_t \quad (2.7)$$

where $(\pi_t - \pi^*)$ is the inflation gap defined as the difference between the current level of inflation (euro area HICP) available at the time of the statement [m] and the ECB inflation target $\pi^* = 2\%$. The 12-month ahead inflation forecast from the ECB Quarterly Survey to Professional Forecasters (SPF) is used as a proxy for inflation expectations π_t^e. The output gap $(y_t - y^*)$ is measured by the difference between the euro area industrial production (excluding construction, as in Gerlach (2007)) [n] and the potential output y^* (from the trend of a Hodrick–Prescott filter). [o] Following Sauer & Sturm (2007), the output gap expectations y_t^e are derived from the European Commission Economic Sentiment Indicator (ESI) minus its long term average. The month-over-month difference of all macroeconomic variables is used in the estimation for stationarity. Appendix B.5 presents the macroeconomic variables and B.6 provides descriptive statistics and correlations.

If the central bank communication does not provide any information additional to previously released macroeconomic data, then both our indicators I_t^{MP} and I_t^{EC} should not be significant in Equations 2.6 and 2.7. If central bank communication conveys relevant information, we expect a positive coefficient for I_t^{MP} : more hawkish (dovish) communication should be associated with more hawkish (dovish) monetary policy. We also expect a positive coefficient for I_t^{EC} : an optimistic (pessimistic) economic outlook from the Governing Council should be associated with a more hawkish (dovish) monetary policy.

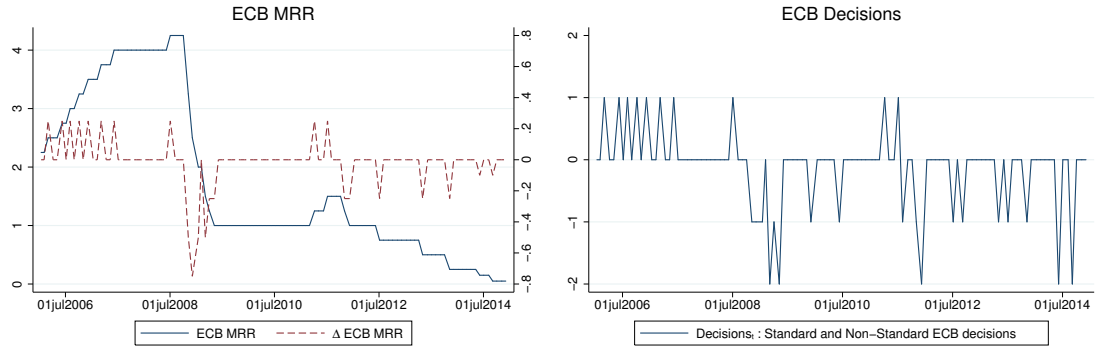
We consider two variables to measure the ECB monetary policy (ECB_t). First, we focus on interest rate decisions using the first difference of the Main Refinancing Operation interest rate (MRR hereafter, $\Delta MRR_t = (-0.75, -0.5, -0.25, -0.15, 0, +0.25)$).

m. The HICP inflation flash estimate is released at the end of the ongoing month but is subject to important revisions. The official HICP is available approximately 15 days after the end of the next month. To account for publication delay, we consider the official HICP data with a one-month lag. Our results are robust to alternative measures of inflation such as the HICP flash estimate or the unrevised HICP.

n. Industrial production for a month m is released around 13 days after the end of month $m + 1$. Again, to account for publication delay, we consider industrial production with a two-month lag.

o. The smoothing parameter λ is set to 14,400.

Figure 2.4. – Measures of the ECB monetary policy ECB_t



Notes : The first figure plots the evolution of the ECB main refinancing rate (MRR) and its first difference between 2006 and 2014. The second figure represents ECB monetary policy decisions between 2006 and 2014. It takes the value of 1 for a restrictive decision, 0 when the monetary policy stance remains unchanged, -1 for an accomodative decision (either a decrease of interest rates or the announcement of a non-standard measure) and -2 for a very accomodative decision (a decrease of interest rates and the announcement of a non-standard measure).

During our sample period, the Governing Council increased the MRR by 25 basis points on ten occasions and decreased it on ten occasions (once by 75 basis points, once by 50 basis points, six times by 25 basis points, and twice by 15 basis points). However, focusing on the MRR fails to consider non-standard policies implemented right after the beginning of the financial crisis. In the spirit of Jansen & De Haan (2009) and in order to account for the non-standard ECB policies, we create a variable $Decision_t$ (with $Decision_t = (-2, -1, 0, +1)$), taking the value of 0 when there is no change in the monetary policy stance, +1 for a hawkish monetary policy decision (an increase of the key interest rate by 25 basis points in our sample), -1 for a dovish monetary policy decision (either through a standard or a non-standard measure), and -2 for a very dovish decision with both a decrease of the key interest rate and a non-standard monetary measure. Appendix B.4 lists all the non-standard policies announced during ECB press conferences and considered in our sample period. Figure 2.4 presents both measures of ECB monetary policy (ΔMRR_t and $Decision_t$).

2.4.2. Empirical Findings

As our two monetary policy measures ECB_t are discrete variables with six outcomes for ΔMRR_t and four outcomes for $Decision_t$, we use an ordered probit model to estimate the coefficients $\alpha, \beta_1, \beta_2, \gamma_1, \gamma_2, \gamma_3, \gamma_4$ and ρ from Equations 2.4 to 2.7. We compare the performance of our indicators with two measures of tone using either the generic LM dictionary (LM_t) or the central bank-specific BN dictionary (BN_t).

Table 2.3 and 2.4 summarize the results from a maximum likelihood estimation of Equations 2.4 and 2.6 (contemporaneous relationship). After controlling for both backward- and forward-looking macroeconomic variables, we find that I_t^{EC} is significant at the 1% level for ΔMRR_t and $Decision_t$, while I_t^{MP} is significant at the 5% level when considering the change of the MRR. Hawkish/positive (dovish/negative) communication is associated with an increase (decrease) in ECB MRR and a more hawkish (dovish) monetary policy decision (standard and non-standard). As expected, we also find that the inflation gap $(\pi_t - \pi^*)$ is significant at the 5% confidence level. However, we do not find that our indicators strongly improve the explanation of the current monetary policy compared to a sentiment indicator from the LM dictionary. Thus, when explaining current ECB monetary policy, the use of the LM dictionary seems to be sufficient to capture ECB sentiment. However, when using forward-looking macroeconomic variables, our indicators significantly improve the two alternative measures (LM_t and BN_t) and previous results from Jansen & De Haan (2009).

Tables 2.5 and 2.6 summarize the results from a maximum likelihood estimation of Equations 2.5 and 2.7 (future monetary policy decisions) for $m = 1$ and $m = 2$. We find that I_t^{EC} is significant at the 1% confidence level while I_t^{MP} does not convey relevant information to explain future policy decisions.[p] A positive (negative) economic outlook at time *t* forecasts a hawkish (dovish) ECB policy at time t+1 and t+2. This result is

p. For $m = 1$ and when we consider $Decision_t$ as the dependent variable, I_t^{MP} is significant at the 10% confidence level. In all other cases, I_t^{MP} is not significant.

consistent with Sturm & De Haan (2011), who empirically find that quantifying communication helps in predicting the next policy decision of the ECB. Compared to the two alternative measures, our field-specific quantification of the content of ECB introductory statements significantly improves the predictability of future monetary policy decisions. Deriving tonality and topics using our field-specific lexicon provides a significantly better fit compared to a model where sentiment is computed using the LM dictionary or the modified version of the BN words list.

2.5. Forecasting Stock Market

2.5.1. Methodology

In this section, we analyze stock market reactions to monetary policy statements. More precisely, we assess whether ECB communication explains the evolution of stock market return and volatility on statement days and/or predicts stock market return and volatility after ECB statements. For both contemporaneous relationship and forecast, we also analyze which components of ECB communication (monetary policy and/or economic outlook), if any, impact stock markets. For all regressions, we compare our results when ECB communication is quantified using the Loughran–McDonald and the Apel–Blix Grimaldi approaches.

We use daily closing values of the Eurostoxx50 (Eurostoxx) to compute stock market return and the "European VIX" (VSTOXX) for stock market volatility (Figure 2.5). We measure ECB decision surprise as the difference between the Bloomberg consensus prior to the decision and the ECB rate announcement (MRR_t).

$$Surprise_t = MRR_t - Consensus_t \tag{2.8}$$

To explain the link between monetary policy and stock market return on the day of the press conference (d=0) and on the day after the announcement (d=1), we consider

Table 2.3. – Results from ordered probit models with the change of the ECB MRR (ΔMRR_t) : Estimation of Equations 2.4 and 2.6

	Base Model			I_t^c		LM_t		BN_t	
ΔMRR_{t-1}	2.750***	2.226**	0.583	-0.420	-2.240*	-1.069	-1.702	0.521	-0.708
	(0.643)	(0.878)	(0.919)	(1.237)	(1.197)	(1.114)	(1.231)	(1.056)	(1.109)
$\Delta(y_t - y^*)$		4.177	-10.357	1.005	-19.266	-0.758	-12.288	6.703	-8.952
		(15.558)	(12.325)	(15.390)	(15.315)	(14.315)	(15.409)	(13.896)	(12.683)
$\Delta(\pi_t - \pi^*)$		0.583	0.310	0.871	0.681	0.739	0.492	0.244	0.030
		(0.496)	(0.500)	(0.541)	(0.585)	(0.589)	(0.603)	(0.543)	(0.555)
Δy_t^e			-0.022		-0.035		-0.034		-0.049
			(0.084)		(0.117)		(0.113)		(0.106)
$\Delta \pi_t^e$			4.292***		5.225***		3.019***		3.947***
			(0.949)		(1.330)		(1.115)		(1.181)
I_t^{MP}				1.143**	1.675**				
				(0.496)	(0.767)				
I_t^{EC}				3.619***	4.525***				
				(0.794)	(1.119)				
LM_t						5.704***	5.038***		
						(0.773)	(0.809)		
BN_t								3.511***	3.680***
								(0.766)	(0.875)
Observations	106	106	106	106	106	106	106	106	106
$Pseudo - R^2$	0.0683	0.0777	0.193	0.321	0.429	0.346	0.389	0.237	0.316

Notes : The tables report the results from an ordered probit model estimated with maximum likelihood between January 2006 and December 2014. The dependent variable is the change of the ECB MRR. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 2.4. – Results from ordered probit models with ECB Policy Variable ($Decision_t$) : Estimation of Equations 2.4 and 2.6

	Base Model			I_t^c		LM_t		BN_t	
$Decision_{t-1}$	0.245*	0.166	-0.131	-0.634**	-0.903***	-0.712***	-0.815***	-0.514**	-0.750***
	(0.138)	(0.141)	(0.148)	(0.270)	(0.262)	(0.224)	(0.217)	(0.217)	(0.198)
$\Delta(y_t - y^*)$		9.911	-5.360	7.085	-6.681	1.029	-6.922	10.887	-1.358
		(12.838)	(11.822)	(13.155)	(13.660)	(14.977)	(15.922)	(13.058)	(13.224)
$\Delta(\pi_t - \pi^*)$		0.454	-0.079	-0.024	-0.523	-0.112	-0.381	-0.250	-0.656
		(0.435)	(0.457)	(0.452)	(0.503)	(0.496)	(0.493)	(0.467)	(0.470)
Δy_t^e			-0.035		-0.062		-0.022		-0.077
			(0.063)		(0.085)		(0.069)		(0.078)
$\Delta\pi_t^e$			3.387***		2.966***		1.851**		2.583***
			(0.680)		(0.834)		(0.785)		(0.801)
I_t^{MP}				1.285***	1.266***				
				(0.336)	(0.390)				
I_t^{EC}				2.129***	2.060***				
				(0.615)	(0.626)				
LM_t						5.517***	5.074***		
						(0.956)	(0.940)		
BN_t								3.425***	3.263***
								(0.561)	(0.588)
Observations	106	106	106	106	106	106	106	106	106
$Pseudo - R^2$	0.010	0.023	0.111	0.285	0.339	0.313	0.333	0.220	0.268

Notes : The tables report the results from an ordered probit model estimated with maximum likelihood between January 2006 and December 2014. The dependent variable represents ECB monetary policy decisions $Decision_t$. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 2.5. – Results from ordered probit models with the change of the ECB MRR (ΔMRR_{t+m}) : Estimation of Equations 2.5 and 2.7

	m = 1				m = 2			
ΔMRR_t	0.931	-1.257	-0.083	-0.420	1.841	0.016	1.139	1.505
	(0.705)	(1.021)	(0.922)	(0.936)	(1.191)	(1.205)	(1.248)	(1.195)
$\Delta(y_t - y^*)$	21.160*	15.239	20.199	22.721*	13.802	7.860	12.525	14.050
	(12.131)	(14.411)	(12.652)	(12.658)	(9.181)	(11.576)	(9.348)	(10.065)
$\Delta(\pi_t - \pi^*)$	0.007	-0.092	-0.033	-0.272	0.805*	0.892*	0.813*	0.687
	(0.434)	(0.537)	(0.439)	(0.464)	(0.474)	(0.504)	(0.482)	(0.500)
Δy_t^e	0.083	0.138	0.092	0.091	0.091	0.121	0.097	0.095
	(0.102)	(0.103)	(0.103)	(0.107)	(0.102)	(0.097)	(0.099)	(0.103)
$\Delta \pi_t^e$	2.321**	2.576**	1.776	1.429	0.287	0.276	-0.101	-0.300
	(1.168)	(1.097)	(1.159)	(1.259)	(1.190)	(1.096)	(1.228)	(1.267)
I_t^{MP}		0.004				-0.357		
		(0.371)				(0.348)		
I_t^{EC}		3.604***				2.995***		
		(0.722)				(0.710)		
LM_t			1.724**				1.194*	
			(0.744)				(0.708)	
BN_t				2.010***				1.125***
				(0.566)				(0.400)
Observations	106	106	106	106	106	106	106	106
$Pseudo - R^2$	0.139	0.326	0.175	0.209	0.0980	0.234	0.116	0.125

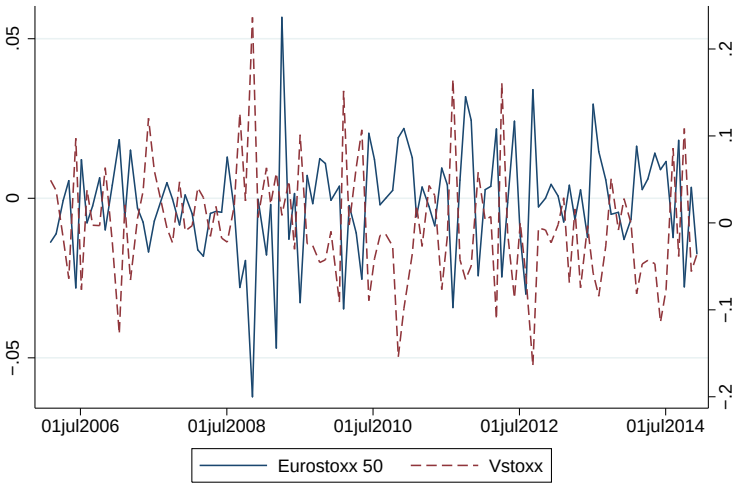
Notes : The tables report the results from an ordered probit model estimated with maximum likelihood between January 2006 and December 2014. The dependent variable is the one period ahead ($m = 1$) or two period ahead ($m = 2$) value of the change of the ECB MRR ΔMRR_{t+m}. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 2.6. – Results from ordered probit models with ECB Policy Variable ($Decision_{t+m}$) : Estimation of Equations 2.5 and 2.7

	m = 1				m = 2			
$Decision_t$	-0.140	-0.910***	-0.653***	-0.583***	0.339*	-0.026	0.163	0.165
	(0.126)	(0.234)	(0.185)	(0.189)	(0.196)	(0.219)	(0.211)	(0.208)
$\Delta(y_t - y^*)$	15.972	10.023	14.341	17.240	13.651	9.457	12.135	13.611
	(12.037)	(14.080)	(12.530)	(12.683)	(9.077)	(11.301)	(9.070)	(9.692)
$\Delta(\pi_t - \pi^*)$	-0.132	-0.539	-0.271	-0.559	0.658	0.461	0.605	0.479
	(0.481)	(0.562)	(0.490)	(0.541)	(0.465)	(0.482)	(0.472)	(0.489)
Δy_t^e	0.063	0.123	0.080	0.084	0.017	0.031	0.023	0.020
	(0.089)	(0.087)	(0.087)	(0.093)	(0.088)	(0.084)	(0.087)	(0.088)
$\Delta \pi_t^e$	2.727***	2.607***	1.998**	1.968**	0.922	0.412	0.588	0.418
	(0.830)	(0.921)	(0.801)	(0.974)	(0.855)	(0.835)	(0.887)	(0.895)
I_t^{MP}		0.577*				0.256		
		(0.313)				(0.278)		
I_t^{EC}		2.592***				1.596***		
		(0.620)				(0.590)		
LM_t			2.711***				0.997	
			(0.701)				(0.615)	
BN_t				2.475***				1.082***
				(0.506)				(0.383)
Observations	106	106	106	106	106	106	106	106
$Pseudo - R^2$	0.0991	0.296	0.175	0.209	0.0855	0.172	0.0972	0.110

Notes : The tables report the results from an ordered probit model estimated with maximum likelihood between January 2006 and December 2014. The dependent variable is the one period ahead ($m = 1$) or two period ahead ($m = 2$) value of the ECB monetary policy decisions $Decision_{t+m}$. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Figure 2.5. – Variations of Stock Markets indicators



Notes : The figure presents the daily change (close to close) of the Eurostoxx 50 (lhs) and the Vstoxx (rhs) on the day of ECB press conferences between 2006 and 2014 from Bloomberg.

the following model :

$$R_{t+d} = \alpha + \beta_1 * R_{t-d-1} + \beta_2 * Surprise_t + \beta_3 * I_t^{MP} + \beta_4 * I_t^{EC} + \epsilon_t \tag{2.9}$$

where R_{t+d} represents the variation of the EuroStoxx50 on day $t + d$ relative to the announcement date t. On the press conference day ($d = 0$) and given the previous results from Rosa (2011) on FOMC statement, we expect β_2 to be negative as a positive surprise about the main refinancing rate (i.e, a rate higher than expected) should lead to a decrease in stock market prices. In the same way, we expect β_3 to be negative if our monetary policy indicator incorporates information about future monetary policy stances not included in the surprise. We expect β_4 to be positive, as good news about the economic outlook should improve companies' rationally discounted future cash flows. [q] On the day after the announcement ($d = 1$), we do not make any hypothesis about the significance or sign of the coefficients. If information about the current decision,

q. Bad news about the economic outlook can also be good news for stock markets (Boyd et al., 2005) if investors anticipate a more dovish monetary policy in the future due to a worsening of the economic situation. However, we conjecture that the indirect effect – from bad economic outlook to dovish monetary policy – should already be captured by our MP indicator.

economic outlook, and future monetary stance is correctly integrated into the market closing price, we should not find any price predictability after the announcement.

To explain the link between monetary policy and stock market volatility, we consider a model similar to Equation 2.9 (replacing R_{t+d} by VOL_{t+d} and R_{t+d-1} by VOL_{t+d-1}) and a model where we consider the absolute surprise (instead of the surprise), as in Rosa (2011) :

$$VOL_{t+k,t+l} = \alpha + \beta_1 * VOL_{t+k-1} + \beta_2 * |Surprise_t| + \beta_3 * I_t^{MP} + \beta_4 * I_t^{EC} + \epsilon_t \quad (2.10)$$

where VOL_{t+d} represents the variation of the VSTOXX index on day $t+d$ relative to the announcement date *t*. On the press conference day ($d = 0$), we expect β_2 to be positive since an unexpected decision should increase market volatility. We expect β_3 to be positive, as a more dovish monetary policy, especially during a period of high uncertainty such as the 2008-2012 period, should decrease market volatility. We expect β_4 to be negative since a better economic outlook should reduce volatility. After the announcement ($d = 1$), we do not make any hypothesis about the significance or the signs of the coefficients.

To control for other macroeconomic news and to account for potential pre-release/post-release drift, we add to previous models a dummy variable and a surprise variable when macroeconomic news (euro area quartely GDP, euro area monthly unemployment, FOMC meeeting, US nonfarm payroll, US jobless claims...) is published between one day before and one day after the ECB press conference. For example, during our sample period, we find that euro area GDP releases coincide with ECB press conferences on 10 occasions (exact same day) and are released one day before or one day after ECB press conferences on 8 occasions. As controlling for other macroeconomic announcements does not affect our conclusions, we do not report the detailed results for the sake of simplicity.

2.5.2. Empirical Findings

Table 2.7 presents our results for d=0 (contemporaneous relationship) for both the EuroStoxx and the VSTOXX. We also present results using the LM and BN dictionaries to quantify ECB communication.

We find that, similarly to Ehrmann & Fratzscher (2007) and Ranaldo & Rossi (2010), monetary policy communications significantly affect asset prices and volatility. Regarding the content of the introductory statement, our MP indicator is significant and of the expected sign at the 5% level for all models. When ECB statements about monetary policy are hawkish (dovish), stock markets increase (decrease) and volatility decreases (increases) on announcement day. Our EC indicator is also significant at the 10% level for models [1] and [5] : a positive (negative) economic outlook is associated with higher (lower) stock market return and lower (higher) volatility. For both stock prices and volatility, we find that the approach we used to derive our MP and EC indicators significantly outperforms sentiment-based indicator derived by considering the Loughran–McDonald dictionary and the Apel–Blix Grimaldi dictionary. This finding reinforces our results from the previous section on forecasting monetary policy.

Then, we analyze if ECB statement at day t helps in predicting stock markets at day $t+1$. Table 2.8 presents our results for d=1 for the EuroStoxx and the VSTOXX. We do not find any significant results when considering MP and EC to forecast stock returns on the next trading day. Information seems to be instantaneously integrated into stock prices in such a way that there is no predictability on the day following ECB announcements, consistent with the efficient market hypothesis. However, we find significant results regarding the volatility of financial markets. Economic Outlook and Monetary Policy indicators derived from ECB statements at date t help in predicting volatility at day t+1, at the 5% level and at the 10% level, respectively. [r]

r. Interestingly, while for d=0 monetary policy is significant at the 5% level and economic outlook only at the 10% level, the situation reverses for d=1. We conjecture that this result could be explained by differences in the speed at which market participants process the "soft information" included in ECB statements, focusing first on monetary policy and monetary stance, and then more slowly incorporating information related to the economic outlook. We encourage further research in this area.

Table 2.7. – Contemporaneous relationship regression results (d=0)

	R_t			VOL_t			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Constant	-0.0006	-0.0016	-0.0001	-0.0057	-0.0028	0.0024	0.0003
	(0.0014)	(0.0016)	(0.0025)	(0.0062)	(0.0063)	(0.0069)	(0.0103)
$Surprise_t$	0.0626	0.0562	0.0610	-0.0793			
	(0.0481)	(0.0524)	(0.0481)	(0.1377)			
$\|Surprise_t\|$					-0.1966	-0.2301**	-0.1929*
					(0.1207)	(0.1015)	(0.1105)
R_{t-1}	-0.2206	-0.1502	-0.1696				
	(0.1359)	(0.1324)	(0.1370)				
VOL_{t-1}				0.0652	0.0866	0.1317	0.1246
				(0.0957)	(0.0906)	(0.0812)	(0.0840)
I_t^{MP}	-0.0100***			0.0356**	0.0342**		
	(0.0034)			(0.0144)	(0.0150)		
I_t^{EC}	0.0125*			-0.0413	-0.0493*		
	(0.0067)			(0.0290)	(0.0292)		
LM_t		0.0050				-0.0315	
		(0.0062)				(0.0243)	
BN_t			-0.0034				0.0009
			(0.0044)				(0.0188)
Observations	106	106	106	106	106	106	106
$Adj. - R^2$	0.0726	0.0228	0.0216	0.0329	0.0519	0.0239	0.0116

Notes : The table reports the results from a linear regression (d=0) of Equation 2.9 and Equation 2.10. The dependent variable on model [1], [2] and [3] is the percentage change of the Eurostoxx 50 on ECB statement days. The dependent variable on model [4], [5] and [6] is the percentage change of the VSTOXX on ECB statement day. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

This result holds only when ECB communication is measured using I_t^{MP} and I_t^{EC} indicators and disappears when communication is quantified through the LM and BN dictionaries. To identify the persistent impact of ECB communication on market volatility, the methodology used to derive quantitative forward-looking information from soft data is therefore of utmost importance. As "all words are not created equal," we provide empirical evidence showing that our weighted field-specific lexicon approach helps in capturing all the subtlety of central bank communication and improves our understanding of the impact of communication on financial markets.

2.6. Robustness check

In this section, we first provide a robustness check showing the results of a real time implementation of our methodology. Then, we present results comparing our indicator with two other measures of uncertainty used in the literature : the number of word related to "uncertainty" from the LM dictionary, as in Jegadeesh & Wu (2015), and a media-based measure of economic policy uncertainty from Baker et al. (2016).

2.6.1. Real-time lexicon generation

In the methodology presented in Section 2.3, we classify all sentences in all ECB introductory statements from 2006 to 2014 in order to construct our field-specific lexicon. N-gram probabilities are computed on the full sample period in such a way that I_t^{MP} and I_t^{EC} indicators are in reality ex-post measures. Sentences classified after a period t may impact n-gram probabilities in t. To check the robustness of our indicators, we simulate a real-time implementation of our methodology, where only sentences classified in *t* are used to compute $P_n^{i,c}$ from Equation 2.1. This approach is equivalent to a situation where a human analyzes and classifies each sentence of an introductory statement when it is pronounced before updating n-gram probabilities and computing $P_n^{i,c}$. We denote those two real-time (unrevised) indicators RT_t^{MP} and RT_t^{EC}.

Table 2.8. – Next day regression results (d=1)

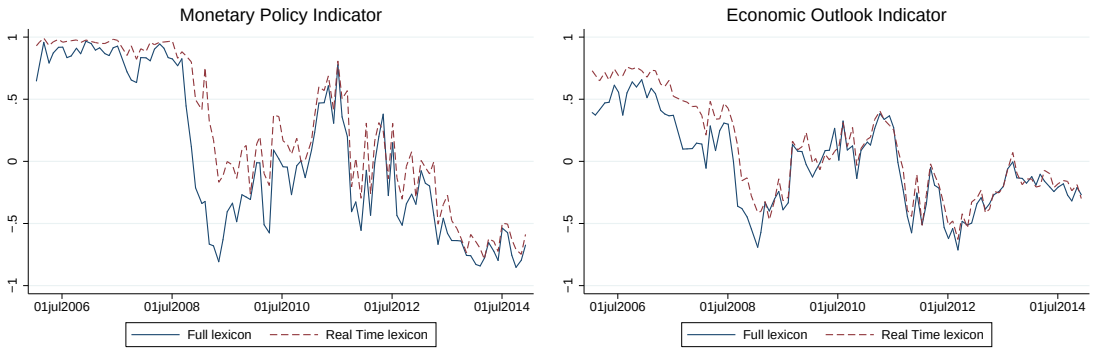
	R_{t+1}			VOL_{t+1}			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Constant		0.0020	0.0020	-0.0071	-0.0065	-0.0056	-0.0045
	(0.0013)	(0.0014)	(0.0025)	(0.0044)	(0.0046)	(0.0049)	(0.0081)
$Surprise_t$	-0.0192	-0.0190**	-0.0200*	0.0366			
	(0.0118)	(0.0084)	(0.0109)	(0.0420)			
$\|Surprise_t\|$					-0.0595	-0.0088	-0.0286
					(0.0554)	(0.0435)	(0.0436)
R_t	0.1456	0.1718*	0.1659				
	(0.1117)	(0.1007)	(0.1076)				
VOL_t				0.0688	0.0595	0.0944	0.0890
				(0.0725)	(0.0717)	(0.0676)	(0.0701)
I_t^{MP}	-0.0036			0.0172*	0.0174*		
	(0.0027)			(0.0095)	(0.0094)		
I_t^{EC}	0.0062			-0.0349**	-0.0378**		
	(0.0051)			(0.0172)	(0.0184)		
LM_t		-0.0046				0.0154	
		(0.0062)				(0.0208)	
BN_t			-0.0004				-0.0010
			(0.0043)				(0.0152)
Observations	106	106	106	106	106	106	106
$Adj. - R^2$	0.0201	0.0218	0.0153	0.0111	0.0133	-0.0064	-0.0119

Notes : The table reports the results from a linear regression (d=1) of Equation 2.9 and Equation 2.10 The dependent variable on model [1], [2] and [3] is the percentage change of the Eurostoxx 50 on the day after ECB statement. The dependent variable on model [4], [5] and [6] is the percentage change of the VSTOXX on the day after ECB statement. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Figure 2.6 presents together the full lexicon indicators I_s^c and the real-time lexicon indicators RT_s^c. To confirm previous findings on the predictability of monetary policy, we replace our initial measures with their real-time equivalent in the empirical estimations from Section 2.4. To also consider the real-time information available to central bankers, we use the HICP flash estimate as our measure of inflation π_t in Equations 2.4 to 2.7. Appendix B.7 and B.8 present a summary of the results. We find that the economic content of the introductory statements remains significant at the 1% confidence level. A negative (positive) real-time economic outlook predicts a dovish (hawkish) monetary policy decision at the next ECB meeting.

However, the monetary policy indicator RT_s^{MP} is no longer significant. This finding is consistent with the fact that our real-time monetary indicator underestimates the dovish tonality of ECB communication after the Lehman Brothers bankruptcy (from September 2008 to September 2009). As in any supervised learning approach, a sufficient number of observations (classified sentences) is necessary to derive n-gram weights and to capture correctly, in real time, the tonality of ECB communication.

Figure 2.6. – Real-time introductory statement indicators



Notes : The figures present the evolution of the two indicators Monetary Policy I_t^{MP} and Economic Outlook I_t^{EC} calculated using the term-weigted lexicon of 2006 to 2014 (Full Lexicon), against their real time equivalent RT_t^{MP} and RT_t^{EC} calculated using the term-weigted lexicon available at time t and without revisions (Real Time Lexicon).

2.6.2. Alternative measure of uncertainty

We also consider two alternative text-based measures of uncertainty in order to confirm (invalidate) our results on explaining (forecasting) market volatility. More precisely, we compute a measure of uncertainty by counting, in each ECB statement, the number of words included in the "uncertain words list" from the Loughran–McDonald dictionary (as in Jegadeesh & Wu (2015)). We denote this indicator ULM_t. We also consider the European media-based measure of economic policy uncertainty from Baker et al. (2016).[s] We denote this indicator UBB_t.

Table B.9 presents the results from Equation 2.10 $(d = 0)$, where we compare our indicators I_t^{MP} and I_t^{EC} to ULM_t and UBB_t. The results confirm that using our field-specific lexicon approach provides a better proxy of market uncertainty around ECB communication compared to other text-based indicators that are used in the literature. ULM_t and UBB_t do not successfully explain the evolution of market volatility on ECB announcement days. In an unreported test, we also find that our approach gives better results after the announcement (forecasting volatility).

2.7. Conclusion

Central bank communication has become a key instrument in the central bankers' toolbox. However, deriving quantitative indicators from soft textual data remains a challenging issues for both practitioners and academics. In this paper, we propose a novel approach using groups of words' term-weighting to better capture the subtlety of central bank communication We develop a publicly available field-specific lexicon to measure the stance of the monetary policy (dovish, neutral, hawkish) and the Governing Council's view on the Eurozone economy (positive, neutral, negative). Computing two indi-

s. http://www.policyuncertainty.com/media/Europe_Policy_Uncertainty_Data.xlsx - The European Uncertainty index is computed by counting the frequency of uncertainty-related words in news reports from Le Monde and Le Figaro for France, Handelsblatt and Frankfurter Allgemeine Zeitung for Germany, Corriere Della Sera and La Repubblica for Italy, El Mundo and El Pais for Spain, and The Times of London and Financial Times for the United Kingdom.

cators for each press conference, we construct a continuous time series quantifying the tone of the ECB communications between 2006 and 2014.

We find that the content of the introductory statements helps in predicting future ECB standard and non-standard monetary decisions, even after controlling for both backward- and forward-looking macroeconomic variables. A dovish (hawkish) textual content about monetary policy and a negative (positive) economic outlook both predict a dovish (restrictive) decision at the next ECB meeting. Quantifying ECB communication also helps in forecasting market volatility. A hawkish (dovish) textual content about monetary policy and a negative (positive) economic outlook predict an increase (decrease) in market volatility the day after the ECB statement. Our indicators significantly outperform a textual classification based on the Loughran–McDonald financial dictionary, the Apel–Blix Grimaldi dictionary, and a media-based measure of economic policy uncertainty.

Our results also shed light on the fact that researchers should be very cautious when relying on existing word lists to quantify central bank structured communication. As all words are not all created equal, we provide evidence that developing a field-specific weighted lexicon helps in capturing the forward-looking information contained in central bank communications.

3

The effects of the ECB's Forward Guidance on overnight index swaps

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Abstract

On July 4, 2013, following several other major central banks, the European Central Bank (ECB) gave for the first time forward guidance on interest rates, which affected market participants' expectations of future interest rates in the context of a Zero Lower Bound (ZLB) of main interest rates. Using an ARMAX(1,1) model in which the effect of the communication of negative macroeconomic news was disentangled from the commitment positive shock, the impact of the forward guidance on money market interest rates is estimated through the Euro Over-Night Index Average (EONIA) Swap, also called Overnight Index Swap (OIS), at maturities between two months and ten years using an abnormal returns from an event study. The results and robustness checks suggest that the ECB's guidance lowered OIS rates for maturities within ten months to three years . These results imply the existence of a commitment effect from the ECB's communication. In the context of decreasing market liquidity because of the three-year long-term refinancing operation (LTRO) repayment, market participants priced the low period of interest rates until mid-2016.

Keywords : OIS, monetary Policy, ECB, event-study, LTRO, forward Guidance

JEL classification : E52, E58, G14

3.1. Introduction

Already used by several central banks (New Zealand since 1997, Norway since 2005, Sweden since 2007, and the Czech Republic since 2008 [a]) as a standard monetary policy tool, the forward guidance from the European Central Bank (ECB) and other major central banks, such as the Federal Reserve (Fed), the Bank of Japan (BoJ) and the Bank of England (BoE), appears in the context of a Zero Lower Bound (ZLB) of nominal interest rates. On July 4, 2013, the ECB gave for the first time in its existence forward guidance during a press conference by stating that "The Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time." This communication was used after the implementation of balance sheet policies with both quantitative (the Covered Bond Purchase Programme, the Securities Markets Programme and the fixed-rate full allotment for the main refinancing operations) and qualitative easing (a change in the maturities of LTRO programs). [b]

The forward guidance relative to the interest rate is a communication by the central bank using an explicit statement about the outlook for future policy rates (Woodford, 2012b). By influencing expected short-term rates, the central bank could affect in the same direction long-term yields. Four central banks (Central Bank of New Zealand, Norges Bank in Norway, Riksbank in Sweden and since 2008, Czech Republic Central Bank) are still [c] providing guidances in the conduct of their conventional monetary policy. The Reserve Bank of New Zealand started in 1997 and provides projections of both macroeconomic variables and the 90 day interest rate using since 2009 a Dynamic Stochastic General Equilibrium (DSGE) model. In 2005, the Norges Bank started its publication of key policy rates forecasts using a DSGE model and a central bank explicit loss

a. For a description see Svensson (2015).

b. Bernanke & Reinhart (2004) and Borio & Disyatat (2010) provide detailed definitions and descriptions of various unconventional policies, and Fawley & Neely (2013) study and describe the instruments used by major central banks since the beginning of the 2007 financial crisis.

c. The US Federal Reserve used forward guidances between 1999 and 2005. See Rudebusch & Williams (2008) for a detailed description of the Federal Reserve communication about future policy rates.

function. The Riksbank of Sweden began in 2007 its forward guidance with forecasts of the Swedish Repo Rate [d] with another specific DSGE model. Both Norway and Sweden central banks are also providing the uncertainty of their forecast using fan charts. However their communication does not imply any form of commitment.

On the other side, as the central bank committed to a future path of policy rates for an imprecise or time-specific period of time, market participants would adjust their anticipations of future short-term interest rates. Following the expectations hypothesis of the interest rate term structure, the central bank could then influence longer term yields. This type of guidance is called "Odyssean" by Campbell et al. (2012) as it ties the central bank to a given future behavior (it is opposed to "Delphic" guidances, followed by the four central banks mentioned above). A commitment implies that regardless of macroeconomic developments, the central bank will maintain the interest rate at a given level (close to the Zero Lower Bound). However, a commitment might also imply considering the central bank loss function (see Svensson, 1997, for a quadratic form), a short-term loss for the central bank as inflation and the output gap deviate from their targets while monetary instruments (main policy rates) remain unchanged. Hence, the central bank will cloud its long-term objectives as the economic variables deviate from the central bank's objectives. When implemented, the forward guidance is then subject to time-inconsistent decision making (Kydland & Prescott, 1977). The communication might also be perceived as negative economic news. As De Graeve et al. (2014) explained, "It is not always clear how agents interpret announced forward guidance : is it a signal of additional monetary stimulus, or rather a sign that the central bank's economic outlook became worse ?" The present analysis tries to disentangle the effect of this negative news from the stimulus effect.

The first contribution of this paper is to provide empirical evidences of the effectiveness

d. Official policy rate since 1994, it represents the interest rate of a borrowing or a deposit at the Riksbank for a 7 days period.

of the ECB's forward guidance on the expected level of interest rates measured with the Overnight Index Swap (OIS). The wording "extended period of time" used by the ECB has raised many questions regarding the length of the commitment to low interest rates. Thus, as a second contribution, this paper assesses market participants' interpretations of the commitment period.

Using daily data of OIS rates with maturities of two months to ten years between January 2012 and January 2014, we first model the different maturities independently with an Auto-regressive Moving Average with regressors ARMAX(1,1) regression and then use an event study on two forward guidance's communications. We consider the initial announcement during a press conference on July 4, 2013, as well as the *firm reiteration* of this statement on January 9, 2014. The effects of forward guidances communication are measured as abnormal returns in an event-study. As the aim of this paper is to understand both the effect of the guidance and its duration priced by market participants, We disentangle the two channels through which the forward guidance might affect interest rates : (i) a change in the prospects of future output and price outlook (negative macroeconomic news) and (ii) commitment to a longer-than-expected period of low short-term interest rates from the central bank. To anticipate the results, we found that the forward guidance significantly lowered OIS rates with maturities between ten months and three years. The larger effect (more than five basis points) was measured for the two-year maturity. Market participants considered policy rates to remain close to the Zero Lower Bound until June 2016.

This paper is organized as follows : Section 2 presents in details the ECB's forward guidance while Section 3 relays a recent literature review. The empirical estimate is presented and explained in section 4 with a presentation of our data and methodology. Results are detailed in Section 5, and concluding remarks are provided in Section 6.

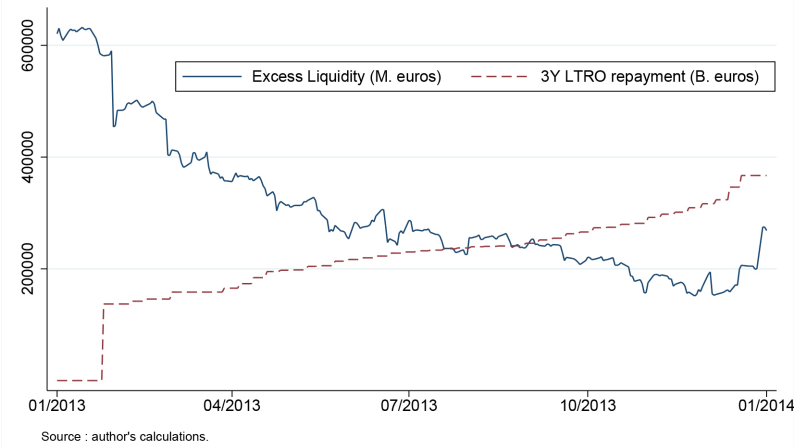
3.2. Central Banks' Forward Guidances during the crisis

We find several examples of forward guidances since the 2007 financial crisis. First the US Federal Reserve used a guidance without time-length (December 16th 2008 : "*the Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time.*"). This communication evolved to include a specific time-horizon (August 9th 2011 "*to warrant exceptionally low levels of the federal funds rate at least through mid-2013*"). This horizon was changed twice in January 2012 ("*[...] through late 2014.*") and September 2012 ("*[...] through mid-2015.*"). Starting on December 12th 2012, the FOMC guidance on low level of interest rates is conditional to macroeconomic variables such as unemployment ("*as long as the unemployment rate remains above 6-1/2 percent*"), short term inflation ("*no more than 0.5% point above [...] 2 percent*") and long term inflation ("*longer-term inflation expectations continue to be well anchored*"). The Bank of England used on August 1st 2013 the same type of guidance by committing to low levels of the Bank Rate and quantitative easing until "*[...] the unemployment rate has fallen to a threshold of 7%*" and at the same time if the short term inflation expectations are not "*0.5 percentage points or more above the 2% target*", medium-term inflation expectations "*remain sufficiently well anchored*" and financial stability is insured.

On July 4, 2013, the European Central Bank used forward guidance with an unspecified time period in the following declaration : "*The Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time.*" This guidance was introduced in the context of decreasing market liquidity as banks had been repaying the two first three-year LTROs since January 2013 (Figure 3.1). During a press conference on January 9, 2014, the ECB emphasized the importance of the forward guidance through the statement : "*We firmly reiterate our forward guidance.*"

The specific wording of the first forward guidance required market participants to

Figure 3.1. – Relation between ECB Excess liquidity and 3Y LTRO repayment in 2013



Notes : The figure presents the evolution the ECB excess liquidity (in millions euros) and the cumulated repayment of the 3Y LTRO (in billions euros) at a daily frequency.

answer three questions to understand and price the new information provided by the central bank :

— What is the policy rate level ?

— Is there a commitment from the central bank ?

— What is the length of the extended period of time ?

Regarding the first question, market participants could anticipate rates to remain at their current levels (50 bps) or decrease closer to the Zero Lower Bound. Later, the main refinancing rates decreased by 25 bps on November 13, 2013 ; June 11, 2014 ; and September 10, 2014. This confirmed the ceiling on the level of policy rates provided with the forward guidance.

Regarding commitment, the ECB followed the strict "no pre-commitment" rule given by Jean-Claude Trichet (2011), which continued during the presidency of Mario Draghi (2013). Benoît Coeuré (2013), ECB Executive Board Member, explained the guidance as "*a way to clarify our communication and provide more stability to financial markets.*" This provided information regarding the path of future interest rates anticipated by the

central bank but was not a commitment. Strictly speaking, this was not an Odyssean guidance ; however, the media immediately translated the statement as a one [e]. If market participants did not consider the commitment, long-term interest rates should have remained unchanged as no new information was provided. One objective of this article is to assess the commitment effect of the forward guidance on OIS rates.

The "extended" word gave rise to many questions regarding the length of the forward guidance. Consequently, questions began during the Press Conference Q&A to which Mario Draghi replied, "*It is not six months, it is not 12 months, it is an extended period of time.*" This uncertainty and insistent questions from the media led to confusing communications from the ECB [f]. A second objective of this paper is to analyze market participants' interpretation of the length of the commitment period.

3.3. Related Literature

According to economists such as Svensson (2003) and Eggertsson & Woodford (2003), one way to lower long-term interest rates is to lower market participants' expectations of future short-term interest rates using central bank communication. A wide overview of this literature and its effect on financial asset prices and their volatility was provided by Blinder et al. (2008) and Knutter et al. (2011). A major issue when estimating the effects of central bank communication is separating the macroeconomic news component of the communication [g] from the monetary policy tool used. Regarding central bank communication, Gurkaynak et al. (2005) (henceforth GSS) relate a path factor to the Federal Open Market Committee (FOMC) announcements about future rates, whereas the target

e. For example, the Financial Times, the AFP and the Times used "pledge" to describe the forward guidance while Reuters News employed "vowed".

f. Five days later, Jorg Asmussen (ECB Executive Board Member) declared to Reuters TV : "*It is not six months, it is not 12 months, it goes beyond,*" providing valuable information to the public. On July 10, 2013, the ECB released a statement that proclaimed : "*No guidance was given as to the exact length of this period of time and it was not Jorg Asmussen's intention to do so.*"

g. The use of unconventional monetary tools suggests to market participants a negative economic outlook from the central bank.

factor describes surprise changes in the federal funds target. This empirical study draws conclusions about the relative importance of central bank communication compared to the target rates. Using GSS methodology with an added « timing » factor, Brand et al. (2010) focus their work on the Eurozone yield curve and confirmed the importance of communication and its effect on long-term interest rates.

However, even if this literature underlines evidence regarding the importance and effect of communications, it does not directly discuss forward guidance and its impact on asset prices [h]. Following GSS and including the early stages of the financial crisis, Campbell et al. (2012) prove the ability of the FOMC to influence several asset prices, including corporate bonds and macroeconomic forecasts such as inflation and unemployment through its forward guidance. Campbell *et al.* also discuss the possible trade-off between Odyssean forward guidance and the price stability objective of the FOMC using DSGE. Kool & Thornton (2012) focus on explicit policy rate forward guidance and the improved predictability of future short- and long-term interest rates for four countries. By comparing market participants' forecasts of future interest rates before and after the forward guidance, they found little improvement, which contradicted the beneficial effects of the forward guidance. Using the New Keynesian framework, Rudebusch & Williams (2008) assess the macroeconomic impact of an interest rate projections publication without a commitment. The authors provide empirical evidences that this publication can increase public understanding and estimation of central bank behavior (through a policy rule) and macroeconomic developments. In a similar framework, Swanson & Williams (2012) confirm the effect of forward guidance on the yield of mid- to long-term maturities for the United States using a macroeconomic impulse model. Moessner (2013) assess FOMC explicit forward guidance by decomposing the daily changes of the one-year-to-five-year-ahead euro-dollar futures rates. The regression includes a surprise component for macroeconomic release dates ; the forward guidance is either explicit policy rate gui-

h. Recent articles, including, but not exclusively, those by Del Negro et al. (2012), McKay et al. (2016) and Campbell et al. (2016), pay specific attention to the macroeconomic impact of Delphic and Odyssean guidance in the New Keynesian framework.

dance, or explicit policy rate guidance and an asset purchase announcement. Moessner found a significant negative effect of the explicit guidance alone for all maturities. Using the EONIA swap curve, we find results in line with the previous finding for the ECB guidance thus providing further empirical evidence on the effectiveness of the commitment effect.

3.4. Empirical Evidences

3.4.1. Data

The money market rate is composed of several maturities (two months to ten years) of the Euro Area Overnight Indexed Swaps (OIS ; also called EONIA swaps) between January 2012 and January 2014 at a daily frequency (Figure 3.2).

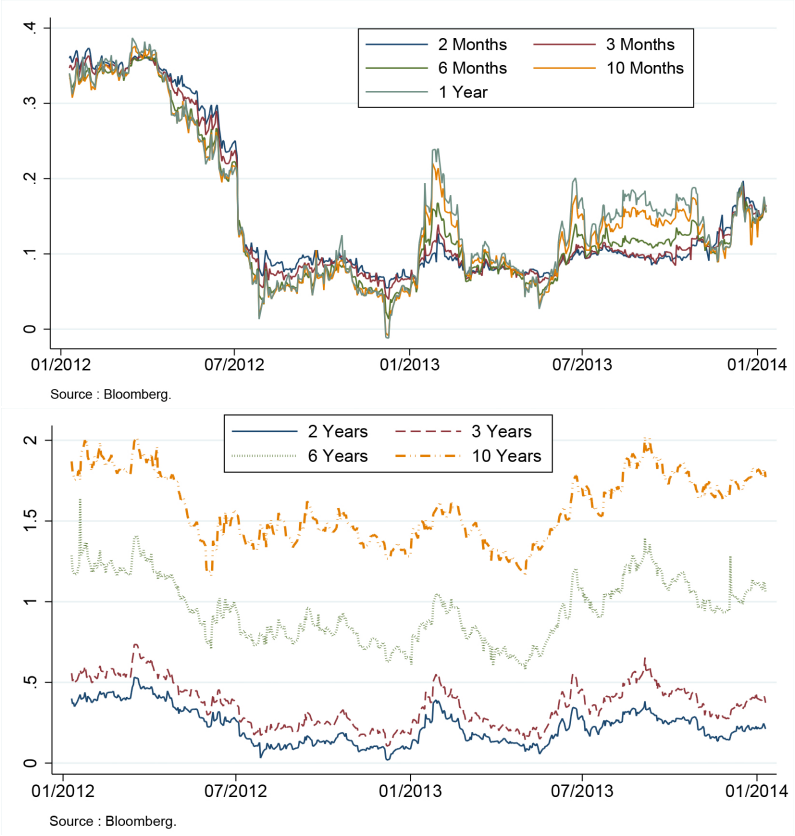
The OIS is a swap with a fixed interest rate called the OIS rate on one leg, with the corresponding maturity of the EONIA for the corresponding floating leg[i]. As the OIS is a swap of interest rates with no capital or counter-parties exchange, there is no credit risk ; The OIS represents the market expectations of future policy rates and exists for maturities from one week to ten years. Focusing on the most liquid maturities, this wide range allows a study of the effect of the guidance at different time horizons as well as the ability of the central bank to change monetary policy rate expectations in two months to ten years.

To explain the daily variations of expected interest rates, different factors are included. First, the liquidity surplus in the market is observed using the ECB liquidity balance (Figure 3.3), defined as the difference between ECB current accounts and both deposit facilities and reserve requirements.

The market participants' macroeconomic outlook is given by inflation expectations

i. At the end of each day, the notional amount is calculated by comparing the spread between the fixed and the floating rate, and the two parties exchange the corresponding amount. As the swaps are OTC derivatives with no capital exchange and no counterparty, they can be considered as market expectations of the future monetary stance (the EONIA for the ECB) at a given maturity.

Figure 3.2. – Euro area OIS swap rates with maturities up to 10 years (in %)

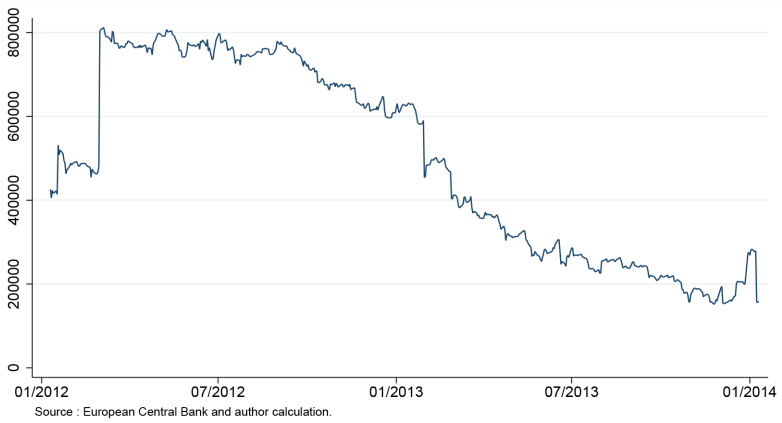


Notes : The figure presents the daily level of the OIS rates in % with maturities between 2 months to 10 years from Bloomberg.

using the ten-year break-even inflation rate for Germany as a proxy (displayed in Figure 3.4). The euro-dollar exchange rate (Figure 3.5) also captures relevant macroeconomic news (Andersen et al., 2003; Evans & Lyons, 2008).

Regarding monetary policy decisions during the period of estimation, the ECB changed the fixed minimum bid rate (MBR) three times since the implementation of the fixed-rate tender procedure with full allotment of the main refinancing operations (MRO) in October 3, 2008. We control for both the announcement of the rate decrease the day of the governing council meeting and its official implementation by the ECB the following Tuesday using dummy variables according to central bank communication literature,

Figure 3.3. – ECB Excess Liquidity (in millions €)



Notes : The figure presents the daily Excess Liquidity in millions euros from the ECB calculated as the ECB Current Account plus deposits left by financial institutions at the Deposit Facility minus Reserve Requierements.

such as Blinder et al. (2008). Finally, to study the direct effect of the three-year LTRO repayment offered by the ECB for all LTRO operations after one year, a variable with the amount of repayment on the day of the announcement captured a possible short-term increase in interest rates. Figure 3.6 reports the cumulated amount in euro billions repaid to the ECB. The repayments were announced by the ECB the Friday before the weekly MRO settlement, which took place on Wednesday[j]. The largest repayment of 137.16 billion euros occurred in January 2013, and our estimation period counts eighteen repayments. The present study also tested for other calendar dummies with various lags, such as the end of the year, the end of the quarter, the end of the month, and the end of the maintenance period ; however, these were not statistically significant in the current model.

j. The announcement of the LTRO repayment does not take place during an MRO announcement, which occurs on Monday, followed by the MRO allotment on Tuesday and the settlement on Wednesday.

Figure 3.4. – German 10Y Breakeven Inflation (in %)

Notes : The figure presents the daily quotes for the German 10 years Breakeven Inflation in % from Bloomberg.

3.4.2. Methodology

To study the forward guidance, we model OIS normal returns (market model) using an ARMAX(1,1) model described below. The abnormal returns on the day of the two forward guidance communications are then calculated as the difference between the returns observed during the event-window and the market returns defined by the one-step-ahead forecast of the ARMAX(1,1) model.

3.4.2.1. Modeling OIS rates

Regarding the estimation model, the daily change of the interest rate is modelled with an autoregressive and a moving average process ; the effects of monetary policy changes are then controlled, including the recent three-year LTRO repayment. In this framework, the impact of both inflation expectation and market excess liquidity on the OIS rates is estimated. The OIS daily changes are then modeled through an ARMAX(1,1) in which the correct order is selected using Information Criterion from Akaike (1974) (AIC) and Schwarz et al. (1978) (BIC). This model takes the following form :

$$\Phi(L)(1-L)(Y-\mu) = \Theta(L)\epsilon_t \tag{3.1}$$

Figure 3.5. – Euro-dollar Exchange Rate (€/$)

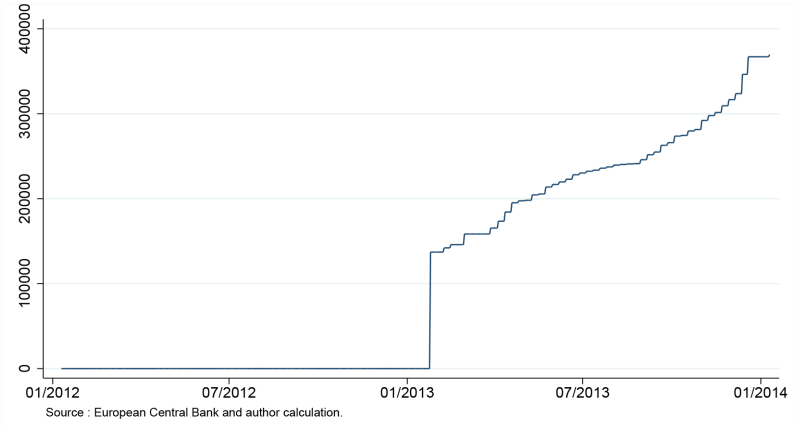
Notes : The figure presents the daily exchange rate between the euro and the dollar from Bloomberg.

$$\mu = \eta EF + \gamma MP + \rho C \tag{3.2}$$

where L is the lag operator, ϵ_t is the error term, and Y is a matrix, such as $Y = \{y_t^1, y_t^2, ..., y_t^n\}$ with y_t^n the OIS at the n maturity from two months to ten years at time t (daily frequency). In the mean equation 3.2, EF is a matrix representing the economic and financial environment with the inflation expectations (10Y break-even inflation), excess liquidity in the market (ECB Excess liquidity), and euro-dollar exchange rate. MP represents the variables related to the implementation of monetary policy. The three 25-bps decreases in policy rates (July 5, 2012 ; May 2, 2013 ; and November 7, 2013) are implemented as dummy variables on the day of the announcement, and the implementation of the three main rate decreases is also a dummy variable. The three-year LTRO repayment is captured as the cumulated repayment. Following Altavilla et al. (2016), three two-day dummy variables are then implemented to assess the three OMT announcements on July 26, 2012 ; August 2, 2012 ; and September 6, 2012.

Several controls are included in the matrix C to consider specific economic releases possibly affecting OIS rates around the forward guidance communications : US jobless

Figure 3.6. – Cumulated 3 year LTRO repayments (in billions €)



Notes : The figure presents the daily cumulated repayments of the 3 year LTRO in billions euros on the day of their announcements.

claims, euro area CPI estimates, and euro area business confidence indicators.[k] For the three variables, we measure the surprise component on the communication day[l].

OIS rates, inflation expectations, ECB excess liquidity, and 3y LTRO repayment time series were normalized between 0 and 1 to allow coefficient comparisons at a given maturity and across maturities. The first-order difference is used for all time series, and this difference is stationary for all dependent and independent variables. The η and γ, Φ, Θ, α and β are estimated using maximum-likelihood estimation, and the model is estimated independently for each OIS maturity.

The following relations between the exogenous variables and OIS rates are expected : excess liquidity in the market will lead to a higher supply of funds, which will decrease

k. Tables in Annexes C.4 and C.5 list the main economic releases around the 4th of July 2013 and the 9th of January 2014. We tested in the OIS model (equations 3.1 and 3.2) several variables to control for potential news effects during the event-study : initial jobless claims (US), ISM Manufacturing and non-manufacturing (US), Unemployment rate (US, Euro Area and Japan), PMI composite (EA), release of CPI estimates (EA), Retails sales (EA), Business climate indicator (EA), PPI (EA), CPI (Japan), Industrial Production (Japan). Among the variables below, only three of them (initial jobless claims (US), release of CPI estimates (EA), Business climate indicator (EA)) were statistically significant for more than one maturity. They were kept as controls in the OIS modeling.

l. This represents the difference between the value announced and the Bloomberg Survey average value.

interest rates ; this effect is expected to be small for long term maturities as the future level of market liquidity is barely anticipated. Concerning inflation expectations, with an inflation targeting central bank, if market participants anticipated an increase in inflation, they will also forecast an increase in the central bank main refinancing rate. Last, the exchange rate coefficient, capturing further macroeconomic news, should therefore be positive. An appreciation of the euro would be a synonym of a better outlook but for short term maturities, this effect can be offset by potentially lower import prices, thus reducing inflation.

3.4.2.2. Event Study

To measure how the market reacted to the ECB's forward guidance, we use an event study, focusing on two communications : a first statement on July 4, 2013 and its firm reiteration on January 9, 2014. The market model is defined by equations 3.1 and 3.2 for the estimation period of 250 days before the event. During the event window of five days before and after the event, out-of-sample one-step-ahead forecasts of OIS rates are used. Each maturity is considered independently. The abnormal returns during the event window are then measured as the difference between the observed changes of the OIS rates and the forecasted changes of the ARMAX(1,1) model. An F-test is used to test the presence of abnormal returns.

3.5. Results

The Tables 3.1 and 3.2 report the estimated parameters of the ARMAX(1,1) model for each OIS maturity from two months to ten years between January 2012 and January 2014. First to assess the performance of our ARMAX(1,1) model and as it exists, to the best of our knowledge, no previous articles modeling the OIS rates, we compared the ARMAX(1,1) to two other models : a simple ARMA(1,1) and an OLS including our regressors with AR(1) process. Table C.1 in Annexes provides for the 3 models the log-

likelihood, the AIC and the BIC. We have also calculated the RMSE for both the model fit and the 11 days forecast around the first forward guidance communication (July 4th 2013). We can conclude than the ARMAX(1,1) model outperforms a simple ARMA(1,1) using all criteria. It also improves an OLS model for the majority of maturities [m]

Regarding the results and in line with our expectations, daily change in the ECB excess liquidity negatively affected short-term OIS rates (two, three, and six months). As liquidity in the market increased, expected short-term rates fell. Such results support the ECB use of non-standard policies to ensure liquidity for financial markets. A shift in inflation expectations would increase OIS rates with a maturity from two to ten years, with a 5% confidence level. As the maturity increased, the importance of the inflation premium also increased, and this was maximized for a ten-year maturity. The euro-dollar exchange rate significantly affected all maturities at a 1% confidence level with a positive relation. An appreciation of the euro might be interpreted by financial markets as an improvement of macroeconomic conditions, thus leading to an increase in expected policy rates. The relation was stronger at a 2-year maturity. Inflation expectations and exchange rates both successfully captured macroeconomic information from the OIS rates.

Regarding monetary policy, a reduction in the main interest rate decreased OIS rates for all maturities on both the day of the announcement and the implementation. The three-year LTRO repayment was also an important driver of OIS rates for maturities higher than three months. Bank reimbursements pushed expected rates up as the liquidity in the market went down. In line with empirical estimates of Altavilla et al. (2016) using government bonds, the first OMT announcement had a significant and negative effect on OIS maturities between two months and three years ; however, the two communications that followed appeared to have mixed results on OIS rates.

m. The lower BIC of the OLS model compared to the ARMAX(1,1) can be explained by the one degree of freedom difference between the two models as the OLS does not include an MA(1) process.

Table 3.1. – Results from ARMAX(1,1) on the euro area OIS with maturity between 1-month and 10-month

	Maturities			
	OIS 2M	**OIS 3M**	**OIS 6M**	**OIS 10M**
Excess Liquidity	-0.083**	-0.063***	-0.065**	-0.041
	(0.041)	(0.023)	(0.027)	(0.026)
Inflation Expectations	-0.017	-0.019	-0.041	-0.002
	(0.023)	(0.024)	(0.026)	(0.034)
Exchange Rate	0.534***	0.788***	0.954***	1.212***
	(0.123)	(0.136)	(0.181)	(0.228)
Policy Rate change	0.034	0.070*	0.127**	0.161***
	(0.023)	(0.038)	(0.057)	(0.040)
LTRO repayment	0.049	0.087**	0.304***	0.534***
	(0.041)	(0.036)	(0.035)	(0.057)
OMT 1	-0.041***	-0.057**	-0.058**	-0.082**
	(0.009)	(0.023)	(0.023)	(0.040)
OMT 2	0.040***	0.039***	0.056***	0.044***
	(0.007)	(0.014)	(0.017)	(0.015)
OMT 3	0.006***	0.007*	0.000	0.004
	(0.002)	(0.004)	(0.016)	(0.027)
AR (1)	0.312	0.472***	0.513***	0.702***
	(0.243)	(0.156)	(0.170)	(0.129)
MA (1)	-0.616***	-0.699***	-0.705***	-0.824***
	(0.219)	(0.142)	(0.164)	(0.110)
Constant	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Observations	524	524	524	524
Log-likelihood	1380.3	1345.9	1129.1	1145.2

Notes : ***, **, * represent significance level at levels of respectively 1%, 5% and 10%. The regression is estimated using Maximum-Likelihood and Standard Errors are in brackets. Number of observations : 523. Sample from January 2012 to January 2014.

Focusing on the forward guidance, Table 3.4 displays the results of the event study on the day of the forward guidance announcement (July 4, 2013) and the *firm reiteration* of the guidance (January 9, 2014). The forward guidance had a negative commitment effect at a five percent confidence level on maturities between ten months and three years, independent of the effect of negative macroeconomic news. Market participants' pricing of the forward guidance on OIS rates implies that on the day of the forward guidance,

Table 3.2. – Results from ARMAX(1,1) on the euro area OIS with maturity between 1-year and 10-year

	Maturities				
	OIS 1Y	**OIS 2Y**	**OIS 3Y**	**OIS 6Y**	**OIS 10Y**
Excess Liquidity	-0.071***	-0.048	-0.023	-0.048	-0.051
	(0.027)	(0.039)	(0.051)	(0.082)	(0.057)
Inflation Expectations	0.022	0.102**	0.166***	0.181***	0.274***
	(0.034)	(0.051)	(0.050)	(0.057)	(0.055)
Exchange Rate	1.380***	1.847***	1.423***	1.131***	1.069***
	(0.251)	(0.325)	(0.339)	(0.339)	(0.315)
Policy Rate change	0.106***	0.170***	0.155***	0.0858	0.141**
	(0.038)	(0.031)	(0.050)	(0.056)	(0.062)
LTRO repayment	0.526***	0.685***	0.620***	0.297***	0.256***
	(0.064)	(0.071)	(0.054)	(0.055)	(0.045)
OMT 1	-0.095**	-0.107*	-0.053*	0.010	0.044***
	(0.042)	(0.060)	(0.032)	(0.013)	(0.007)
OMT 2	0.040***	0.015*	-0.001	0.009	-0.000
	(0.009)	(0.009)	(0.015)	(0.021)	(0.070)
OMT 3	0.005	0.009	0.015	0.021	0.028
	(0.029)	(0.035)	(0.038)	(0.018)	(0.036)
AR (1)	0.775***	-0.556**	-0.633***	-0.284	-0.352*
	(0.174)	(0.220)	(0.179)	(0.272)	(0.211)
MA (1)	-0.856***	0.479**	0.566***	-0.040	-0.216
	(0.154)	(0.239)	(0.197)	(0.323)	(0.227)
Constant	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES
Observations	524	524	524	524	524
Log-likelihood	1128.6	989.8	968.4	989.3	977.1

Notes : ***, **, * represent significance level at levels of respectively 1%, 5% and 10%. The regression is estimated using Maximum-Likelihood and Standard Errors are in brackets. Number of observations : 523. Sample from January 2012 to January 2014.

policy rates were already expected to remain low for six months. The *extended* period of time could then be estimated to last until June 2016. The firm reiteration of the forward guidance did not affect OIS rates as abnormal returns were not significant.

As robustness checks, two other event-windows (six days and twenty days) provide similar results with abnormal returns significant at a 5% confidence level at all maturities from ten months to three years. Results are displayed in Annexes C.2 and C.3. To ensure that the first forward guidance communication was not a one day negative shock to OIS rates, we calculate the cumulative abnormal returns three days after the communication

and results are displayed in Table 3.5. The first guidance is still significant at a 5% confidence level for maturities between ten-months and three-years expect for the one-year maturity (statistically significant at 10%).

Table 3.3. – The effect of the ECB Forward Guidance announcement on short term OIS rates (in basis points)

	Maturities			
	OIS 2M	**OIS 3M**	**OIS 6M**	**OIS 10M**
Event Study				
July 2013	-0,476	-0.638	-1.194*	-2.772***
January 2014	0.297	0.154	-0.306	-0.588
AAR	-0.089	-0.242	-0.750*	-1.681***
Descriptive statistics				
Average Daily Change	0.240	0.200	0.241	0.118
Std. Dev.	0.570	0.623	0.909	1.212

Notes : *, **, and *** denote significance of the F-test for abnormal return at 10%, 5%, and 1%, respectively. Abnormal returns from an event-study where the market model is an ARMAX(1,1) model with a 250 days estimation period ; The event window includes 5 days before the communication to 5 days after.

3.6. Concluding Remarks

In this paper , we discussed the effect and context of the ECB's forward guidance starting on July 4, 2013. The negative macroeconomic news component of the forward guidance was disentangled using a proxy for inflation expectations and the exchange rate from the commitment effect, which addressed the cautions provided by De Graeve et al. (2014). The results suggest that the ECB's commitment to an extended period of low interest rates was effective in lowering OIS rates at maturities between ten months and three years. This effect was large but did not persist for more than three days ; it did, however, emphasize the new information content of the forward guidance. Agents anticipated the forward guidance to last until approximately mid-2016.

The forward guidance appears to be an effective monetary policy communication but must be studied in the specific context of other ECB monetary policies, especially the

Table 3.4. – The effect of the ECB Forward Guidance announcement on long term OIS rates (in basis points)

	Maturities				
	OIS 1Y	**OIS 2Y**	**OIS 3Y**	**OIS 6Y**	**OIS 10Y**
Event Study					
July 2013	-2.490**	-5.625***	-4.806**	-3.778	-0,883
January 2014	-1.105	-1.756	-0,95	0.457	0.524
AAR	-1.797**	-3.690***	-2.879**	-1.661	-0,179
Descriptive statistics					
Average Daily Change	-0.059	-0.264	-1.054	-1.054	-0.895
Std. Dev.	1.239	2.445	2.536	3.521	3.624

Notes : ***, **, * represent significance level at levels of respectively 1%, 5% and 10% based on a F-test. Abnormal returns from an event-study where the market model is an ARMAX(1,1) model with a 250 days estimation period ; The event window includes 5 days before the communication to 5 days after.

Table 3.5. – The effect of the ECB Forward Guidance announcement on OIS rates (three days after communication)

	Maturities					
	OIS 6M	**OIS 10M**	**OIS 1Y**	**OIS 2Y**	**OIS 3Y**	**OIS 6Y**
Event						
July 2013	-1.686	-3.614**	-3.462*	-7.047**	-8.305**	-10.911
January 2014	3.161	3.460	2.867	-1.252	-2.947	-7.772
CAAR	0.887	-0.077	-0.297	-4.149*	-5.626*	-9.342

Notes : ***, **, * represent significance level at levels of respectively 1%, 5% and 10% based on a F-test. The estimation is made using an ARMAX(1,1) model ; The event window includes 5 days before the communication to 5 days after. CAAR are Cumulative Average Abnormal Returns.

three-year LTRO repayment. The guidance and the repayment appear to have moved OIS rates in opposite directions. The excess liquidity of the ECB and of the market were steadily decreased by the voluntary 3Y LTRO repayment. As short term rates were threatening to increase, the forward guidance effectively steered them down. In terms of monetary policy implementation, this communication can be perceived as a way to offset the unexpected drawbacks, such as early repayment, of other non-standard policies. Regarding the wording of the communication, the extended period of time created difficulties. First, the ECB's explanations after the press conference were confusing ; second, market participants were required to estimate the commitment period. Even if the ECB used this communication as a way to avoid a clear, unconditional commitment, market participants understood it to be so. Moreover, with respect to the design of the forward guidance, if ECB policy makers had in mind a different time period than the one priced by the financial sector given their macroeconomic information, a specific time length or conditional guidance might have improved the effectiveness of this communication. As the forward guidance has continued to be used in the ECB's monetary policy statement even after June 2016, the use of a time-specific guidance could provide relevant information to better align the central bank and the market expectation of future policy rates.

Conclusion

Summary of the findings

The objective of this empirical thesis is to assess the transmission channels of ECB standard and non-standard policies implemented since 2008. It focuses on two distinct channels particularly relevant to the euro area monetary policy : the bank lending channel and the signaling channel. In the first essay, we estimate the influence of monetary policies on different banks' lending activities in the syndicated loan market. After studying 37,000 syndicated loans from 15 euro area financial institutions, we can argue that non-standard policies do influence financial institution short-term financing operations. Our results provide evidence of the existence of the bank lending channel. In addition, we have found that non-standard ECB policies successfully reduce banks' funding constraints, while standard measures prove ineffective. We also demonstrate that non-standard measures support credit supply with a positive impact on loan amounts, but that this positive impact is stronger for banks with less capital. The second and third essays of this thesis study the signaling channel of the ECB monetary policy. The second essay introduces a new approach to measuring the content of ECB press conferences by identifying sentences related to the economic outlook and monetary policy decisions (topics). The methodology used also introduced groups of words' probabilities to belong to one of the two topics with a given inclination (positive, neutral, or negative). Our

indicator of ECB communication improves the understanding of contemporaneous monetary policy decisions as well as increases the predictability of future monetary policy decisions. It also helps to explain next-day stock market volatility. The third essay considers a specific unconventional communication from the ECB : the forward guidance on interest rates. To estimate the effect of such communication on expected interest rates, we disentangled the macroeconomic content of the news from the central bank commitment effect and modeled the daily variations of OIS rates. We also controlled for the macroeconomic news effect by utilizing medium-term inflation expectations and the liquidity condition in the interbank market. We found that the forward guidance had a negative commitment effect on OIS rates with maturities between ten months and three years, independent of the effect of negative macroeconomic news.

Further Research

The second essay of this thesis pays specific attention to the content of the ECB introductory statements, or the first part of the press conference. However, the second part of the press conference is a session of questions and answers with a panel of selected journalists. So far, very few studies examine the content of this session. Even if regular press conferences continue to be the main form of central banks' communication, other forms of media are gaining importance. In 2005, members of the ECB Executive Board gave less than one interview per month. In 2016, they participated in four interviews every month. These interviews were conducted mainly in English with the financial press, but they also included direct communication with daily papers, allowing them to reach a larger audience. Further research could study the content of such alternative forms of communication. As central banks increased communication aims at easing the transmission of monetary policy, the influence of this communication on both market participants' understanding of monetary policy decisions and their expectations could be researched. While the first essay of this thesis focuses on the influence of monetary policy on len-

ding activities, it only considers loan amounts. The quantity of money distributed by the banks in the syndicated loan market is of utmost importance for the transmission of monetary policy since it represents money available to firms for their development, cash management or other projects. However, a lending or borrowing decision is not determined exclusively by the loan amount. Both financial institutions and firms must consider the credit conditions, or lending terms, of the loan. In the syndicated loan market, loan characteristics include : amount, interest rate decomposed into the benchmark rate and the spread, duration (or maturity), if the loan is secured, and covenants and fees. Dennis et al. (2000) study the simultaneous determination of four terms [n] for revolver credit agreement, one of the lending type in the syndicated loan market. However, the influence of monetary policy decisions, especially unconventional policies, on such terms remains an ongoing topic for research. Changes to monetary policy rates have a direct influence on benchmark rates such as LIBOR or EURIBOR rates. However, accommodative or restrictive monetary policies can also influence other credit conditions. For example, the liquidity provided to financial institutions through the non-standard programs could have encouraged lending to riskier firms (risk-taking channel, Gambacorta (2009)). It could also translate into an increase of secured lending in the syndicated loan market. In addition, as the credit conditions are jointly determined, it may also influence the spread and duration of the loans. Further research could then focus on the influence of monetary conventional and unconventional policies on loans' terms.

n. Namely duration, spreads, secured and the commitment fees on undrawn funds.

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Annexes

A. Appendix to Chapter 1

A.1. Pearson Correlation Matrix

	CD_i	STB_i	$\Delta EONIA_j$	*All-in spread*	*Maturity*	*Industry risk*	$\Delta T1$	*Strategy*	ΔGDP	*BLS*
CD_i	1									
STB_i	0.74	1								
$\Delta EONIA_j$	-0.03	0.03	1							
All-in spread	0.19	0.07	-0.10	1						
Maturity	0.01	0.01	0.10	0.24	1					
Industry risk	-0.14	-0.09	0.38	-0.14	0.16	1				
$\Delta T1$	0.02	-0.01	-0.08	0.02	-0.01	-0.04	1			
Strategy	0.46	0.44	0.06	-0.02	-0.05	0.07	-0.02	1		
ΔGDP	-0.16	-0.01	0.56	-0.26	0.11	0.54	-0.06	0.02	1	
BLS	-0.01	-0.04	0.02	0.07	-0.02	-0.03	-0.02	-0.02	-0.23	1

B. Appendix to Chapter 2

B.1. ECB Statement sentences classification : Topic Monetary Policy

Accomodative	
04/12/2008	On the basis of its regular economic and monetary analyses, the Governing Council decided to reduce the key ECB interest rates by a further 75 basis points.
02/10/2013	The Governing Council confirms that it expects the key ECB interest rates to remain at present or lower levels for an extended period of time.
13/01/2011	Accordingly, the Governing Council will continue to monitor all developments over the period ahead very closely.
04/09/2014	The newly decided measures, together with the targeted longer term refinancing operations which will be conducted in two weeks, will have a sizeable impact on our balance sheet.
Neutral	
02/11/2006	On the basis of our regular economic and monetary analyses, we decided at today s meeting to leave the key ECB interest rates unchanged.
05/11/2009	The current rates remain appropriate.
04/12/2014	In this context, early next year the Governing Council will reassess the monetary stimulus achieved, the expansion of the balance sheet and the outlook for price developments.
Restrictive	
05/10/2006	At today s meeting, we decided to increase the key ECB interest rates by 25 basis points.
06/07/2006	Therefore, if our assumptions and baseline scenario are confirmed, a progressive withdrawal of monetary accommodation remains warranted.
06/09/2007	Accordingly, the Governing Council will monitor very closely all developments.
14/01/2010	The Governing Council will also continue to implement the gradual phasing out of the extraordinary liquidity measures that are not needed to the same extent as in the past.

Notes : This table displays several examples of sentences from ECB introductory statement between 2006 and 2014 classified by the authors as related to the monetary policy content with a dovish, neutral or hawkish inclination.

B.2. ECB Statement sentences classification : Topic Economic Outlook

Positive	
07/12/2006	Domestic demand in the euro area is expected to maintain its relatively strong momentum.
05/03/2009	Over the course of 2010, the economy is expected to gradually recover.
07/07/2011	Euro area exports should continue to be supported by the ongoing expansion in the world economy.
01/08/2013	Furthermore, the overall improvements in financial markets seen since last summer appear to be gradually working their way through to the real economy, as should the progress made in fiscal consolidation.
Neutral	
03/08/2006	Turning to price developments, according to Eurostat s flash estimate, annual HICP inflation was 2.5 in July 2006, unchanged from June and May.
05/07/2007	The risks surrounding this favourable outlook for economic growth are broadly balanced over the shorter term.
03/12/2009	The Governing Council continues to view the risks to this outlook as broadly balanced.
Negative	
06/12/2007	However, the reappraisal of risk in financial markets is still evolving and is accompanied by continued uncertainty about the potential impact on the real economy.
06/11/2008	To sum up, the intensification and broadening of the financial market turmoil is likely to dampen global and euro area demand for a rather protracted period of time.
03/11/2011	In the Governing Council s assessment, the downside risks to the economic outlook for the euro area are confirmed in an environment of particularly high uncertainty.
07/03/2013	The GDP outcome for the fourth quarter of 2012 was weak, with Eurostat s second estimate indicating a contraction of 0.6 quarter on quarter.

Notes : This table displays several examples of sentences from ECB introductory statement between 2006 and 2014 classified by the authors as related to the economic outlook content with a positive, neutral or negative inclination.

B.3. ECB Statement sentences classification : Topic NONE

Data sentences	
09/01/2014	According to Eurostat s flash estimate, euro area annual HICP inflation was 0.8% in December 2013, compared with 0.9% in November.
06/06/2012	The June 2012 Eurosystem staff macroeconomic projections for the euro area foresee annual real GDP growth in a range between 0.5% and 0.3% for 2012 and between 0.0% and 2.0% for 2013.
04/04/2012	The annual growth rate of M3 was 2.8% in February 2012, compared with 2.5% in January.
Repetition	
Each speech	Ladies and gentlemen, the Vice President and I are very pleased to welcome you to our press conference.
Each speech	Let me now explain our assessment in greater detail, starting with the economic analysis.
+70 times	Over the medium term, inflation expectations remain firmly anchored in line with price stability.
29 times	we will continue to monitor very closely all developments over the period ahead.
Other Topic or explanation	
08/07/2010	A lagged response of loans to non financial corporations to developments in economic activity is a normal feature of the business cycle.

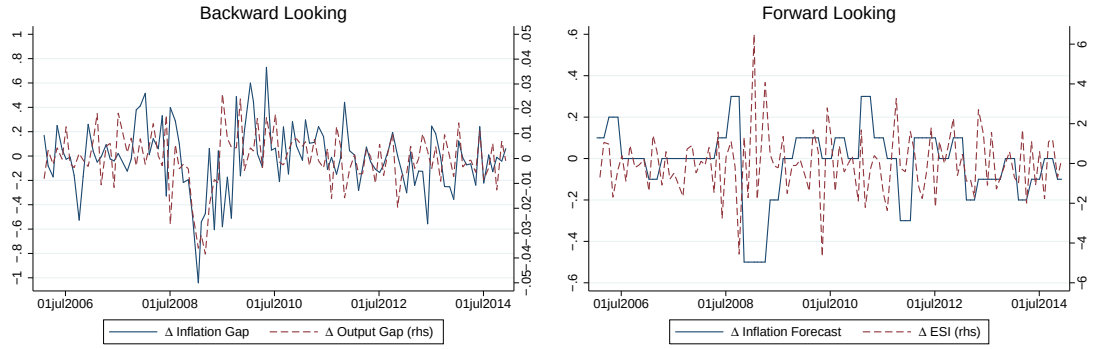
Notes : This table displays several examples of sentences from ECB introductory statement between 2006 and 2014 classified by the authors as not related to either the monetary policy or economic content.

B.4. ECB Non Standard Policies Announcements

Date	Reference	Wording from Introductory Statement
05/07/2009[1]	CBPP1	the Governing Council decided today to proceed with its enhanced credit support approach.
	1Y LTRO	we will conduct liquidity-providing longer-term refinancing operations with a maturity of 12 months
08/04/2011	6M LTRO	the Governing Council today also decided to conduct a liquidity-providing supplementary longer-term refinancing operation (LTRO) with a maturity of approximately six months
10/06/2011	LTRO	The Governing Council has decided to conduct two longer term refinancing operations LTROs , one with a maturity of approximately 12 months in October and the other with a maturity of approximately 13 months in December.
	CBPP2	Furthermore, the Governing Council has decided to launch a new covered bond purchase programme CBPP2 .
12/08/2011[1]	3Y LTRO	First, to conduct two longer-term refinancing operations (LTROs) with a maturity of 36 months and the option of early repayment after one year.
	Collaterals	Second, to increase collateral availability by reducing the rating threshold for certain asset-backed securities (ABS).
	Reserve Ratio	Third, to reduce the reserve ratio, which is currently 2 , to 1 .
09/06/2012	OMT	the Governing Council today decided on the modalities for undertaking Outright Monetary Transactions OMTs in secondary markets for sovereign bonds in the euro area.
07/04/2013	FG	The Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time.
06/05/2014[1]	TLTRO	targeted longer term refinancing operations
	SMP	we have decided to suspend the weekly fine tuning operation sterilising the liquidity injected under the Securities Markets Programme.
	ABS	preparatory work related to outright purchases of asset backed securities
09/04/2014[1]	ABS	In addition, the Governing Council decided to start purchasing non financial private sector assets.
	CBPP3	the Eurosystem will also purchase a broad portfolio of euro denominated covered bonds issued by MFIs domiciled in the euro area under a new covered bond purchase programme CBPP3 .

[1] : The Governing Council also announced an interest rate cut before the Press Conference.

B.5. Macroeconomic Variables



Notes : The two figures present the macroeconomic variables between 2006 and 2014 at a monthly frequency used as independant variables in our model. The first part focuses on backward looking variables with the month-to-month variation of the output (rhs) and inflation gaps. The second part presents forward looking variables namely the month-to-month variations of inflation forecasts and Economic Sentiment Indicator (ESI, rhs).

B.6. Descriptive Statistics

	Mean	Std. Deviation	Min.	Max.	ADF t-statistic
R_t	1.712	1.354	.05	4.25	-0.127
ΔR_t	-.016	.149	-.75	.25	**-6.590**
$(\pi_t - \pi^*)$	-.001	.010	-.026	.021	-0.955
$\Delta(\pi_t - \pi^*)$	-.001	.003	-.010	.007	**-7.928**
$(y_t - y^*)$	.001	.037	-.117	.078	-1.540
$\Delta(y_t - y^*)$	-.000	.011	-.038	.026	**-9.189**
Δy_t^e	-.0068299	1.56758	-4.679339	6.495041	**-14.150**
$\Delta \pi_t^e$	-.0186916	.172731	-.5	.3	**-3.794**
$\Delta Eurostoxx_t$	-0.002	.017	-.062	.057	**-11.344**
ΔVOL_t	-.003	-.067	-1.644	.236	**-10.057**

Notes : The ADF test null hypothesis H_0 assumes the existence of a unit root. Values in bold reject H_0 at a 1% confidence level (the 99% critical value is equal to -3.508) with 0 lag.

	Correlation Matrix			
	$\Delta(y_t - y^*)$	$\Delta(\pi_t - \pi^*)$	Δy_t^e	$\Delta \pi_t^e$
$\Delta(y_t - y^*)$	1.0000			
$\Delta(\pi_t - \pi^*)$	0.2415	1.0000		
Δy_t^e	-0.1698	-0.1729	1.0000	
$\Delta \pi_t^e$	0.3861	0.3718	-0.2153	1.0000
I_t^{MP}	0.2875	0.2564	-0.1515	0.4212
I_t^{EC}	0.1580	0.2501	-0.1689	0.4151
LM_t	0.2530	0.2495	-0.1973	0.5266
BN_t	0.2308	0.3303	-0.1570	0.5059

Notes : This table displays Pearson correlation coefficients of our independant variables between 2006 and 2014 at a monthly frequency.

B.7. Results from Equation 2.6 using the real time indicators RT_s^c

	Monetary policy decisions ECB_t	
	ΔMRR_t	$Decision_t$
ECB_{t-1}	-0.817	-0.786***
	(1.185)	(0.267)
$\Delta(y_t - y^*)$	-12.182	-3.238
	(14.383)	(13.452)
$\Delta(\pi_t - \pi^*)$	0.368	-0.285
	(0.558)	(0.521)
Δy_t^e	-0.040	-0.049
	(0.106)	(0.075)
$\Delta \pi_t^e$	4.727***	3.418***
	(1.047)	(0.915)
I_t^{MP}	0.355	0.523
	(0.454)	(0.342)
I_t^{EC}	3.040***	2.240***
	(0.783)	(0.657)
Observations	106	106
$Pseudo - R^2$	0.353	0.294

Notes : The tables report the results from an ordered probit model estimated with maximum likelihood between January 2006 and December 2014. The dependent variable is, for the upper part, the change of the ECB MRR and, for the lower part, ECB monetary policy decisions. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

B.8. Results from Equation 2.7 using the real time indicators RT_s^c

	Monetary policy decisions ECB_t			
	ΔMRR_{t+m}		$Decision_{t+m}$	
	m=1	m=2	m=1	m=2
ECB_t	-1.197	0.542	-0.789***	0.023
	(0.987)	(1.052)	(0.220)	(0.198)
$\Delta(y_t - y^*)$	14.665	10.922	11.500	13.815
	(14.195)	(11.057)	(13.302)	(10.791)
$\Delta(\pi_t - \pi^*)$	1.433**	0.378	-0.073	-0.087
	(0.629)	(0.557)	(0.573)	(0.446)
Δy_t^e	0.129	0.099	0.125	0.029
	(0.102)	(0.096)	(0.086)	(0.089)
$\Delta \pi_t^e$	1.918*	0.153	2.499***	0.743
	(1.112)	(1.196)	(0.899)	(0.946)
I_t^{MP}	-0.394	-0.473	-0.103	0.006
	(0.415)	(0.372)	(0.373)	(0.321)
I_t^{EC}	3.366***	2.246***	2.980***	1.609***
	(0.707)	(0.622)	(0.657)	(0.508)
Observations	106	106	106	106
$Pseudo - R^2$	0.322	0.181	0.290	0.156

Notes : Coefficients are maximum likelihood estimations of an ordered probit model between January 2006 and December 2014. The dependent variable is the one period ahead ($m = 1$) or two period ahead ($m = 2$) value of, for the upper part, the change of the ECB MRR and, for the lower part, ECB monetary policy decisions . Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

B.9. Regression results - Market Volatility and Text-Based Market Uncertainty

	VSTOXX		
	[1]	[2]	[3]
VOL_{t-1}	0.0866	0.1038	0.1229
	(0.0906)	(0.0867)	(0.0838)
$Surprise_t$	-0.1966	-0.1800	**-0.1832***
	(0.1207)	(0.1094)	(0.1101)
I_t^{MP}	**0.0342****		
	(0.0150)		
I_t^{EC}	**-0.0493***		
	(0.0292)		
ULM_t		1.7542	
		(1.5764)	
UBB_t			-0.0086
			(0.0118)
Observations	106	106	106
$Adj. - R^2$	**0.0519**	0.0204	0.0164

Notes : The table reports the results from a linear regression of contemporaneous market volatility (Equation 2.10). Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

C. Appendix to Chapter 3

C.1. Comparison of models and forecasts for all OIS maturities

	OIS 2M			OIS 3M			OIS 6M			OIS 10M		
	ARMA	*OLS*	*ARMAX*	*ARMA*	*OLS*	*ARMAX*	*ARMA*	*OLS*	*ARMAX*	*ARMA*	*OLS*	*ARMAX*
Log-likelihood	1258.4	1364.2	**1379.8**	1241.8	1335.3	**1345.9**	1147.766	1223.7	**1228.0**	1075.3	1137.4	**1143.3**
AIC	-2508.8	-2702.0	**-2727.5**	-2475.7	-2645.8	**-2659.9**	-2287.5	-2421.4	**-2424.0**	-2142.6	-2248.9	**-2254.6**
BIC	-2491.8	-2646.7	**-2659.3**	-2458.7	-2590.5	**-2591.7**	-2270.5	**-2366.1**	-2355.8	-2125.5	**-2193.5**	-2186.4
Model RMSE	0,1511	0,132	**0,1306**	0,1537	0,1371	**0,1352**	0,1689	0,155	0,155	0,1787	0,1659	**0,1658**
Forecast RMSE	0.0459	0.042	**0.0414**	0.0466	0.0407	**0.0404**	0.0565	0.0475	**0.0469**	0.0728	0.0665	**0.0659**

	OIS 1Y			OIS 2Y			OIS 3Y			OIS 6Y		
	ARMA	*OLS*	*ARMAX*	*ARMA*	*OLS*	*ARMAX*	*ARMA*	*OLS*	*ARMAX*	*ARMA*	*OLS*	*ARMAX*
Log-likelihood	1054.5	1122.0	**1126.2**	926.4	988.2	**988.9**	921.5	964.7	**967.8**	954.3	987.6	**989.2**
AIC	-2100.9	-2218.3	**-2220.4**	-1844.9	**-1950.5**	-1945.8	-1835.1	**-1902.1**	-1903.5	-1900.5	**-1949.1**	-1946.5
BIC	-2083.9	**-2162.9**	-2152.2	-1827.9	**-1895.0**	-1877.6	-1818.0	**-1846.1**	-1835.5	-1883.5	**-1893.8**	-1878.3
Model RMSE	0.1838	0.1697	**0.1696**	0.2058	0.1896	**0.1895**	0.2037	**0.1912**	0.1908	0,1974	0,1889	**0,1871**
Forecast RMSE	0.0746	0.0671	**0,0657**	0.0974	**0.088**	0.091	0.0875	**0.0769**	0.079	0.0736	**0.0676**	0.0741

	OIS 10Y		
	ARMA	*OLS*	*ARMAX*
Log-likelihood	934.7	979.3	**981.8**
AIC	-1861.4	**-1932.7**	-1931.6
BIC	-1844.4	**-1877.3**	-1863.5
Model RMSE	0.2045	0.1927	**0.1921**
Forecast RMSE	0.0835	**0.0802**	0.0818

Notes : The tables above present different model selection criterion for all OIS maturities. Model ARMA is a ARMA(1,1) estimated with maximum likelihood. Model OLS refered to an OLS estimate of the main equations (1) and (2) without the MA(1). Model ARMAX coresponds to the model used in the paper and defined by equations (1) and (2). For all maturities and model, we provide the log-likelihood, Akaike Information Criterion (AIC), Schwarz Information Criterion (BIC), the Root Mean-squared of errors (RMSE) of the estimation period and the RMSE of the forecasted period (11 days starting on June 27th 2013).

C.2. The effect of the ECB Forward Guidance announcement on OIS rates (in basis points, 3 days)

	2M	3M	6M	10M
Event Study				
July 2013	-0.476	-0.638	-1.194*	-2.772***
January 2014	0.297	0.154	-0.306	-0.589
AAR	-0.089	-0.242	-0.750*	-1.681**

Events	1Y	2Y	3Y	6Y	10Y
July 2013	-2.490**	-5.625***	-4.806**	-3.778	-0.883
January 2014	-1.105	-1.756	-0,952	0.457	0.524
AAR	-1.797**	-3.691***	-2.879**	-1.661	-0.179

Notes : ***, **, * represent significance level at levels of respectively 1%, 5% and 10% based on a F-test. The estimation is made using an ARMAX(1,1) model ; The event window includes 3 days before the communication to 3 days after.

C.3. The effect of the ECB Forward Guidance announcement on OIS rates (in basis points, 10 days)

	2M	3M	6M	10M
Event Study				
July 2013	-0.439	-0.609	-1.177*	-2.787***
January 2014	0.307	0.152	-0.043	-0.626
AAR	-0.066	-0.228	-0.610	-1.716***

Events	1Y	2Y	3Y	6Y	10Y
July 2013	-2.791***	-5.413***	-4.928***	-4.242*	-1.268
January 2014	-1.102	-1.756	-0,970	0.472	-0.076
AAR	-1.947***	-3.585***	-2.949**	-1.868	-0.672

Notes : ***, **, * represent significance level at levels of respectively 1%, 5% and 10% based on a F-test. The estimation is made using an ARMAX(1,1) model ; The event window includes 10 days before the communication to 10 days after.

C.4. List of main economic releases around the 4th of July 2013

	USA	Euro Area	Japan	United Kingdom
27/06/2013	**Initial Jobless Claims**	Economic Confidence **Business Climate Indicator** M3 Money Supply		GDP Growth Rate
28/06/2013			*Jobless Rate* *National CPI* *Industrial Production*	
01/07/2013	Markit Manufacturing PMI *ISM Manufacturing*	Markit Manufacturing PMI **CPI Estimate** *Unemployment Rate*		Markit PMI Manufacturing Money Supply M4
02/07/2013		*PPI*	Monetary Base	
03/07/2013	Trade Balance **Initial Jobless Claims** *ISM Non-Manf. Composite*	*Markit Composite PMI* Markit Services PMI *Retail Sales*		Markit Services PMI
04/07/2013			Jap. Buying For. Assets For. Buying Jap. Assets	New Car Registrations BoE Bank Rate
05/07/2013	*Unemployment Rate* Change in Payrolls		Coincident Index	
08/07/2013				
09/07/2013				Industrial Production Manufacturing Production Trade Balance
10/07/2013	Fed Minutes June Meeting		PPI	
11/07/2013	**Initial Jobless Claims**			

Notes : This table displays the main macroeconomic releases around the communication of ECB forward guidance on July the 4th 2013. Source : Bloomberg. In **bold**, releases used in the OIS model. In *italic*, releases tested in the OIS model but not significant.

C.5. List of main economic releases around the 9th of January 2014

	USA	Euro Area	Japan	United Kingdom
02/01/2014	**Initial Jobless Claims** Markit Manufacturing PMI *ISM Manufacturing*	Markit Manufacturing PMI		Markit PMI Manufacturing
03/01/2014		M3 Money Supply		Money Supply M4
06/01/2014	*ISM Non-Manf. Composite*	*Markit Composite PMI* Markit Services PMI		Markit Services PMI
07/01/2014	Trade Balance	**CPI Estimate** *PPI*	Monetary Base	New Car Registrations
08/01/2014	Fed Minutes Dec. Meeting	*Unemployment Rate* *Retail Sales*		
09/01/2014	**Initial Jobless Claims**	Economic Confidence **Business Climate Indicator**		Trade Balance BoE Bank Rate
10/01/2014	*Unemployment Rate* Change in Payrolls		Jap. Buying For. Assets For. Buying Jap. Assets Coincident Index	Industrial Production Manufacturing Production
13/01/2014				
14/01/2014	Retail Sales	Industrial Production		PPI
15/01/2014	PPI	Trade Balance	Money Stock	
16/01/2014	**Initial Jobless Claims** CPI	CPI	PPI	

Notes : This table displays the main macroeconomic releases around the communication of ECB forward guidance on January the 9th 2014. Source : Bloomberg. In **bold**, releases used in the OIS model. In *italic*, releases tested in the OIS model but not significant.