Determinants and transmission of monetary policy in China

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Abstract

The objective of this thesis is to enhance the understanding of the determinants and the transmission mechanisms of monetary policy in China over the last two decades. It contributes to the literature providing two alternative new composite measures of monetary policy in China based on alternative approaches, one combining price, quantity and administrative instruments and the other based on central bank speeches about monetary policy. Both are substitutes and prove to be essential to take into account the complex and adaptive behaviour of the People’s Bank of China in the context of partial economic reforms and gradual liberalisation of the financial system (while under state control).

More specifically, our instrument-based monetary policy index (MPI) emphasizes substantial changes in policy style towards smoother but more hawkish policy moves from 2002 onwards, consistent with the start of the mandate of Governor Zhou Xiaochuan, the progressive interest rate liberalization process and the increasing trade and financial opening. Moreover, it allows us to evaluate appropriately the rule followed by the central bank considering structural economic transformation in China. The estimation of a dynamic discrete-choice model implies from 2002 onwards a conduct of monetary policy characterized by implicit inflation targeting. Moreover, the PBC’s behaviour pre-2002 resembles that of the pre-1979 inflation-accommodating G3 countries, and is characterized after 2002 by a policy rule similar to the post-1979 anti-inflation (forward-looking) policy of the G3.

Then, our research provides evidence of the expected effects of progressive interest liberalization in China examining the deformation of the interbank bond yield curve over the last decade. While regulated interest rates can hamper the use of the yield curve as a benchmark for pricing risk and capital, the structure of the yield curve moves in line with the other traditional monetary policy instruments and the macroeconomic situation in China. Moreover, since the Global Financial Crisis, the interbank bond market seems to be responsive to central bank communication about monetary policy, a crucial step toward a more-market oriented system. Finally, we find that both the determinants and the transmission mechanisms of monetary policy require to consider China as an open-economy with its growing trade and financial opening after its WTO accession in 2001, as reflected in the significant influence of US interest rate policy.
Résumé

L’objectif de cette thèse est d’apporter une meilleure compréhension des déterminants et des mécanismes de transmission de la politique monétaire en Chine au cours des deux dernières décennies. Elle contribue à la littérature par le biais de deux nouvelles mesures composites de la politique monétaire en Chine basées sur des approches alternatives, la première combinant les divers instruments utilisés par la banque centrale (prix, quantité, administratifs) et la deuxième basée sur les discours de la banque centrale sur la politique monétaire. Les deux approches peuvent se substituer et révèlent être essentielles pour prendre en compte le comportement complexe et adaptatif de la Banque Populaire de Chine (BPC) dans le cadre des réformes économiques et la libéralisation progressive du système financier (encore sous contrôle de l’État).


Ensuite, notre recherche apporte sa contribution sur les effets attendus de la libéralisation graduelle des taux d’intérêt en Chine en examinant la déformation de la courbe des rendements obligataires interbancaires au cours de la dernière décennie. Alors que les taux d’intérêt réglementés peuvent entraver l’utilisation de la courbe de taux comme référence pour évaluer correctement des actifs et les risques, la structure par terme des taux d’intérêt évolue également en lien avec les autres instruments traditionnels de politique monétaire et la situation macroéconomique en Chine. De plus, le marché obligataire chinois semble réagir de plus en plus aux communications de la banque centrale sur la politique monétaire depuis la crise financière mondiale, une étape importante pour la
transition vers un système plus axé sur les mécanismes de marché. Enfin, nous constatons que les déterminants et les mécanismes de transmission de la politique monétaire nécessitent de considérer l’économie chinoise comme une économie ouverte du fait de son ouverture commerciale et financière après son adhésion à l’OMC en 2001, comme en témoigne, dans nos estimations, l’influence de la politique monétaire US sur la conduite de la politique monétaire chinoise et l’évolution de la courbe de taux.
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Introduction générale

Contexte de la recherche

La Chine a connu une croissance économique remarquable au cours des dernières décennies, soulevant la question de la singularité de son processus de développement économique. En effet, la croissance rapide de l'économie chinoise, malgré certaines faiblesses apparentes dans son développement économique et financier, remet en question la théorie économique et pose un certain nombre de questions et de débats parmi les économistes. Comme l’a souligné Summers (2007), la Chine a connu le même degré d’industrialisation au cours des trente dernières années que l’Europe en deux siècles.

Depuis 1979, la Chine a entrepris d’importantes réformes économiques avec une priorité particulière au passage progressif d’un système économique planifié à celui d’une économie davantage basée sur des mécanismes de marché tout en renforçant une politique macroéconomique basée sur des contrôles indirects. Plus récemment, la Chine a cherché à accélérer les réformes dans un contexte de ralentissement économique structurel et de rééquilibrage vers un modèle de croissance plus orienté sur la consommation domestique. Par conséquent, la Chine vise un système de marché moderne par « l’établissement d’un système unifié, ouvert, compétitif et ordonné » qui devrait jouer un rôle décisif pour une meilleure allocation des actifs. Pour y parvenir, la Chine est entrée au cours de la dernière décennie dans un processus de libéralisation financière, et notamment par le biais de la libéralisation progressive des taux d’intérêt et du développement d’une courbe de rendement obligataire (reflétant la relation entre l’offre et la demande sur le marché). Les autorités chinoises doivent également moderniser et renforcer la supervision et la formation de la politique monétaire. Ainsi, la Chine fait face à des challenges complexes liés particulièrement au fait que les spécificités qui ont aidé le pays à parvenir au développement économique remarquable au cours des décennies passées (spécificités de la politique économique, structure de son système financier) pourrait entraver à l’avenir son développement économique nécessitant ainsi des réformes importantes.

Dans ce contexte, cette thèse vise à améliorer notre compréhension de l’évolution des déterminants et la transmission de la politique monétaire au cours des vingt dernières années, compte tenu de la transformation institutionnelle, économique et financière de la Chine. Sur le premier aspect, la
Banque Populaire de Chine (BPC), sous le contrôle du Conseil d’État, est responsable de la conception et de la mise en œuvre de la politique monétaire, en particulier depuis la confirmation de son statut juridique en tant que banque centrale en 1995. Cependant, les objectifs, stratégies et cadres institutionnels de la politique monétaire en Chine sont en général différents de ceux des banques centrales dans la région Asie et Pacifique. En effet, la BPC a un double mandat de promouvoir la croissance économique et le maintien de la stabilité de la monnaie. Comme l’a souligné Filardo et Genberg (2009), la deuxième priorité indique le maintien de la valeur interne en termes de biens et de services (le niveau des prix) et / ou de la valeur externe (taux de change), alors que les autres banques centrales de la région Asie et Pacifique poursuivent généralement comme objectif principal la stabilité des prix. De plus, les stratégies adoptées pour atteindre les objectifs sont souvent différentes des autres banques centrales poursuivant généralement un ciblage de l’inflation (comme l’Australie, l’Indonésie, la Thaïlande, les Philippines, la Corée du Sud et, plus récemment, l’Inde). Seule la Chine, la Malaisie et le Japon ne mettent pas en pratique, du moins officiellement, une politique de ciblage de l’inflation. Enfin, la majorité des institutions asiatiques utilisent un taux d’intérêt de court terme pour mener à bien leur politique sauf la BPC qui utilise plusieurs instruments de politique monétaire (taux d’intérêt, taux des réserves obligatoires, opérations d’open market…). Comme l’ont justement décrit Filardo et Genberg (2009), les contrôles existants sur le système financier domestique et sur les flux de capitaux internationaux rendent davantage possible l’utilisation de plusieurs instruments par la BPC, une option moins réalisable dans les juridictions où les marchés financiers intérieurs sont plus libéralisés, efficientes et avec des comptes de capitaux plus ouverts. Par conséquent, l’analyse des déterminants et de la transmission de la politique monétaire en Chine pose un certain nombre de challenges liés au fait que la banque centrale ne semble pas poursuivre les mêmes objectifs et stratégies que les autres banques centrales de la région Asie et Pacifique.

De plus, le développement économique et financier de la Chine présente trois caractéristiques spécifiques ayant des implications importantes sur la conduite de la politique monétaire et le développement du marché obligataire : (1) une approche économique expérimentale ayant conduit à des fluctuations économiques excessives et des actions de politique monétaire soit trop lâches soit trop restrictives, (2) la nature spécifique du système financier bancaire contrôlé par l’État depuis les années 1980s expliquant l’environnement réglementé de la politique monétaire orienté par le
financement des banques pour les investissements en capital fixe, et l'utilisation de mesures administratives de contrôle des prix et de l'investissement pendant les périodes de chocs (y compris la dernière crise financière globale) et (3) une politique d’ouverture commerciale menant la Chine à devoir gérer de plus en plus les forces monétaires et financières mondiales, tout en essayant de naviguer autour du trilemme – c’est à dire une mobilité croissante des flux de capitaux, une monnaie quasi indexée et une politique monétaire indépendante – ce qui est théoriquement impossible.

Dans ce contexte, cette thèse vise à améliorer la compréhension des relations entre l’évolution de la politique monétaire, les réformes institutionnelles et économiques ainsi que les caractéristiques du système financier, en poursuivant deux objectifs : (1) l’analyse des déterminants macroéconomiques de la politique monétaire depuis le milieu des années 1990 et (2) l’analyse des mécanismes de transmission de la politique monétaire au regard des mouvements de la courbe des rendements obligataires. Ces deux angles de recherche visent à évaluer les étapes que confronte la Chine pour réussir sa transition économique vers un système plus axé sur les mécanismes de marché.

**Revue de la littérature sur les déterminants et la transmission de la politique monétaire**

**Déterminants de la politique monétaire en Chine**

Girardin, 2013) défend l'idée qu'une telle mesure conventionnelle présente de nombreux inconvénients (problème de liquidité au moins initialement, la segmentation des marchés du crédit, etc.) et ne peut pas être utilisée comme proxy pour mesurer correctement le cadre de la politique monétaire chinoise.


Ainsi, une troisième partie de la littérature s'est intéressée à la construction d'une mesure de politique monétaire appropriée dans le cas de la Chine. He et Pauwels (2008), Xiong (2012) ont dérivé un indicateur discret implicite de la politique monétaire depuis le début des années 1990s, en utilisant une approche initiée par Gerlach (2007) classant les changements observés des instruments (y compris les changements dans la croissance du crédit) en trois classes : « hawkish », « neutre » et « dovish ». Ensuite, des analyses quantitatives de type probit ordonné sont utilisées pour estimer la fonction de réaction. Cependant, ces recherches ont fourni des résultats divergents et une confusion dans les conclusions. He et Pauwels (2008) constatent que le cadre de la politique monétaire est compatible avec une politique « de ciblage implicite de l’inflation » avec les écarts de l’inflation à une cible expliquant de manière significative les décisions de la BPC, mais pas l’écart à une croissance de l’activité économique tendancielle. Par ailleurs, Xiong (2012) conclut que la politique monétaire réagit à la croissance économique dans un modèle tenant compte des éléments retardés (« backward-looking »). En revanche, lorsque le modèle prend en compte les écarts de la croissance économique à la tendance ou bien des éléments prospectifs (« forward-looking »), l’inflation joue un rôle clé dans la détermination de la politique monétaire menée par la BPC. Enfin, Shu et NG (2010) constatent que la croissance économique et l’inflation sont les principaux déterminants de la
politique monétaire et que la BPC semble suivre une règle basique en utilisant des moyennes historiques comme cible plutôt que des cibles officielles.

Par conséquent, chaque aspect de la littérature empirique sur la détermination de la politique monétaire chinoise présente ses propres avantages et inconvénients. De plus, ces études mettent en évidence l’importance du choix d’une mesure de la politique monétaire adéquate et des questions de spécification dans le cas chinois. Cette thèse se base sur cette littérature existante pour estimer la règle de politique monétaire de la Chine en combinant à la fois la construction d’une mesure de la politique monétaire et en testant différentes spécifications.

*Transmission de la politique monétaire en Chine*

La majorité de la littérature existante sur la transmission de la politique monétaire chinoise trouve un lien historiquement faible entre la politique monétaire et les performances économiques. Cependant, avec le développement constant du système financier chinois, des récents travaux empiriques ont réexaminé la transmission de la politique monétaire en Chine au cours des dix dernières années et tendent à conclure sur son efficacité croissante sur l’économie réelle.

He and Wang (2012) ont également examiné empiriquement la transmission de la politique monétaire sur les marchés monétaires et obligataires à travers un modèle GARCH sur la période 2004-2010. Ils trouvent que les taux d’intérêt du marché sont très sensibles aux variations des taux des dépôts de référence, répondent également aux variations sur le ratio des réserves obligatoires, mais pas particulièrement réactifs aux opérations d’open market. Cependant, la plupart de la littérature sur les mécanismes de transmission au travers du canal des taux d’intérêt s’est concentré sur les effets sur le marché monétaire, et dans une moindre mesure sur les rendements obligataires alors que ces derniers apparaissent comme les conduits fondamentaux dans la transmission de la politique monétaire. Comme décrit par Svensson (2004), la politique monétaire consiste dans une large mesure au management des anticipations. Ainsi, les rendements obligataires contiennent les anticipations des taux d’intérêt futurs, et non pas les changements récents de la politique monétaire. Par conséquent, l’efficacité de la politique monétaire dépend de la déformation de la courbe de taux reflétant les perceptions de la politique monétaire à venir.

Comme l’ont souligné Schmidt et Nautz (2011), une communication efficace devrait également veiller à ce que les marchés financiers comprennent bien la politique de la banque centrale. En effet, l’objectif de la communication est de guider et d’influencer les anticipations du marché concernant les futures décisions de politique monétaire et ainsi affecter les taux d’intérêt de long terme. Garcia-Herrero et Remolona (2008) font également valoir que « le canal des anticipations » fonctionne plus efficacement lorsque les marchés financiers sont prospectifs, lorsqu’ils comprennent bien les projections économiques des décideurs, l’évolution de la politique monétaire et comment la banque centrale peut répondre en cas de changement dans les perspectives. Toutefois, la communication de la banque centrale n’est pas toujours efficace. Par exemple, les prévisionnistes peuvent en effet « comprendre » la politique monétaire, mais mal percevoir les décisions futures de taux d’intérêt, simplement parce qu’ils ne disposent pas de bonnes projections concernant l’inflation et la croissance économique future.

La BPC est devenu plus active en prononçant plus de discours par les autorités chinoises et en publiant des communiqués après chaque comité de la politique monétaire (MPC) sur les questions de politique monétaire et les perspectives économiques. Garcia-Herrero et Girardin (2013) ont montré que le marché monétaire chinois n’est pas seulement à l’écoute des discours de la BPC mais comprend aussi le ton de la politique monétaire. Par conséquent, ils constatent que la volatilité
Objectifs et contributions de la thèse

Le but de cette thèse est d’améliorer la compréhension de l’évolution de la politique monétaire en Chine en cours des vingt dernières années, tout en poursuivant trois objectifs. Premièrement, nous tentons d’expliquer les spécificités de la politique monétaire en Chine en parallèle de certaines réformes économiques et des spécificités du système financier contrôlé par l’État. Cela permet d’expliquer pourquoi la BPC a utilisé une batterie d’instruments basés sur les prix et quantités ainsi que des mesures administratives. Cependant, de nombreuses questions sur la politique monétaire restent ouvertes. Essayer d’évaluer correctement les changements dans l’orientation de la politique monétaire chinoise présente de nombreux défis, car aucun instrument n’est un bon indicateur de la politique monétaire de la Chine.

Par conséquent, nous contribuons à la littérature en fournissant deux nouveaux indicateurs composites à haute fréquence de la politique monétaire fondés sur des approches alternatives. Tout d’abord, nous construisons un indicateur mensuel, à partir des travaux de He et Pauwels (2008), en combinant les différents instruments de prix, quantité et directives administratives, déployés par la banque centrale sur la période 1993-2013 en Chine. Notre mesure va un peu plus loin en prenant en compte l’ampleur des changements de politique monétaire, normalisée en termes d’équivalent de taux d’intérêt, qui peut s’interpréter en accord avec la règle conventionnelle de Taylor basée sur un taux d’intérêt. De plus, notre mesure permet de détecter un changement substantiel dans le style de la politique monétaire vers une politique plus graduelle et agressive envers l’inflation depuis 2002 (un résultat également défendu par Chen et Huo, 2009), cohérent avec le début du mandat du gouverneur Zhou Xiaochuan.

Le second indicateur repose sur une nouvelle méthodologie basée sur les discours quotidiens de la banque centrale et agrégeant, grâce à une approche automatisée, les contenus officiels des articles publiés dans les médias sur les futures décisions de politique monétaire. Cet indicateur apparaît comme un bon substitut du premier indicateur basé sur les instruments et confirme que les deux
indications essentielles pour bien prendre en compte le comportement complexe et adaptatif de la Banque Populaire de Chine dans le cadre de certaines réformes économiques et en tenant compte de la nature étatique du système financier. De plus, l'indicateur basé sur les discours fournit des informations utiles sur la politique monétaire comme outil de transparence, mais sert aussi d'outil de communication en tentant de renforcer les actions de politique monétaire, particulièrement pendant les périodes de resserrement des politiques monétaires.

Ensuite, nous utilisons notre indicateur construit à partir des instruments pour estimer une règle de politique monétaire dynamique en utilisant une méthode bayésienne proposée par Dueker (1999) et Monokroussos (2011), combinant l'algorithme d'augmentation des données et l'échantillonnage Gibbs, une méthode de Monte-Carlo par chaînes de Markov (MCMC). Cette approche présente de nombreux avantages par rapport à la littérature existante en tenant compte de la nature discrète de l'indicateur de politique monétaire. De plus, il nous permet d'interpréter et de comparer les coefficients de long terme aux résultats standards proposés par Taylor (1993), ce qui est impossible en utilisant des modèles de type probit ordonné (comme utilisés par He et Pauwels, 2008).


La deuxième partie de la thèse vise à analyser les facteurs expliquant les principaux mouvements de la courbe des rendements obligataires en Chine. Nous nous interrogeons plus particulièrement sur la
capacité des taux obligataires, déterminés par le marché, de refléter les conditions de liquidité et
d’agir comme référence pour l’évaluation des prix des actifs et la politique monétaire. Cette
recherche suit une méthodologie initialement utilisée par Porter et Xu (2009), modifiée par Garcia-
GARCH afin d’évaluer les effets des mesures de politique monétaire et des facteurs
macroéconomiques sur le marché obligataire sur la période 2007-2013. Nous ajoutons à la littérature
sur la transmission de l’information sur le marché obligataire en Chine au travers de deux principales
contributions. Premièrement, le modèle se concentre sur l’ensemble de la courbe des rendements
plutôt que sur les marchés monétaires ou une sélection réduite de maturités de rendements
obligataires. En effet, la politique monétaire vise à influencer non seulement les taux d’intérêt de
court terme, mais également les anticipations du marché et les trajectoires des taux courts futurs
reflétés dans la courbe de taux. Par conséquent, nous estimons empiriquement la courbe des taux en
Chine au travers du fameux modèle de Nelson Siegel, très utile pour résumer la structure par terme
des taux d’intérêt en trois facteurs latents facilement interprétables liés au niveau, la pente et la
courbure de la courbe de taux. Deuxièmement, le modèle englobe des facteurs clés en plus des
instruments traditionnels de politique monétaire qui affectent potentiellement la courbe de taux, y
compris les communications de la banque centrale, les annonces des chiffres macroéconomiques et
la politique monétaire américaine.

Nous mettons en évidence les effets attendus de la libéralisation progressive des taux d’intérêt en
Chine en examinant la déformation de la courbe de taux au cours de la dernière décennie. Alors que
les taux d’intérêt réglementés peuvent entraver l’utilisation de la courbe des rendements comme
référence pour évaluer les actifs et les risques, la structure de la courbe de rendement évolue bien en
lien avec les autres instruments traditionnels de la politique monétaire et la situation
macroéconomique de la Chine. De plus, le marché obligataire interbancaire semble être sensible aux
communications de la banque centrale en termes de politique monétaire, en particulier depuis la
crise financière globale, une étape importante pour la transition vers une économie reposant plus sur
des mécanismes de marché. Enfin, nos résultats empiriques montrent des effets significatifs de la
transmission de la politique monétaire américaine sur la courbe de taux chinoise, y compris
l’assouplissement monétaire exceptionnelle initié après la crise financière globale.
Structure de la thèse

Cette thèse est organisée en trois chapitres. Les premier et deuxième chapitres examinent les déterminants de la politique monétaire en Chine. Le premier chapitre concentre l’analyse sur la relation entre certaines réformes économiques, le système financier étatique et la conduite de la politique monétaire. Ce chapitre met également en évidence l’importance de construire de nouvelles mesures pour examiner correctement la politique monétaire en Chine. Le deuxième chapitre se concentre sur l’estimation des déterminants de la règle de la politique monétaire. Enfin, la transmission de la politique monétaire en Chine est traitée dans le troisième chapitre en analysant les mouvements de la structure par terme des taux obligataires en Chine.
General introduction

Context of the research

China has achieved remarkable economic growth over the last decades raising the question of the singularity of its economic development process. Indeed, the rapid growth in the Chinese economy, despite some apparent weakness in its economic and financial development, challenges the mainstream economic theory and also poses many economic puzzles and generates interesting debates among economists. As pointed out by Summers (2007), in the past three decades, China has experienced the same degree of industrialization that took two centuries to occur in Europe.

Since 1979, China’s economy has been undergoing major economic reforms with specific priorities granted to the gradual transition from a planned- to a more market-oriented system and the establishment of a macroeconomic system based on indirect control. More recently, China has aimed at accelerating reforms in the background of a structural economic slowdown and the economic rebalancing to a more consumer-led growth model. Therefore, China aims at achieving a Modern Market System by “establishing a unified, open, competitive and orderly market system” which could play a decisive role in the allocation of resources. To achieve it, over the last decade, China has been in the process of further financial liberalization notably through gradual interest rate liberalization and the improvement of the national debt yield curve (that reflects the relationship between market supply and demand). It would also require modernization and strengthening in supervision and monetary policy formation. These represent challenging tasks particularly because the specificities of China’s economic policy and the structure of its financial system which helped the country to achieve remarkable economic development over the past decades could hamper it in the future without reforms.

In this context, this thesis aims at enhancing our understanding of the evolving determinants and transmission of monetary policy in China over the last two decades considering the institutional, economic and financial transformation. On the first aspect, under the leadership of the State Council, the People’s Bank of China is responsible for designing and implementing the monetary policy, particularly since the confirmation of its legal status as a central bank in 1995. However, the objectives, strategies and institutional frameworks for monetary policy in China are different from
those of the central banks in the Asia and Pacific region in general. Indeed, the People’s Bank of China (PBC) has a dual mandate of promoting economic growth and maintaining the stability of the value of the currency. As pointed out by Filardo and Genberg (2009), the latter means either the internal value in terms of goods and services (the price level) and/or the external value (the exchange rate) while other central banks in the Asia and Pacific region generally pursue price stability as the principal objective. Moreover, strategies adopted to achieve the objectives are also different from central banks generally portrayed as inflation targeters (such as Australia, Indonesia, Thailand, Philippines, South Korea and more recently India). Only China, Malaysia and Japan did not officially implement an inflation targeting policy yet. Finally, the majority of the institutions in this region carry out their policy by means of targeting a short-term interest rate but the PBC employs several instruments in the implementation of its monetary policy (interest rates, required reserve ratio, open market operations...). As rightly portrayed by Filardo and Genberg (2009), existing controls on the domestic financial system and on international capital flows arguably make it possible for the PBC to use several instruments, an option less feasible in jurisdictions with more liberalized and efficient domestic financial markets, and with more open capital accounts. Consequently, the challenges of analyzing monetary policy determinants and transmission in China mainly stem from the fact that the central bank does not pursue (at least officially) standard objectives, strategies and frameworks as in other central banks in the Asia and Pacific region.

Moreover, three important characteristics in China’s economic and financial development are noticeable and have had significant impacts on the conduct of monetary policy and the development of the bond market: (1) a gradual and experimental economic approach leading to excessive economic fluctuations and monetary policy actions, either too loose or too tight, (2) the specific nature of the bank-based and state-controlled financial system from the early 1980s explaining the regulated monetary policy environment in China driven by bank’s finance for fixed assets investment, and the use of administrative window guidance to control prices and investment during shock periods (including the Global Financial Crisis) and (3) an open-door policy leading China to increasingly manage global monetary and financial forces while attempting to avoid the trilemma – increasing capital flows’ mobility, a quasi-pegged currency and an autonomous domestic monetary policy – which is normally impossible.
In this context, this thesis aims at enhancing the understanding of the interrelation between the evolving monetary policy, the institutional and economic reforms as well as the characteristics of the financial system, pursuing two objectives: (1) analyzing the macroeconomic determinants of the monetary policy rule since the mid-1990s and (2) studying aspects of the monetary transmission mechanism related to the movements of the bond yield curve. Both aspects would provide some insights and help evaluating the crucial steps China faces to achieve its economic transition to a more-market oriented system.

**Literature review on the determinants and transmission of monetary policy**

*Determinants of monetary policy in China*

Three strands of the literature have examined the monetary policy rule formation in the case of China. The first category of works tries to transpose a specification standard for advanced countries to the case of China. This strand of research typically models the interbank interest rate, in line with the methodology of Clarida, Gali and Gertler (2000), estimating a forward-looking Taylor rule and turning to a nonlinear specification (Markov Switching Model) to take into account changes in the economic and policy environment. Overall, Zheng et al. (2012), Chen and Huo (2009), find that the response of interest rate policy to inflation and output is time-varying with a larger response to inflation after 1998 and 2002. Chen and Huo (2009) also find that a pure forward-looking monetary policy rule cannot fully explain the Chinese situation and that the PBC is partly backward-looking. However, one drawback of the analyses in this category is their questionable measure of monetary policy in China, generally using China’s inter-bank offered rate (CHIBOR) as the policy rate (Zheng et al (2011) along with Xie and Luo (2002)). However, there is a broad consensus (He and Pauwels 2008, Xiong, 2012, Garcia-Herrero and Girardin, 2013) arguing that such a conventional measure presents many drawbacks (such as initial lack of liquidity, segmentation of credit markets etc.) and cannot be an accurate proxy of the Chinese monetary policy framework.

A second stand of the literature finds that the monetary authority in China tends to pursue a simple money growth rule (i.e. a McCallum’s rule), as in Burdekin and Siklos (2008) examining the 1990-2003 period, or Chen and Huo (2009), Xie, (2004) and Koivu, (2009). However, as pointed out by Fernald, Spiegel and Swanson (2014), the financial liberalization process in China from the mid-1990s
appeared to increase the impact of monetary policy with an increasing role played by price instruments in parallel to quantity variables. However, while the PBC uses a mix of price- and quantity-based instruments, Guo and Chen (2012) argue that no single policy tool can properly summarize the monetary policy stance in the case of China.

Thus, the third strand of the literature has turned to the construction of an appropriate monetary policy measure in the case of China. He and Pauwels (2008), and Xiong (2012) derived an implicit discrete index of PBC’s monetary policy stance since the early 1990s, using an approach pioneered by Gerlach (2007) classifying the observed changes in policy instruments (including changes in credit growth) into three classes: “hawkish”, “neutral” and “dovish”. Then ordered-probit techniques are used to estimate the reaction function. However, such research provides diverging results and confusing messages. He and Pauwels (2008) find that the monetary policy framework is consistent with one of “implicit inflation targeting” with deviations of CPI inflation from an implicit target, but not the output gap, figuring significantly as determinants of PBC’s policy changes. By contrast, Xiong (2012) concludes that, in a backward-looking model from 2001 to 2010, monetary policy reacts to actual output growth. But when deviations from trend levels are considered or in a forward-looking model, inflation plays a key role in determining the PBC’s policy stance. Finally, Shu and Ng (2010) find that growth and inflation are key monetary policy determinants and that the PBC appears to follow a rule of thumb, using historical averages as target rather than official targets.

Therefore, each strand of the empirical studies of China’s monetary policy has its own advantages and drawbacks. Moreover, such studies highlight the strong importance of adequate measures in the case of China and some specification issues. This thesis builds on the existing literature of these two strands to estimate China’s monetary policy rule by combining the construction of an appropriate monetary policy measure and specification.

Transmission of monetary policy in China

The majority of the existing literature on China’s monetary policy transmission finds the link between monetary policy and real economic performance to be historically weak. However, motivated by the evolving financial system, recent empirical research has re-examined the monetary policy transmission in China over the past decade only, and tends to conclude on its increasing effectiveness on the real economy.
Among others, Liu (2010), using a VAR framework from 1997 to 2005, finds that China’s output and price decrease significantly following a contractionary policy shock, suggesting the presence of an interest rate channel. Cassola and Porter (2011) using a VAR model find that bond yields contain considerable information about the state of the economy as well as evidence of an emerging transmission channel. Indeed, their results show that changes in PBC rates influence the term structure of interest rates (treasury, financial and corporate bond yields) which are then associated with changes in growth and inflation. Among other works, Sun (2013) finds that monetary policy over the 2000-2011 period has a large and persistent impact on output in China. Finally, Fernald, Spiegel and Swanson (2014) using a FAVAR model also conclude that the monetary policy transmission channels in China have moved closer to those of Western market economies and argue that monetary policy instruments, including interest rates, have a significant impact on economic activity and inflation.

He and Wang (2012) have also examined empirically the monetary policy transmission to money and bond markets through a GARCH model over the 2004-2010 period. They find that market interest rates are most sensitive to changes in benchmark deposit interest rates, significantly responsive to changes in reserve requirements, but not particularly reactive to open market operations. However, most of the literature on the transmission mechanism through the interest rate channel has focused on the effects on the money market rate and to a lesser extent on bond yields while the latter appear as the fundamental conduits for the transmission of monetary policy. As rightly portrayed by Svensson (2004), monetary policy is to a large extent the management of expectations. Indeed, bond yields contain expectations of future policy rates, not recent monetary policy changes. Therefore, monetary policy effectiveness depends on the deformation of the yield curve which reflects perceptions of future monetary policy.

As pointed out by Schmidt and Nautz (2011), effective communication should also ensure that financial markets understand the central bank’s interest rate policy. Indeed, the objective of communication is to guide and to influence market expectations concerning the future monetary policy decisions and thereby affect long-term interest rates. Garcia-Herrero and Remolona (2008) also argue that “the expectation channel” operates most effectively when the financial markets are forward looking, when they understand how policymakers expect economic conditions and monetary policy to evolve over time and how the central bank would respond to any changes in the outlook.
However, central bank communication is not always effective. For instance, forecasters may indeed “understand” monetary policy but misperceive future interest rate decisions simply because they do not have good projections about future inflation and output. The PBC has become much more active in delivering speeches by its governing body and publishing statements after each monetary policy committee (MPC) meetings on monetary policy issues and economic outlook. Garcia-Herrero and Girardin (2013) have shown evidence that the money market not only listens to the PBC’s words but also understands the tone of the monetary policy. Therefore, they find that the conditional volatility of money market rates changes right after a speech from the PBC’s governing body. Second, they find a statistically significant rise in interbank rates the more hawkish the speeches are.

**Objectives and contributions of this thesis**

The purpose of this thesis is to enhance the understanding of China’s evolving monetary policy over the last two decades while pursuing three objectives. First, we attempt to explain the specificities of the monetary policy in China in parallel with partial economic reforms and the specificities of the state-controlled financial system. This helps explaining why the PBC has employed a battery of price- and quantity-based instruments as well as administrative window guidance. However, many questions over China’s monetary policy remain open-ended. Trying to assess appropriately the changes in the monetary policy stance in China faces many challenges because no single policy instrument represents a good proxy of China’s monetary policy.

Therefore, we contribute to the literature providing two new high-frequency composite monetary policy indicators based on alternative approaches. First, we build in part on the works of He and Pauwels (2008) and Xiong (2012) and construct a monthly instrument-based indicator combining the multiple price, quantity and administrative tools deployed by China’s central bank over the period 1993-2013. Our measure goes one-step further by taking into account the magnitude of monetary policy changes, scaled in policy-rate equivalent terms that can be interpreted in line with the conventional Taylor rule based on a target interest rate. Moreover, it allows emphasizing a substantial change in policy style towards smoother but more hawkish policy moves from 2002 onwards (a break also found by Chen and Huo, 2009), coinciding with the start of the mandate of Governor Zhou Xiaochuan.

The second new indicator concerns a novel method based on daily central bank speeches which aggregates, through an automated approach, official content in media articles about future
monetary policy decisions. This indicator appears as a substitute of the instrument-based indicator and confirms that both indicators are essential to take into account the complex and adaptive behaviour of the People’s Bank of China in the context of partial economic reforms and the state-controlled nature of the financial system. Moreover, the speech-based indicator provides useful information about the monetary policy stance as a transparency tool but also serves as a communication tool by attempting to reinforce monetary policy actions, particularly during tightening monetary policy periods.

Then, we use the instrument-based indicator to estimate a dynamic monetary policy rule using a Bayesian method proposed by Dueker (1999) and Monokroussos (2011), combining data augmentation and single-move Gibbs sampling of the Markov-Chain Monte Carlo literature. This approach has many advantages compared to the existing literature by taking into account the discrete nature of the monetary policy instrument. Moreover, it allows us to interpret and compare long-term coefficients to the standard suggested by Taylor (1993) which is not possible when using ordered-probit model (as used by He and Pauwels, 2008).

This research highlights that the PBC seems to have gradually changed its strategy towards a more “standard” monetary policy rule from 2002 onwards with a conduct of monetary policy characterized by implicit inflation targeting as in most central banks in the Asia and Pacific region (a result also supported by He and Pauwels, 2008). Moreover, we find that the PBC’s behaviour pre-2002 resembles that of the pre-1979 inflation-accommodating G3 countries, and is characterized after 2002 by a policy rule similar to the post-1979 anti-inflation (forward-looking) policy of the G3. Finally, we argue that an accurate estimation of the monetary policy rule after 2002 needs to consider China as an open-economy with its rapid trade and financial opening (after its WTO accession in December 2001) and the significant influence of US interest rate policy. Indeed, the evolving Chinese exchange rate regime may have influenced the conduct of monetary policy in China and the attempt to avoid large currency appreciation and massive capital inflows in the 2000s may explain the influence of the US Fed Funds rate in the conduct of monetary policy in China.

The second part aims at examining factors that explain major moves in the interbank bond yield curve in China. We question specifically the ability of market determined rates to reflect liquidity conditions and act as benchmark for use in asset pricing and monetary policy. This research follows a methodology initially used in the paper of Porter and Xu (2009), modified by Garcia-Herrero and
Girardin (2013) and recently used by He and Wang (2011), by estimating GARCH models to look at the effects of monetary policy measures and macroeconomic factors on the bond market over the 2007-2013 period. We add to the literature on the transmission of information across maturities in China’s bond market through two main contributions. First, the model focuses on the entire yield curve rather than money markets or selected bond yield maturities. Indeed, the monetary policy aims at altering not just current short-term interest rate but market expectations and the “anticipated” path of short-term rates reflected in the bond yield curve. Therefore, we estimate empirically the yield curve in China through the well-known Nelson-Siegel model, powerful for summarizing the term structure into three easily interpretable latent factors at each date, related to the level, the slope and the curvature of the yield curve. Second, the model encompasses additional key factors to traditional monetary policy instruments that potentially affect the bond yield curve, including central bank communication, macroeconomic news and US monetary policy.

We find evidence of the expected effects of gradual interest liberalization in China examining the deformation of the interbank bond yield curve over the last decade. While regulated interest rates can hamper the use of the yield curve as a benchmark for pricing risk and capital, the structure of the yield curve moves in line with the other traditional monetary policy instruments and the macroeconomic situation in China. Moreover, the interbank bond market seems to be responsive to central bank communication about monetary policy, particularly from the Global Financial Crisis onwards, a crucial step toward a more market oriented system. Finally, we find significant spillover effects on the Chinese bond yield curve through empirical evidence of a transmission of US monetary policy changes, including the exceptional monetary easing after the GFC on China’s economy.

**Structure of the thesis**

This thesis is organized in three chapters. The first and second chapters examine the determinants of monetary policy in China. The first chapter concentrates the analysis on the interrelationship between partial economic reforms, the state-controlled financial system and the conduct of monetary policy. This chapter also highlights the importance of constructing new measures to examine properly monetary policy in China. The second chapter focuses on the estimation of the determinants of the monetary policy rule. Finally, the transmission of monetary policy in China is treated in the third chapter by analysing the movements of the bond yield curve in China.
Part One: The monetary policy in China and its determinants
Chapter 1
Assessing the monetary policy in China
1.1. Introduction to chapter 1

China has achieved remarkable economic growth since the mid-1990s, including during the Global Financial Crisis (GFC), raising the question of the singularity of its economic development process and more specifically its conduct of monetary policy and financial system reform. However, monetary policy mechanisms, closely linked to the specific financial development and partial economic reforms, are complex and unlike those in advanced economies, often leading to misunderstanding among observers. The objective of this chapter is thus to enhance the understanding of monetary policy in China.

While China’s economy is described as a fast-growing economy in transition, the broad monetary policy setting has presented common and invariant features since 1979. As pointed out by Jin (1994), China has reformed its economy using a trial-and-error approach, meaning a gradual and experimental process built on five main pillars: (1) the decentralization of economic management to local governments (2) the gradual introduction of market mechanisms and interest rate liberalization (3) the development of non-state sectors (4) the establishment of a macro management system based on indirect control and (5) the liberalization of cross-border economic activities (the open-door policy). As a consequence, China has been subject to large economic fluctuations and excessive monetary policy adjustments characterized by an expansionary bias.

This expansionary bias, specific to China, is attributable both to the economic reform program and the functioning of its financial system, which remains bank-based, with a major contribution of bank loans in total financing, and under state-control. Indeed, two monetary policy instruments have been mainly used over the past three and a half decades: (1) administrative window guidance and (2) low and regulated lending and deposit rates, typical of financial repression, resulting in a dual-track system (He and Wang, 2012) with money market and bond rates being market determined. On the one hand, these two characteristics have particularly helped state-owned enterprises with low funding costs to support massive investment and have managed to some extent to insulate the economy from financial instability, such as during the GFC. On the other hand, “financial repression” is theoretically recognized (McKinnon, 1973, Shaw, 1973) to prevent an efficient allocation of resources and thereby hamper economic growth.
Chapter 1 – Assessing the monetary policy in China

However, Chinese authorities have made great effort to enhance financial reforms over the last two decades. First, the 1990s were particularly marked by the easing in credit control through the abandonment of credit quotas in 1998, the strengthening of banking sector supervision since the confirmation of the PBC legal status as central bank in 1995, the removal of all restrictions on money market and bond market rates, allowing interbank lending, central government bonds, and financial institution bonds to be fully priced by the market. Then, China WTO entry in December 2001 required policymakers to modernize China’s financial system and enhance the competitiveness of Chinese banks with the development of security markets and the opening up to an increasing number of (domestic and foreign) investors. Moreover, the post-2002 period marks a new step towards gradual interest rate liberalization (both regulated lending and deposit rates). Therefore, Chinese policymakers understand the importance to enhance security markets and liberalize interest rates as both aspects would play a fundamental role in effective resource allocation and would also enhance monetary policy transmission.

Consequently, the understanding of the monetary policy setting has to be examined in parallel with partial economic reforms and the specificities of the financial system which explain most of the differences with the conduct of monetary policy in Western countries. While some specifics of the monetary policy setting have prevailed over time, the central bank, the People’s Bank of China, had to adapt its behavior particularly over the last decade through the acceleration of two priority reforms, the open-door policy and the financial market liberalization.

The complex domestic monetary policy setting has to be considered in a more global environment with the increasing degree of trade openness of China from the 1990s, and especially since the WTO adhesion at end-2001. Therefore, the management of global monetary and financial forces is of high importance in China and the central bank had to adapt its monetary policy to the growing world integration and its rapid domestic economic development. However, the exceptional economic performance of China raises the question of monetary independence. It is usually argued that greater monetary independence allows policy makers to stabilize the economy through monetary policy without being subject to other economies’ macroeconomic outcomes, thus potentially insulating the economy (Chinn, 2014). However, China has tried to play around the trilemma (Mundell, 1963) over the past decades, attempting at once, albeit in an evolving way, to reach domestic monetary policy
objectives, maintain a quasi-pegged exchange rate and control capital movements, which is theoretically impossible.

The consequences of navigating the trilemma have been an enormous foreign exchange reserve accumulation and the need to sterilize it to limit the currency appreciation (because of higher domestic interest rates, massive trade surplus and capital inflows). Therefore, while quantitative controls were the main instrument during the 1990s, the PBC progressively diversified its instruments during the 2000s, using various quantitative instruments such as the Reserve Requirement Ratio (RRR) to drain liquidity and conducting Open Market Operations (OMO) by selling its own bills. This diversification is not specific to China. Indeed, quantitative instruments were the main instruments of monetary policy for decades in Western Europe, Japan and East Asia after the Second World War.

Consequently, the development of the Chinese economy (reforms, world integration) and its financial system (gradually liberalized but still under state-control) has led the PBC to employ a battery of price- and quantity-based instruments as well as administrative window guidance and their relative importance has varied over time. Therefore, many questions over China’s monetary policy remain open-ended and can lead to wrong perceptions, including the appropriate variable to identify monetary policy. Conventional measures of monetary policy (such as interbank rates and monetary aggregates) frequently used in the literature present many drawbacks and we argue in this chapter that no single indicator can appropriately represent the monetary policy in China. To address these drawbacks, we contribute to the literature by building two new high-frequency composite measures using alternative approaches, which describe accurately the PBC’s monetary policy behavior over the last two decades.

The first measure is based on the initial work of He and Pauwels (2008) and Xiong (2012), and stems from the construction, on a monthly basis, of a new aggregate measure of China’s monetary policy, by combining the multiple price, quantity and administrative instruments deployed by the PBC over the 1993-2013 period. Our measure goes one-step further by combining these instruments in a way that allows for an interpretation of that measure in terms of basis point equivalent changes in the policy rate. The second approach suggests a narrative approach relying on daily media-based information on central bank communication about future monetary policy decisions. This automated method is relevant to account for the peculiarity and complexity of monetary policy, particularly in the case of China where unobserved quantitative controls are used. More specifically, our speech-
based indicator features two important roles: (1) a transparency tool providing useful information about the monetary policy stance, and particularly window guidance aspects and (2) a communication tool aiming at reinforcing monetary policy actions, particularly during tightening monetary policy periods.

We find that both indicators are equivalent and seem to capture the important changes in China’s monetary policy well. Moreover, the instrument-based indicator leads us to identify a major change in 2002 in the conduct of monetary policy in China. By taking into account the magnitude of changes, our research is able to show that the Chinese monetary policy is featured with dovish changes and a policy style of bigger but infrequent moves before 2002, while afterwards it is characterized with relatively hawkish changes and a smoothing style of frequent but smaller steps.

Moreover, we find that this change in monetary policy from 2002 corresponds well to important changes in institutional aspects with the greater role of the PBC as a central bank from 1995 and mainly the start in 2002 of the new mandate of Governor Zhou Xiaochuan. Moreover, the acceleration of interest rate liberalization from 2002 (after a first stage of financial reforms in the 1990s) and the rapid, de jure or de facto, opening of cross-border flows following China’s WTO accession in December 2001, are important economic and financial transformations that would lead to a clear change in monetary policy strategy. Therefore, institutional, economic and financial reforms well justify the need for the central bank to change its behavior and adopt a more predictable monetary policy rule (by enhancing also communication about its monetary policy).

Section 2 details specificities of China’s economy regarding the financial system and the conduct of the monetary policy. Section 3 develops our first approach to build an appropriate instrument-based monetary policy measure in the case of China. Section 4 analyses the central bank communication about monetary policy and develop our second approach, based on a speech-based monetary policy measure, while section 5 combines both approaches and validates our measures. The final section concludes.
1.2. Specifics of monetary policy in China

The conduct of monetary policy in China has evolved over time to adapt to the development of the financial system and economic reforms in a fast-growing developing open-economy. This section explains the domestic and foreign factors that explain the complexity of the monetary policy setting in China.

1.2.1. A trial-and-error economic approach

China’s economy grew 10% per year for over 30 years beginning in the early 1980s. No other economy had ever experienced such rapid economic growth on such a large scale requiring an adaptive policymaking approach characterized by experimentation, assessment and adjustment. Deng Xiaoping, in its reform program in the 1980s, characterized this strategy with the expression “cross the river by feeling the stones”. Four main periods characterize the reform path and one lesson from the Chinese reform experience is the right sequence of economic reform policies. First, authorities initiated agriculture reforms from 1978 to 1983, given the overwhelming dependence of the population on the primary sector. This would ensure that the majority of the population benefited from the initial reforms and provided political support for the subsequent stage of the reform process. The agricultural reforms included, among other changes, price increases, relaxing of rural market restrictions, and the decentralization of farming and resulted in an acceleration of domestic production and a more competitive sector. The success of the early agriculture-led reforms also increased the demand for non-agricultural goods and released a surplus of labor and capital into the rural non-farm sector, which put pressure on the urban economy to reform as well, since non-farm enterprises in rural areas (Township and Village Enterprises, TVEs) became more competitive than SOEs (Zhang, 2006). Therefore, the second phase of reform, from 1984 to 1988, focused more on the urban industrial sectors. Meanwhile, the People’s Bank of China (PBC) became in 1983 the central bank and increasing emphasis was placed on the role of (the newly formed four
sectoral) banks and monetary policy in the mobilisation and allocation of financial resources. The third phase, from 1988 to 1992, was a period of policy austerity in the background of inflationary pressures slowing down and even some reversal in reform process. Finally, the process of reform accelerated from 1992. In 1992, the Communist Party formally embraced Deng Xiaoping’s view (in the wake of his ‘Tour’ of the South) that the market system was not incompatible with ideals of socialism and called for the establishment of a socialist market economy.

However, the Chinese economic reform program has not been achieved without bumps. Indeed, the economic development faced excessive fluctuations explained by too loose or too tight monetary policy adjustments. Figure 1 illustrates three serious economic overheating and inflation periods: (1) 1987-1988 (2) 1992-1994 and (3) 2006-2008.

**Figure 1: Real GDP growth, CPI inflation, M2 and M1 growth (%)**

Over the first period, the GDP growth rate and consumer price inflation rose respectively at 11.3% and 18.7% in 1988. The tightening monetary policy through credit control, with M1 growth evolving from 25% in 1988 to 8% in 1989, lead to a drastic drop of the GDP growth rate to 4.1% in 1989 and CPI to 3.1% in 1990. Similar excessive fluctuations can be observed during the second period, from 1992 to 1994 with GDP growth rate at 14% in 1993 and CPI inflation at 24.2% in 1994, falling respectively to 7.6% in 1999 and inflation turned into deflation (-1.4%) during the same year. Such excessive fluctuations can be explained by instability in macroeconomic policy, improper monetary policy, too loose or too tight. From 1984 to 1987, monetary policies were adjusted loosely, the growth rate of M1 increased to 20%-25% promoting rapidly economic growth and inflation.
Subsequently tighter economic policies were adopted in 1988 and 1990, the growth rate of M1 dropped to 8% with a significant decline in economic growth. In 1992 and 1993, a much looser monetary policy was adopted, and the M1 growth rate increased to more than 30%. Administrative policies were taken in order to control prices and investment. The third overheating period, in 2006-2008, was characterized by GDP growth at 14% in 2007, CPI inflation at 5.9% in 2008, and deflation (-0.7%) in 2009. While the monetary policy after 2000 was more diversified, relying gradually on more market-oriented instruments, the PBC turned back to administrative window guidance to fight the Global Financial Crisis.

Therefore, China has enjoyed remarkable economic growth over the past decades following a trial-and-error approach which has led to excessive economic fluctuations and also an excessively active conduct of monetary policy, too loose or too tight. Moreover, each crisis period, including the GFC, has been characterized by a PBC strong reliance on the use of administrative window guidance to control prices and investment, allowed by the state-controlled nature of the financial system.

1.2.2. From a state-controlled to a more liberalised financial system

Since 1979, China’s economy has been undergoing major changes under the new development strategy and economic reform program. As pointed out by Jin (1994), the reform process has been gradual and experimental which has notably led to an expansionary monetary policy bias in China. First, he argues that monetary expansion was driven by bank financing of fixed assets investment combined with the lack of alternative channels for financial intermediation in a situation where households had increasingly become the dominant savers. Second, excessive bank credit expansion can be explained as a product of an investment game between the central and local governments. More precisely, the investment strategies of the two levels of government differed; the former focused on the updating and transformation of existing enterprises as well as infrastructure projects while the latter encouraged the setting up of new local processing industrial enterprises. However, because of decentralisation, the central government was no longer the major saver. Therefore, policy makers turned to banks to finance priority investment which sustained growth but increased the demand for credit from inefficient enterprises leading to the growth of non-performing loans. This
Chapter 1 – Assessing the monetary policy in China

highlights two features of the functioning of the financial system: (1) the state control and (2) a bank-based system with a major contribution of bank loans in total financing in China.

Starting in the early 1980s, China has been gradually reforming its financial system. The PBC became formally the central bank, but remained under the guidance of the State Council, while the PBC’s central bank status was only confirmed much later (in March 1995 under the Law of the People’s Republic of China during the Third Plenum of the Eighth National People’s Congress). Three state-owned banks were established to take responsibility for commercial banking businesses: the Bank of China (BOC), the People’s Construction Bank of China (PCBC), and the Agriculture Bank of China (ABC). Finally, the fourth state-owned commercial bank, the Industrial and Commercial Bank of China (ICBC) was formed in 1984. In the early 1990s, the financial system developed outside the banking sector, with the establishment of two domestic stock exchange markets, the Shanghai Stock Exchange (SHSE) and Shenzhen Stock Exchange (SZSE). The national interbank bond market was also established by the State Council in 1997. However, the Chinese financial system remains dominated by a large banking sector and still mainly controlled by the four largest state-owned banks, meaning that the government retains control on the banking system.

This ownership structure explains in part the effectiveness of monetary policy during the GFC and has served banks well in terms of avoiding major problems encountered by major financial institutions in developed economies. Indeed, the Chinese government adopted two important policies to fight against the GFC: a 4 trillion Yuan stimulus package and a very expansionary monetary policy through a massive bank credit increase by 7.3 trillion RMB in the first half of 2009. This monetary expansion can be interpreted as a “direct” unobservable quantitative easing as the central bank used a specific monetary policy tool, called administrative window guidance. Indeed, after several interest rate cuts at end-2008, no other traditional monetary policy instruments were used during the massive monetary expansion in 2009. Officially, China abandoned in 1998 annual loan quotas for each bank. However, as previously mentioned, China temporarily used window guidance as a monetary policy instrument consisting in putting pressure on banks to influence directly their credit creation without using indirect mechanisms. Concretely, commercial banks have to submit their credit plan to the PBC which defines maximum quarterly and annual credit objectives. The PBC also provides credit allocation advice to adjust the structure of credit. Institutionally the use of this instrument results in meetings between the PBC governor and commercial bank CEOs and other
occasional brief meetings if necessary. Such pervasive government intervention and dominant role in the financial system have played an important role over the last decades.

Another feature of the state-controlled financial system in China concerns the benchmark deposit and lending interest rates regulation. As pointed out by He and Wang (2012), China has a dual-track system with bank deposit and lending rates regulated (with, until recently, deposit rate ceiling and lending rate floor in retail banking operations even if they were not necessarily binding in practice) while money and bond rates are market determined. This has often led to “financial repression” meaning low, if not negative, real interest rates on household deposits, implying an implicit tax on households. Figure 2 and 3 emphasize a large decrease in both real deposit and lending rates in 2007 while they increased in nominal terms. Real deposit rates even became negative from January 2007 to October 2008 and again after 2010. Conversely, this has helped state-owned companies with low funding cost to support massive investment and has been able to some extent to insulate the economy from financial instability.

However, a vast empirical literature has analyzed the links between financial development and macroeconomic outcomes. Levine (2005) concludes that countries with more developed financial sectors growth faster. Influential work by McKinnon (1973) and Shaw (1973) suggests that reducing the role of the state in the financial system would enhance the efficiency of domestic financial systems. Moreover, they argue that “financial repression” prevents an efficient allocation of capital and thereby can hamper economic growth. While still relying on state-control, Chinese authorities have committed to gradual financial liberalization since 1979, within the gradual transition from a planned- to a more market-oriented system.
They have particularly adopted a cautious approach towards the timing and sequencing of financial liberalization, an important aspect according to Laurens and Maino (2007) to minimize disruptions to the stability of the financial system. To illustrate that, we use an indicator about financial reforms developed by Abiad, Detragiache and Tressel (2008) over 1985-2005 and updated until 2013. They distinguish between seven different dimensions of financial sector policy: (1) credit control and excessively high reserve requirements (2) interest rate control (3) entry barriers (4) prudential regulations and supervision of the banking sector (5) state ownership in the banking sector (6) capital account restrictions and (7) securities market policy¹. Liberalization scores for each category are then combined in a graded index normalized between zero (highest degree of repression) and one (full liberalization).

The observed indicator highlights, from the mid-1980s, a gradual financial liberalization in China. Until 1993, Figure 4 shows a high degree of financial repression with a score close to zero. Then, China formally embarked on financial liberalization from 1994 and adopted a cautious approach towards the timing and sequencing of the liberalization to minimize disruptions to the stability of the financial system. Two successive steps in interest rate liberalization are noticeable. First, Chinese authorities made great efforts to enhance financial reforms from 1993 to 2001 with the indicator increasing from 0.08 in 1993 to 0.35 in 2001. This period is particularly marked by the easing in credit

control through the official abandonment in 1998 of credit quotas and the strengthening of banking sector supervision since the confirmation of the PBC central bank status 1995. Moreover, Table 1 also shows that the end-1990s is characterized by the removal of all restrictions on money market and bond market rates, allowing interbank lending, central government bonds, and financial institution bonds to be fully priced by the market.

Then, China WTO entry in December 2001 required policymakers to modernize China’s financial system and enhance the competitiveness of Chinese banks, given the commitment to open the country’s financial services sector to foreign competitors within five years. Therefore, the phase from 2002 to 2013 highlights a new step towards financial liberalization while less impressive with a progression of the indicator from 0.39 to 0.54. However, important measures were taken over the post-2002 period, specifically further interest rate liberalization and the development of security markets. The Chinese bond market has emerged very rapidly from early 2000s, opened to an increasing number of domestic investors but Chinese authorities have also progressively relaxed regulation of foreign investors from late 2002 with the launch of the Qualified Foreign Institutional Investor (QFII) scheme gradually offering in an increasing way foreign capital an opportunity to invest in the Chinese bond market.²

Then, China has embarked into deposit and lending rates liberalization from 2003. The PBC began removing all ceilings on lending rates and all floors on deposit rates and reduced the lending rate floor to 0.9 times the benchmark rates. It continued gradual reforms until fully liberalizing lending rates in 2013. Removing deposit rate ceiling would be the next step to fully liberalize interest rates. Consequently Chinese policymakers understand the importance to enhance security markets and liberalize interest rates as both aspects would play a fundamental role in effective resource allocation and would also enhance monetary policy transmission.

² More details about the development of the Chinese bond market in Chapter 3 section 2.
Table 1: History of interest rate liberalization

<table>
<thead>
<tr>
<th>Date</th>
<th>Events</th>
</tr>
</thead>
</table>
| 1996 | Bond market interest rates liberalization  
      | ▪ Interbank offered rates liberalized, marking a significant step on interest rate liberalization  
      | ▪ Market-oriented government bond issuance in stock exchange |
| 1997 | ▪ Liberalized interbank bond repo rates and spot rates |
| 1998 | ▪ Liberalized policy financial bond rates |
| 1999 | ▪ Market-oriented government bond issuance in interbank market |
| 2003 | ▪ Gradually abolished controls on foreign currency deposit and lending rates in domestic market |
| 2004 | ▪ Removed floor on deposit rates of financial institutions  
      | ▪ Removed ceiling on lending rates of financial institutions, lowered floor to 0.9x of benchmark rates |
| 2012 | ▪ Raised deposit rates ceiling to 1.1x of benchmark rates  
      | ▪ Lowered lending rates floor to 0.7x of benchmark rates |
| 2013 | ▪ Abolished lending rates floor, lending rates fully liberalized |
| 2014 | ▪ Increased deposit rates ceiling to 1.2x, liberalized 5-year and longer deposit benchmark rates |
| 2015 | ▪ Increased deposit rates ceiling to 1.5x |

Source: JP Morgan Asset Management, PBC
1.2.3. Adaptive monetary policy under global financial integration

The economic boom in China is usually attributed to the increasing degree of trade openness observed after the Open Door Policy initiated by Deng Xiaoping in 1978 and especially after 2001 with WTO entry. Indeed, trade in China increased from 22% of GDP in 1985 to 39% in 1995 and 69% in 2005. Thus, since WTO entry in December 2001, the integration of China’s trade and financial system and overall economy with the rest of the world has significantly sped up. A consequence has been the change in the PBC conduct of monetary policy to adapt to the growing world integration and the rapid domestic economic development, being exposed to global monetary and financial forces. Indeed, while lowering trade barriers offered a range of gains from trade, China was also more exposed to shocks and trends from abroad. More specifically, the good economic performance of China raises the question of monetary independence as it is often argued that greater monetary independence allows policy makers to stabilize the economy through monetary policy without being subject to other economies’ macroeconomic outcomes (Chinn, 2014).

However, the impossible trinity theory, developed by Fleming (1962) and Mundell (1963) stipulates that it is impossible to simultaneously have a fixed exchange rate, free capital movement and independent monetary policy. Hence, if there are free capital flows, only floating exchange rates permit monetary policy independence. Indeed, capital flows would be triggered by any interest rate differential with the rest of the world leading exchange rate variations or central bank intervention on interest rates not related to domestic objectives. Such theoretical concept has many practical implications and the combination of the three policies has resulted in a number of financial crises in some emerging economies in the 1990s in the context of greater financial liberalization and openness.

However, China has tried to play around this trilemma over the past decades, albeit in an evolving way. Indeed, the management of the Chinese currency experienced a switch from a dollar peg over the 1994-2005 period to a managed floating from July 2005 through July 2008 and since June 2010 (as illustrated in Figure 7). The last decade has also been characterized by a surge in international capital flows into China (Figure 8) with huge foreign direct investment (China being one of the largest FDI recipient in the world) and a gradual easing of capital flows’ management. Indeed, Chinese authorities relaxed capital controls launching two programs to allow portfolio inward
investment for foreigner, the Qualified Foreign Institutional Investors (QFII) scheme introduced in 2002, and outward for resident, the Qualified Domestic Institutional Investors (QDII) scheme launched in 2006.

Finally, with the transition of China’s economy from an export-led model towards a domestic consumption-led growth one, the central bank would carefully pay increasing attention to achieving domestic objectives, notably favoring the goal of price stability over the medium-term. Therefore, China attempted at once to increasing international capital mobility, maintain a quasi-pegged currency and conduct an autonomous domestic monetary policy, which is complex to achieve in practice. Such a combination implies that China has had to sterilize an enormous foreign currency reserve accumulation to limit the currency appreciation because the domestic interest rate has often
been higher than US interest rates and China also has recorded massive trade surplus and capital inflows.

Thereby, the PBC started conducting open market operations (OMO) on a regular basis in 1998 and selling its own bills on a meaningful scale in 2002 to sterilize foreign exchange reserve accumulation (Figure 10). However, to avoid that a progression of the monetary base transmit to rapid credit growth, China needed also to implement credit control mainly through changes in the reserve requirement ratio (RRR).\(^3\) Since late 2007, the central bank has increasingly used reserve requirements to drain liquidity (Figure 9). Indeed, the ratio of required reserves (RRR) to PBC bills outstanding stood at 6:1 in June 2011, compare to 1:1 in 2005 (Ma, Yan, Liu, 2011). Three main reasons justify the use of RRR rather than OMOs: (1) the use of the reserve requirement ratio withdraws liquidity on a more permanent basis, (2) is more cost efficient from the PBC point of view and (3) the remuneration rate on required reserves is lower than the one-year PBC bill yield. Finally, administrative controls were used temporarily as a monetary policy instrument, an useful tool only possible in a state-control system as in China.

\textbf{Figure 9: Reserve requirement ratio, excess reserves (%)}

\(^{3}\) See Mehrotra (2012) for an empirical analysis on the choice of particular sterilization instrument. Indeed, in order to investigate under which conditions liquidity absorption takes place through the issuance of sterilization paper, rather than through increases in reserve requirements, he specifies an econometric model relating liquidity absorption to various macroeconomic and financial factors.
1.3. How properly measuring monetary policy in China?\textsuperscript{4}

Measuring monetary policy accurately is important both to policy makers for practical reasons and to researchers for analytical reasons. The PBC has a dual mandate of price stability and economic growth which is similar to that of some G3 central banks. However, its conduct of monetary policy differs significantly from central banks in most OECD economies related to partial economic reforms and the state-controlled financial system nature. The PBC gradually shifted its monetary policy from a direct regulatory framework dominant until 1998 (based mainly on credit size management, using quotas to control credit and cash directly) to indirect management with more diversified monetary policy tools and a process of gradual interest rate liberalization.

Therefore, many questions over appropriate China’s monetary policy measure remain open-ended, the challenges mainly stem from the fact that there is no single principal policy rate as the key operating target in the Chinese monetary policy framework. However, to well understand the evolving monetary policy in China, a good measurement of monetary policy is crucial and cannot be overlooked while using partial information contained in some instruments could lead to wrong perceptions. This sections starts with a review of indicators used in the literature and discusses both the challenges of measuring PBC’s monetary policy stance and our approach to constructing a new

\textsuperscript{4}The research in this section has been done in collaboration with Dr Eric Girardin, my PhD supervisor and professor of economics at Aix-Marseille University, Dr. Guonan Ma, then senior economist at the Bank for International Settlements (BIS).
“Monetary Policy Indicator” (MPI). We finally describe historically the policy style from mid-1990s based on our new indicator.

1.3.1. Lessons from the literature

As mentioned by Xiong (2012), a good measure of the monetary policy should be able to tell us, either qualitatively or quantitatively, whether monetary policy is becoming contractionary, unchanged, or expansionary. The question of a proper measurement of monetary policy changes is crucial in China’s case because the PBC behaviour differs significantly from that of central banks in most major OECD economies. The latter central banks typically implement monetary policy using a short-term interbank interest rate as the main operating target, such as the Fed funds rate for the United States and EONIA for the Euro area.

Two interbank rates are commonly used in the literature on China (Zheng et al., 2011, Xie and Luo, 2002). First, the China’s inter-bank offered rate (CHIBOR) refers to a weighted average of actual transaction rates on the interbank market and, second, the Shanghai’s interbank offered rate (SHIBOR), available since January 2007, represents the daily average of the quotes of 16 banks. However, Garcia-Herrero and Girardin (2013) argue that the liquidity in the CHIBOR (or even the SHIBOR) may not have been deep enough, at least initially, to be regarded as a good signal of the functioning of money markets. He and Pauwels (2008) and Xiong (2012) also agree that short-term interbank interest rates are not necessarily a good measure of the policy stance due to the segmentation of credit markets and the low response of firms and individuals to the price of capital. Then, Chen, Chen and Gerlach (2011) find that the relation between monetary policy and the interbank rate depends on whether the regulated interest rates are above or below the unobserved equilibrium levels, defined as the rate in the absence of regulation. Finally, another important difference with developed markets is that interbank rates in China are not directly controlled by the PBC, in contrast with the Eonia or the Fed Funds rate. Consequently, short-term interbank rates in China cannot serve as operational targets as in Western countries.
A number of papers (Xie, 2004, Burdekin and Siklos, 2008, Koivu et al., 2009) also analyze monetary policy in China through intermediate targets, especially monetary aggregates (the monetary base growth, broad money supply growth rate). However, these variables are endogenous and may not be a good monetary policy proxy. Monetary base, M1 and M2 all reflect demand shocks as well as the PBC’s policy stance (Xiong, 2012). For example, the changes in monetary aggregates can reflect foreign capital inflows or export revenues. While a share of the increased money is typically sterilized by the central bank, the relationship between the growth of broad money after sterilization operations and the PBC’s policy actions remains complicated (Xiong, 2012). Moreover, as pointed out by He and Pauwels (2008), even though the PBC makes annual announcements of targets on monetary aggregates, these indicative targets are not a good indicator of PBC’s policy stance, which changes throughout the year along with the macroeconomic and financial conditions of the economy.

Accordingly, analyzing the PBC behavior is a challenging task mainly for the identification of an accurate proxy of the Chinese monetary policy stance. Indeed, there is no single policy tool, interest rate or otherwise, that can properly summarize the monetary policy stance of the PBC. The PBC deploys multiple tools to implement its policy, relying more frequently on quantitative than on price-based instruments, but the mix of these instruments has evolved over time, notably with the gradual change towards a more market-oriented system. Guo and Chen (2012) test different instruments
individually (the regulated bank deposit rate, reserve requirement rate, loan size, the short-term interbank market rate and monetary base) and find similar conclusion that none of these policy tools on its own is a good measure of monetary policy stance. Moreover, while abolished in 1998, traditional direct management based mainly on credit size management, using quotas to control credit, remains somewhat omnipresent in the conduct of monetary policy, more specifically to influence bank lending directly during shock periods such as the GFC. It is worth noting that omitting such administrative window guidance aspects would lead to wrong perceptions of monetary policy. Therefore, the literature lacks an appropriate measure of the policy stance of the PBC.

To better gauge the monetary policy in China, we argue that measuring and identifying monetary policy with a narrative approach is the best way to give a proper account of the monetary policy stance when quantitative controls are used. Moreover, a composite measure has the advantage to take into account the changing mix of policy instruments used by the PBC. A limited number of recent works have turned to the construction of an appropriate monetary policy measure in the case of China. He and Pauwels (2008) constructed a discrete monetary policy index, using an approach pioneered by Gerlach (2007) classifying the observed changes in the policy instruments into three classes: “hawkish”, “neutral” and “dovish”. They take the discrete changes in the reserve requirement ratio, lending and deposit rates, and the magnitude of open market operations over the 1997-2007 period. Xiong (2012) also derived an implicit index of PBC’s monetary policy stance from the observed changes in its policy instruments from 1986 to 2010. He considers more specifically the changes in the various monetary policy instrument implemented by the PBC since 1986. However, in order to reduce the possibility of losing any instruments, he takes into account changes in credit growth arguing that credit control by the PBC still played an important role even after the official abandonment in 1998 of the credit plan for banks’ lending. Finally, both papers assume that all the policy instruments share the same weight in determining the direction of the policy movement.

We build in part on the works of He and Pauwels (2008) and Xiong (2012) and construct a new aggregate measure of China’s monetary policy, by combining the multiple price, quantity and also administrative instruments deployed by the PBC. However, our measure goes one-step further by taking into account the magnitude of monetary policy changes through converting each instrument change in terms of a “27 basis point equivalent” change rather than the restrictive three classes: “hawkish”, “neutral” and “dovish”.

50
1.3.2. Descriptive statistics on monetary policy instruments

Over the last two decades, the PBC has deployed multiple policy tools to implement its monetary policy. There are three main categories of such instruments: (i) Price-based instruments, such as the regulated bank deposit and lending rates, the interest rates on required and excess reserves as well as the lending rate on the PBC refinancing.\(^5\) (ii) Quantity-based instruments with the reserve requirement ratio (RRR) and open-market operations (OMOs). (iii) From time to time, the PBC uses administrative window guidance to influence bank lending, which is not directly observable. Table 2 summarizes the frequency of monthly changes for each instrument over 1993-September 2013 with two distinct periods (1) from 1993 to 2001 and (2) from 2002 to September 2013, consistently with the previously identified financial liberalization phases.

<table>
<thead>
<tr>
<th></th>
<th>1993-2001</th>
<th>2002-2013</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Price-based</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deposit and lending rates</td>
<td>11</td>
<td>21</td>
<td>32</td>
</tr>
<tr>
<td>Interest rates for required and excess reserves</td>
<td>9</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Lending rate on PBC refinancing</td>
<td>11</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td><strong>Quantity-based</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reserve Requirement Ratio (RRR)</td>
<td>2</td>
<td>37</td>
<td>39</td>
</tr>
<tr>
<td>Open Market Operations (OMOs)(^6)</td>
<td>0</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td><strong>Administrative window guidance</strong></td>
<td>yes</td>
<td>yes</td>
<td>...</td>
</tr>
</tbody>
</table>

Source: CEIC

Such a table highlights the use of the different monetary policy tools has evolved over time. The pre-2002 period features less frequent policy moves and the PBC mostly relied on price-based instruments. Indeed, The PBC used similarly the benchmark deposit and lending rates, the interest rate on required and excess reserves and the lending rate on PBC refinancing. The post-2002 period

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\(^5\) From July 2013, all bank lending rates are no longer directly regulated by the government.

\(^6\) For open market operations, the number of changes corresponds to all monthly net liquidity injections or withdrawal that are caused by these operations and larger than 260 billion RMBs in absolute terms (see next section for further explanation)
An alternative measure of monetary policy using PBC speeches

is characterised by more frequent policy steps and the introduction of quantity-based instruments; typically the Reserve Requirement Ratio (RRR) and Open Market Operations (OMO), played a predominant role in the conduct of monetary policy. Both quantity instruments were introduced in 1998 but used on regular basis only from 2002. Conversely, adjustment of the benchmark deposit and lending rates were less frequent after 2002 (21 monthly changes) than changes on quantity-based instruments (37 monthly changes in RRR). However, those changes are in general perceived to carry a larger weight than adjustments of the quantity-based instruments in signaling the strength of policy changes (He and Wang, 2012). In addition, the PBC operates in general a coordinated policy, shifting at the same date both benchmark lending and deposit rates in the same direction.

The preference for quantity-based instruments can be explained by the heavy need for the PBC to sterilize foreign exchange interventions. Thus, the PBC started conducting OMOs from 2002 (the PBC controls the amount, price and composition of central bank issuance) and increasingly used the RRR from mid-2006. As pointed out by Ma, Yan and Liu (2011), the PBC sometimes favored the use of RRR to drain liquidity, mainly because its use to withdraw liquidity on a more permanent basis was more cost effective from the PBC’s point of view. Indeed, the ratio of required reserves to PBC bills outstanding stood at 6:1 in June 2011, compare to 1:1 in 2005. However, there may be various interrelated channels for a RRR change to affect an economy’s monetary conditions. A noticeable feature is that it is often difficult to isolate the effects of reserve requirement changes from other policy actions because, historically, both policy rates and RRR are often adjusted one after another in the same direction, apparently aiming to reinforce the tightening or easing effects.

Finally, the formidable weapon used by the central bank in case of domestic or external shocks is well known under the term administrative window guidance or “moral suasion”, mainly used for the direct quantity-based allocation of credits in the Chinese financial system. The PBC started to adopt this “tool” in 1998, after officially abolishing the credit plan. This consists in putting pressure on (particularly the four state-owned commercial) banks in order to influence their lending decisions. However, such a window guidance process is difficult to measure because it consists in verbal guidance to banks. We distinguish two specific periods of moral pressure over our sample period. First, during the summer 2003, the authorities published a notice (on June 2003) about “Further Strengthening the Management of Real Estate Credit Business” and organized three meetings (in July, August and September 2003) with representatives of the banking sector to limit credit
expansion in the real estate sector. More precisely, the PBC invited to these meetings representatives of all Chinese financial institutions and repeatedly asked them to pay attention to the proper capital adequacy ratio and to limit credit and liquidity risks. Second, the PBC used window guidance in 2009 to support the fiscal package announced in November 2008. It was so effective that China’s monthly domestic loan increased by more than 20% year-on-year from January 2009 to October 2009.

1.3.3. Construction of a new Monetary Policy Indicator (MPI)

As pointed out by He and Pauwels (2008), the analysis of monetary policy in China suffers from the lack of a good measure of the policy stance of the PBC. We take on the challenge by constructing a new measure of the monthly Monetary Policy Index (MPI) into four main steps: (i) Converting a given monthly change in each instrument into a 27-basis-point equivalent change of the policy rate. (ii) Combining these equivalents of all instruments under consideration into a monthly aggregate change in monetary policy. (iii) Modifying these aggregate changes by taking into account possible window guidance and by adjusting for the effects of the Chinese New Year and one-off institutional changes. (iv) Cumulating these aggregate changes into a monthly MPI. Finally, additional alternative measures are tested, with respect both to the indicator conversion and the aggregation methods.

Conversion of each instrument into a 27bp equivalent change

The first step is to compute a monthly “27 basis point equivalent” change in the policy rate for each instrument. This 27bp change (25bps since 2010) corresponds to the usual move on all regulated bank deposit and lending rates and interest rates paid and charged by the PBC. Next, while the interest rates are mostly changed by 27bps, the RRR usually moves by 50bps. We assume a typical 50bp RRR change to be equivalent to a 27bp change in our policy rate. For instance, a 100bp hike in the RRR is treated as a 54bp policy rate hike.

Finally, we convert a given net liquidity change from open market operations (OMOs) into an equivalent 27bp rate change in the following way. OMOs consist of PBC bills issuance and non-bill OMOs, such as PBC repos, reverse repos and outright bond transactions. A net monthly liquidity withdrawal or injection from OMOs is viewed respectively as a tightening or easing move. He and
Pauwels (2008) and Xiong (2012) take the threshold of CNY 200 billion as equivalent to a 50bp change in the RRR. We assume this threshold to be equivalent to a 27bp change, while CNY 350 billion is equivalent to a 54bp change and CNY 500 billion to a 81bp change.

**Figure 12: Density probability function of open market operations in China (in absolute terms)**

![Figure 12: Density probability function of open market operations in China (in absolute terms)](image)

**Introduction of window guidance aspects**

The third step is to take into account possible informal credit quotas and window guidance, which are not directly observable, and to adjust for effects of the Chinese New Year and one-off institutional changes. First, following Xiong (2012), we approximate the unobserved policy changes via administrative window guidance in terms of unusual loan-growth acceleration. We define a “minus 27 bp equivalent change” if year-on-year loan growth is above 20% and accelerates and a “minus 54 bp equivalent change” if loan growth is above 30% and accelerates. This is an ad hoc method that takes only partial account of possible changes via window guidance but it at least allows us to reflect to some extent the observed extremely expansionary monetary policy in 2009. The underlying motivation is that an explosive acceleration of loan growth without changes in other observable policy instruments may likely relate to window guidance operations. It is particularly important to take this feature into account since directing a record growth in bank credit was the means found by the Chinese authorities to side-step the (lack of effectiveness of the) transmission
mechanism (in driving bank credit growth) which handicapped quantitative easing in the G3 during the GFC.

In addition, we compare in Figure 13 different indicators related to credit acceleration in China: loan growth (the benchmark indicator), broad money growth and the growth in a broad measure of financing in the economy, often viewed as a proxy for shadow banking, the total social financing stock (TSF) indicator. The three indicators are strongly correlated and identify quite similarly two periods of unusual loan-growth acceleration in 2003 and 2009 (with a threshold at 20% for the first two indicators and 35% for the latter). Therefore, we will examine window guidance only through the analysis of loan-growth acceleration.

**Figure 13: Sources of financing growth in China (% y/y)**

Combination of instruments into an aggregate monthly change index and seasonal adjustment

The second step is to combine these monthly 27 bp equivalent changes of various instruments. We adopt the following simple aggregation rules: (1) If different policy instruments move in opposite directions in a given month, we sum their monthly “27 bp equivalent” variations. In this case, we allow the changes of these different instruments to offset each other. (2) If all policy instruments move in the same direction in that month, we keep only the instrument change that gives rise to the maximum monthly “27 bp equivalent change”. In this case, we do not take into account multiple variations of different instruments. The intuition is that the PBC typically changed both deposit and loan rates in the same direction by 27 bps, which should not be regarded as a policy move of 54 bps. Also, the PBC rarely changed the two quantity instruments in the same direction. Finally, a mix of rate
An alternative measure of monetary policy using PBC speeches

and quantity tools in the same direction should be viewed as a change in the quantity tool to ensure the money market rates move in line with the prevailing bank deposit and lending rates. For these considerations, we only take the maximum changes when two instruments move in the same direction, to avoid double-count.

In a final step, we adjust our Monetary Policy Index (MPI) for Chinese-New-Year effects, as liquidity is usually injected before the Chinese New Year and withdrawn soon afterwards. We remove such liquidity injection/withdrawal when constructing our measure of monetary policy changes. Third, we also remove the big 500 bps RRR cut in March 1998, as it was not a monetary policy signal but simply part of the PBC operations to recapitalize commercial banks and unify the reserve requirement system. The fourth step simply cumulates these estimated monthly monetary policy changes into a single index of MPI, starting from 1993.

In sum, our MPI, while still leaving some room for future improvements, enjoys a number of distinct advantages. First, it builds and improves upon the past efforts of He and Pauwels (2008) and Xiong (2012). Second, it considers more policy instruments than previous studies and captures the evolving mix of interest rates, liquidity management tools and window guidance. Third, it attempts to better reflect the magnitude of various instrument changes by combining them in a single index and appears able to better capture the important historical changes in Chinese monetary policy. Finally, it allows the index to be interpreted as multiples of a 27 basis-point equivalent change in the policy rate in our subsequent empirical estimation of the Taylor rule in China, as it captures the magnitude of instrument changes, an addition to the pure qualitative-variable approaches used in Gerlach (2004) for the ECB, and He and Pauwels (2008) and Xiong (2012) for the PBC.

Alternative methods to construct the Monetary Policy Index

While no metric is available to determine which Monetary Policy Index (MPI) best represents the Chinese monetary policy, there is benefit in comparing different versions of the MPI as well as using these alternative MPIs to conduct robustness tests in our empirical estimations. For this purpose, we propose four alternative MPI measures, in addition to our benchmark MPI. The main difference

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7 After the March 500bps 1998 RRR cut, commercial banks used the new liquidity to purchase government bonds, and the proceeds of these bonds were then injected in the commercial banks as equity capital (Mo, 1999; and Ma and Fung, 2002).

8 The starting point of the MPI in January 1993 is taken as the one-year lending rate in that month.
between our benchmark MPI and these five alternative MPIs lies either in the conversion factor used to map any instrument change into a 27bp equivalent change or the rules of aggregating individual instruments when these instruments move in the same direction.

Table 3 describes the alternative methods. First, we suggest a different assumption for the conversion of RRR changes into a 27 bp equivalent change. MPI(A) and MPI(C) assume a usual 50bp change to be equivalent to a 27 bp change (similar to the benchmark MPI). However, MPI(D) and MPI(B) are characterized by a lower weight put on RRR changes by assuming a 100 bp RRR change to be equivalent to a 27 bp change. In this case, we consider a lower effectiveness of RRR changes.

Second, alternative methods are added in terms of aggregation rules. MPI (A) and (B) are generated by summing up the monthly changes across all instruments, except when only interest rates are involved. By contrast, MPI (C) and (D) are generated by summing up the monthly changes across all instruments except when the instrument changes involve any interest rate (in this case, the highest variation is kept).

<table>
<thead>
<tr>
<th>Combination of instruments</th>
<th>Benchmark MPI</th>
<th>Alternative MPIs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indicator selection and conversion methods</td>
<td>MPI(A)</td>
</tr>
<tr>
<td>(1) “Equivalent 27bps” change for RRR</td>
<td>27bp</td>
<td>27bp</td>
</tr>
<tr>
<td>(2) Window guidance proxy**</td>
<td>Loan</td>
<td>Loan</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aggregation rules</th>
<th>Sum</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) All move in the same direction</td>
<td>Max</td>
<td>Max</td>
</tr>
<tr>
<td>- Interest rate instruments</td>
<td>Max</td>
<td>Sum</td>
</tr>
<tr>
<td>- Quantity instruments</td>
<td>Max</td>
<td>Sum</td>
</tr>
<tr>
<td>- Mix of interest rate &amp; quantity</td>
<td>Max</td>
<td>Max</td>
</tr>
</tbody>
</table>

(*) “Sum” refers to summing up the monthly 27bps equivalent changes of different instruments. “Max” refers to taking the maximum monthly 27bps equivalent change only among all the instruments.

(**) Loan is for loan growth acceleration.

Source: Authors’ computation.
The resultant MPIs constructed using alternative rules highlight the benchmark MPI as the central scenario, representing roughly the average of other MPIs. Differences between MPIs are ultimately noticeable from 2007 onwards when the PBC introduces new instruments such as the RRR and open market operations. Obviously, they move in the same direction but the magnitude of changes differs, particularly during monetary policy tightening periods, in 2007/2008 and end-2010/2011, when the PBC faced an unfavorable combination of upward inflation pressures and economic slowdown.

1.3.4. MPI historical review

Our research contributes to the literature through this novel measure of the monetary policy stance represented by our composite monetary policy index (MPI). It well captures the gradual change towards a more market-oriented system, the evolving mix of policy instruments and liquidity management tools, and provides a way to take administrative window guidance into account. Omitting such aspects could lead to a biased measurement of monetary policy particularly during the GFC.

The resultant measure shows an interesting historical pattern of monetary policy changes, with two contrasting regimes before and after 2002, in terms of both policy changes and policy style (Figure 14). First, the 1993-2001 period witnesses generally more dovish monetary policy changes, as part of the government policy package to resist the deflationary pressures from both domestic corporate restructuring and competitive currency devaluation by its neighbours during the East-Asian financial crisis. Moreover, after the Asian Financial Crisis in 1997, the expansionary monetary policy played an active role in boosting continuously weak domestic demand.

The 2002-2008Q2 period shows mostly hawkish moves amidst strong growth (GDP growth rose to 14.0% in the first half of 2007), large external surplus and some emerging price pressure before the global financial crisis explained by the commodity price boom (from 1.0% in January 2002 to 8.7% in February 2008). The economic growth slowdown from early 2008 amplified by the negative impact of the GFC led China to implement an extraordinary loosening monetary policy and active fiscal policy from 2008Q3 to stimulate economic growth domestically.
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Figure 14: Changes in China Monetary Policy Index (MPI)
(in terms of 27 basis point equivalent change in policy rate)

Figure 15: Benchmark and alternative Monetary Policy Index (%)

Source: Author's calculation
Chinese authorities began in September 2008 cutting deposit and lending rates as well as the reserve requirement ratio and injecting massive liquidity. From end-2008, the central bank put a more aggressive strategy in place allowing commercial banks to expand credit through cancelling credit ceilings and using window guidance to adjust the credit structure and encouraging banks to support major infrastructure projects. This massive loosening of monetary policy resulted in rapid growth of loans and money supply. This monetary stimulus succeeded in boosting economic growth and countering deflationary pressures.

From early 2010, CPI inflation rate continuously increased, surpassing the 3.0% government target from mid-2010 and even reached a peak of 6.5% at mid-2011. In parallel, GDP growth well rebounded after the crisis from a low point at 6.5% in 2009Q1 to 11.9% in 2010Q1 but subsequently faced again an economic slowdown. Faced with rising inflation and also a real estate bubble, the PBC began to tighten monetary policy with three successive 50bp rises in RRR during the first half of 2010 and particularly fight against inflationary pressures from end-2010 to mid-2011 with successive monthly 50bp increases in RRR to reach a record level at 21% and five 25bp increases in deposit and lending rates between October 2010 and July 2011. Finally, the central bank used a more “prudent” monetary policy in 2012 and 2013 fine-tuning liquidity through multiple central bank bills injections and withdrawals.

Figure 16: Monetary Policy Index, real GDP growth, CPI inflation in China
Our novel MPI measure also highlights distinct monetary policy styles between the pre- and post-2002 periods. The 1993-2001 period features mostly bigger but less frequent policy moves, while the post-2002 period under the new Governor Zhou Xiaochuan, is characterised by relatively smaller but more frequent policy steps, i.e. a smoother and less abrupt policy style. This observation is consistent with a possible shift by the PBC to smooth monetary policy changes as in most developed economies. Indeed, Clarida, Gali and Gertler (2000) argue that it is generally recognized that, outside occasional large shocks, central bank behavior is less destabilizing when it tends to change the short-term interest rate by multiple small steps in the same direction, rather than using infrequent large changes.

This change in PBC behavior after 2002 corresponds well to important institutional, economic and financial reforms in China mentioned in the first section. First, institutional aspects concern both the greater role of the PBC as a central bank (but still under state council control) from 1995 but also mainly the start in 2002 of the new mandate of Governor Zhou Xiaochuan. Moreover, the acceleration of interest rate liberalization from 2002 (after a first stage of financial reforms in the 1990s) and the rapid, de jure or de facto, opening of cross-border flows following China’s WTO accession in December 2001 are important economic and financial transformation that would lead to a clear change in monetary policy strategy. Therefore, institutional, economic and financial reforms well justify the need for the central bank to change its behavior and adopt a more predictable monetary policy rule. Moreover, navigating the trilemma through foreign exchange sterilization also supposes to adjust instruments step by step.

Table 4 further confirms the different policy styles before and after 2002. While all of the monthly monetary policy moves during the 1993-2001 period are equal to or larger than a 54 basis-point equivalent change in policy rate, 70% (53 out of 75) of the policy changes during the second period of 2002-2013 are 27 basis-point equivalent or less. Also, there was an average of around one policy move per annum before 2002 but more than 6 policy moves a year after 2002. In other words, the PBC appeared to conduct monetary policy before 2002 with bigger and less frequent moves but operate with smaller but more frequent steps afterwards.

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9 Adding the changes in different instruments in the same month would of course imply a different count.
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The more diversified monetary policy in the new Millennium has made its measurement more complex. The construction of an instrument-based index has revealed a number of difficulties from the discontinuous use of tools to the complexity to weight them. Moreover, identifying window guidance practice is also challenging while omitting it could lead to wrong monetary policy perceptions. Thus, our instrument-based monetary policy index has attempted to tackle a number of issues testing different hypothesis. However, to verify its full reliability and to complement our understanding, we suggest constructing a second monetary policy index developed on an alternative approach. This methodology is based on central bank communication about monetary policy which presents many attractive features developed in the first part of this section followed by the technical aspects.

#### 1.4.1. Role of central bank communication about monetary policy in China

As pointed out by Amato, Morris and Shin (2003), communication is an integral part of modern monetary policy. The role of communication has become a popular theme in policy dialogues in advanced economies and a broad consensus among researchers tends to support the enhancing of clear communication about monetary policy. From the point of view of macroeconomic stabilization, the common belief nowadays is that there is more to be gained from managing market expectations.
through an open dialogue with market participants than by surprising them (Filardo and Guinigundo, 2008). Theoretically speaking, one well-known paper, written by Blinder (2009), highlights that central bank communication would not play a role in the context of “pure rational expectations paradigm”. He argues that if the economic environment is “stationary”, expectations are “rational” and the central bank is “credible”, central bank communication would be redundant because any systematic pattern in the way monetary policy is conducted would already correctly be inferred from the bank’s observed behavior. However, those hypotheses are not realistic due to the presence of non-stationarities (with changing target priorities), non-rational expectations (due to information asymmetries) and the difficulty for a central bank to reach full credibility.

A large number of papers such as Bernanke (2007), Blinder (1998), Woodford (2005), Ehrmann and Fratzscher (2007), Svensson (2006) provide evidence that central bank transparency increases the effectiveness of monetary policy and therefore enhances economic and financial performance. Therefore, central banks have made determined efforts to improve the way they communicate with the public. Jeanneau (2009) has provided evidence of this development with a survey based on earlier work such as Filardo and Guinigundo (2008) and Nelson (2008). He reports on communication practices of 32 members of the Central Bank Governance Network (including China) and highlights three motives behind central bank communication: (1) to ensure better accountability in line with greater central bank independence (2) to enhance the public’s understanding of the objectives of policy and the decision-making process consistently with the inflation targeting policy adoption by many industrialized and emerging market countries and (3) to guide market expectations with the development of financial markets.

The role of central bank communication in the conduct of monetary policy may be relevant in China, particularly as a consequence of financial liberalization and the transition towards a more market-oriented system. The argument relies on the view that in China state control has been efficient to insulate the economy from financial stability. Therefore, increasing indirect management (through the development of money and bond markets, bank recapitalization, progressive interest rate deregulation) at the cost of declining state dominance in the economy would prompt the PBC to increase its credibility to maintain financial stability. This means that market expectations (including foreign expectations to avoid large scale and sudden capital flows) and interest rates would progressively play a greater role. By definition, monetary policy is to a large extent the management
of expectations (Svensson, 2004). Indeed, Bernanke (2004) stresses that monetary policy works largely through indirect channels, in particular by influencing private-sector expectations and thus long-term interest rates. While controlling only the short-term interest rate, central banks may attempt to influence market perceptions and reduce uncertainty through clear communication about future economic conditions and monetary policy orientation. Therefore, since monetary policy effectiveness crucially depends on market perceptions, it is now increasingly recognized that transparency is key (Fracasso, Genberg and Wyplosz, 2003).

Therefore, if economic agents view the central bank as credible, inflation expectations are more likely to be well anchored, further enhancing the effectiveness of monetary policy. Moreover, it can also substitute monetary policy actions. In case of rapid inflation, the central bank has to well adjust interest rate increases and inflation expectations to maintain its inflation target. If the central bank gathers public confidence about its ability to keep inflation low through words, deeds such as large interest rate increases would not be necessary. Issing (2005) and Mishkin (2004) argue that transparency is not an end in itself but merely a mean to help the authority to achieve its mandate. Finally, a clear and firm PBC policy signal could help flatten and stabilise the Chinese yield curve, which in turn would cushion economic growth, pre-empt deflation risk, facilitate structural adjustment and support financial liberalization (Ma, 2015).

In addition to increasing predictability, central bank communication may have a different objective in the case of China. Indeed, the difficulty in measuring monetary policy stems from the unobserved nature of some monetary policy instruments, particularly the administrative window guidance practice as during the GFC. Garcia-Herrero and Girardin (2013) explain that the objectives of PBC speeches are not only to provide signals and guidance about monetary policy strategy and future actions. It also send signals on the current and future moral suasion or window guidance. In other words, such communication would raise the signal-to-noise ratio, providing market participants with news on unobserved monetary policy decisions and leading to a reduction in noise.

It is of high importance to take this feature into account when analyzing monetary policy since during the GFC directing a record growth in bank credit was the means found by the Chinese authorities to side-step the transmission mechanism (in driving bank credit growth). However, such practice is not statistically observable but can be captured indirectly when analyzing central bank communications. Accordingly, the way the PBC communicates may well go beyond a simple measure
of transparency but rather enable us to identify unobservable monetary policy actions, a great advantage of this alternative way to approximate monetary policy in China.

Finally, the complexity in monitoring monetary policy actions in China makes public communication very useful. While central banks in advanced economies have recently used “forward guidance” to amplify the impact of monetary policy, to manage market expectations, the PBC can also communicate to reinforce monetary policy actions and also simply to explain when multiple instruments move. As pointed out by Ma (2015), the central bank can issue confusing “backward guidance” cautioning the market not to interpret its interest rate cut as monetary easing. Therefore, communication can serve to improve transparency about monetary policy particularly when it evolves a lot as in emerging markets.

1.4.2. How transparent is the PBC in terms of monetary policy?

Monetary policy makers have adopted a range of methods to improve their communication with the public, including timely announcements of policy actions, expanded release of minutes of policy meetings, frequent public speeches, and the regular publication of reports about the economy and monetary policy. They talk about their overall objectives and strategy, the motives behind particular policy decision, the economic outlook, and future monetary policy decisions. However, the recent financial turmoil also shows there is a room for improvement in terms of communication. For instance, ECB credibility was at a historical low level at the height of the financial crisis (Geraats, 2010). Yet now, financial markets are so volatile that any bad news can induce huge consequences.

Interestingly, some researchers have gradually developed measures to compare transparency across countries. Among others, Fry et al. (2000), Siklos (2002) were pioneers in providing useful central bank transparency indices for OECD countries. Then, Eijffinger and Geraats (2006) distinguished more aspects of transparency (political, economic, procedural, policy and operational aspects) and examined transparency across time but just for nine central banks. Dincer and Eichengreen (2008, 2010) built also a transparency indicator relying on the methodology of Eijffinger and Geraats (2006) and Geraats (2002) but widely expanding the number of countries and years covered. Indeed, they provided indices of transparency for 100 central banks from 1998 to 2006. Finally, Crow and Meade (2008) constructed indices of both the transparency and independence of thirty-seven central banks.
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over the 1998-2006 period using criteria similar to Dincer and Eichengreen (2007). Here, we focus only on the latter, updated by Siklos (2011) through 2009 and again by Dincer and Eichengreen (2014) until 2010 for 120 central banks, including the People’s Bank of China. Their central bank transparency index (rank from 0 to 15) is the sum of the scores of fifteen questions related to policy transparency (related to openness about policy objectives), economic transparency (focuses on the economic information that is used for monetary policy and internal forecasts communication), procedural transparency (the way monetary policy decisions are taken), policy transparency (prompt disclosure of policy decisions, indication of likely future policy actions) and operational transparency (related to implementation of the central bank’s policy actions, evaluation of operating target achievement). The Figure 17 and 18 present some of their results in East Asia and for China specifically.

**Figure 17: Central bank transparency measure in East Asia in 2010**

![Bar chart showing central bank transparency in East Asia in 2010](image)

*Source: Dincer and Eichengreen (2014)*

**Figure 18: Central bank transparency in China**

![Bar chart showing central bank transparency in China](image)

Among Asian countries, Figure 17 shows that central bank transparency is low in China, at 4 over 15 in 2010, India registering the lowest level at 3 (the only country with a lower transparency measure among the selected countries) and Japan the highest at 10.5. Central banks in Indonesia, Philippines and Thailand seem to favor a transparent policy with an index at around 9-10 and in a lesser extent Malaysia (6), Hong Kong (7.5) and Korea (8.5). However, the evolution of transparency in China on Figure 18 emphasizes the significant efforts made by the PBC over the last decade to enhance transparency, particularly since 2003. Indeed, the measure for China has jumped from 1 in 2000 to 4.5 in 2003. This PBC behavior change in terms of transparency from 2003 is not really a surprise as
we find a substantial contrast in the conduct of monetary policy after (December) 2002 under the new Governorship of Zhou Xiaochuan (as described in the previous section) and in the context of gradual financial liberalization and in transition towards a more market-oriented system. Thus, improving central bank credibility through a clear policy is a manner to enhance financial stability.

Consequently, the PBC has made great effort in the 2000s to strengthen policy communication, enhance transparency, guide the public, including announcements of policy actions, frequent public speeches, and regular publication of reports about the economy and monetary policy. For instance, the PBC has held a monetary policy committee meeting every quarter since the end-1990s. The State Council released in 1997 *Rules on Monetary Policy Committee of the People’s Bank of China* stipulating responsibilities of the Monetary Policy Committee in macroeconomic management and in the making and adjustment of monetary policy. It is a consultative body, whose responsibility is to advise on the formulation and adjustment of monetary policy and policy targets for a certain period, the application of monetary policy instruments and the coordination between monetary policy and other macroeconomic policies. Following each committee, the PBC releases its China Monetary Policy Report on a quarterly basis.

In addition, the PBC also reports regularly to the National People’s Congress Financial and Economic Affairs Committee about the implementation of monetary policy (Sun Goefeng, 2014). Moreover, the National Bureau of Statistics of China issues on its website on an annual basis the Statistical Communiqué of the People’s Republic of China on National Economic and Social Development which details economic objectives, notably the annual targets on economic growth, inflation and M2 growth. Finally, the PBC explains relevant policies using its website, the media and press conferences, an important channel to guide expectations. Therefore, the PBC publishes a range of data and reports on its website, which support the increasing determination of the central bank to be more transparent in the conduct of its monetary policy. To complement and validate our instrument-based monetary policy index, we suggest a second approach relying on media-based information on central bank communication. This narrative method appears very relevant in the case of China to account for the peculiarity and complexity of monetary policy when unobserved quantitative controls are used.
1.4.3. Methodology for measuring monetary policy communication

We turn now to the issue of how to measure communication using a narrative approach. The method was pioneered by Friedman and Schwartz in their *Monetary History of the United States* (Friedman and Schwartz 1963) and has been applied by Romer and Romer (1989, 2004). It relies on the reading of the central bank’s written documents that provide additional information on policy-makers’ intentions. Three studies to our knowledge have chosen this approach in the case of China. Shu and Ng (2010) has applied the narrative approach to examine monetary policy by the PBC. They computed their index by compiling information from official reports, meeting notes of the MPC and the quarterly Monetary Policy reports. Then, Xiong (2012) also examined the PBC’s statements in its quarterly Monetary Policy reports from 2001 to 2010. Finally, Sun Rongrong (2013) also used PBC’s documents to analyse monetary policy stance.

Our approach aims at going one-step ahead, not relying on the reading of official reports but on media-based information. The idea is here to not only capture information from quarterly or annual reports but to compile real-time information such as press statements and conferences which are announced on a more irregular frequency. This methodology assumes that the media translates very well the content of official reports, meaning that press information encompasses and summarizes key messages from official reports, but adds also the report by the media of oral communication. An analysis from Knütter, Mohr and Wagner (2011) identifies a pronounced effect of central bank communication in developed economies on financial market variables, with statements and press conferences being seemingly the most effective channel of central bank communication. As pointed out by Filardo and Guinigundo (2008), the press can act as an ally in the transmission of information since it has a comparative advantage in translating the arcane world of monetary policy to a broader audience. However, while they also argue that the press can prove to be counter-productive at times, especially when journalists have more interest in provocative headlines, our methodology consists in focusing only on objective reporting of the facts.

For practical purposes, our methodology is based on commonly used newswire services, Factiva and Lexis Nexis, to extract all reports about monetary policy statements on a daily basis. The objective is to extract all press statements in real time from January 2006 to December 2013 translating speeches delivered by the PBC governor, Mr. Zhou Xiaochuan, the Prime Minister, Mr. Wen Jiabao, and a
prominent academic member of the MPC, Dr. Fan Gang. Overall, we analyze contents of more than 10,000 articles in which officials provide information about China monetary policy over our sample period.

Then, we proceed into two steps to examine media-based information. The first one consists in evaluating the relevance of our approach by reading each article over a short period, from January 2007 to May 2010. Each news are classified either as those that convey either a hawkish or very hawkish message, coded 1 or 2 respectively, or those that contain a dovish or very dovish message, coded -1 or -2 respectively, as followed:

\[
CB\ speech = \begin{cases} 
1 \text{ or } 2 & \text{the more hawkish} \\
0 & \text{neutral} \\
-1 \text{ or } -2 & \text{the more dovish}
\end{cases}
\]

However, this classification is rather based on our own judgment and reading of the newswire reports. This indicator can serve as a benchmark indicator but a more scientific method is required to follow PBC speeches.

Therefore, we have developed our own method, based on text mining analysis, to construct a high frequency central bank communication indicator over the 2006-2013 period. Our program, written with the software R, has been developed into two principal steps. The first step concerns the extraction of relevant articles among more than 10,000 articles identified in Factiva and Lexis Nexis which translate information about monetary policy in China. Then, we proceed to a new filter in order to select only articles translating Chinese official speeches about monetary policy. Moreover, this step also provides a comprehensive framework of articles with different identified fields related to the article title, the content, the publication date, the source and an approximation of the official announcement date (which can be different from the publication date of the article).

Then, the second step aims at identifying the monetary policy stance by inspecting specific combinations of subject, verbs and adjectives in each speech, as described in Table 5. As an example, if an article contains “interest rate” and “cut” in a sentence, then the article is coded as -2. Further details about the method are explained in Appendix 1.A.
**Table 5: Automation of our media-based Monetary Policy Stance Index**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Verbs, adjective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest rate, monetary policy, lending rate, reserve requirement, RRR, reserve ratio, liquidity crunch</td>
<td>Cut, ease, loose, avoid, + tweak, fine-tune, relax, cool, charge less, lower</td>
</tr>
<tr>
<td>Financial support, loan, liquidity, credit growth, money supply, money growth, monetary credit, domestic</td>
<td>support, increase, charge less, faster, add, boost, extend, expansion, inject, pump, juice up, stimulate</td>
</tr>
<tr>
<td>Interest rate, monetary policy, inflation, asset bubble, control liquidity, reserve requirement, RRR, lending rate</td>
<td>Increase, raise, rise, tighte, + increasing risk, manage, step up, vigilant, high pressure,</td>
</tr>
<tr>
<td>Loan, credit, liquidity, capital inflows, foreign exchange, inflation, price stable, OMO, open market operations</td>
<td>bolster, tackle Control, soak up, contain, abnormal, mop up, strenghen, liquidity-driven, hot, curb, fear, steriliz*</td>
</tr>
</tbody>
</table>

Source: Authors’ calculation

Consequently, our methodology presents a major innovation by constructing a comprehensive high-frequency measure of monetary policy stance, based on our own recording of PBC speeches and statements, and coded from -2 to 2. The magnitude of a speech is dependent on the stance used. The more the present or future is used the higher our index is coded while the conditional stance makes further policy actions less probable at the short-term horizon.

Finally, we suggest an alternative communication index that weighs our communication index by the number of published articles at each date which relate the same information with the rationale that higher is the number of articles, the more relevant is the information and higher the likelihood of further policy actions. Consequently the obtained indicator is coded from -6 to 6.
1.4.4. Media-based PBC monetary policy indicators review

This section presents the results of our speech-based approach to measure the monetary policy stance in China. First, Figure 19 compares, for the overlapping sample, the evolution of our automated communication index and our hand-made indicator (reading each article and subject to our own interpretation). While the indices are built on a daily basis, they are presented on a monthly basis to easily detect the turning points for each indicator. This first step attempts to validate both the approach of using media information to measure monetary policy and the reliability of our algorithm. We find that both indicators evolve globally in the same direction with similar turning points, particularly well identifying the move from a hawkish stance to a dovish one during the third quarter of 2008. The timing at end-2009 of the changes in monetary policy stance from dovish to hawkish speeches is also equivalent for both indicators. The magnitude of both proxies appears sometimes different, such as early 2007 or mid-2009. However, this cannot reject our automated approach which is convincing when analyzing the complex conduct of monetary policy in China.

**Figure 19: Evolution of media-based PBC Monetary Policy Communication Indices**

Then, Figure 20 illustrates on a daily basis our automated weighted media-based monetary policy communication index in China from January 2007 to December 2013, in comparison with GDP.
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Four distinct monetary policy periods can be examined: (1) a hawkish period over the period January 2006 to August 2008 (2) dovish speeches from September 2008 to November 2009 (3) a hawkish stance between December 2009 and October 2011 and (4) an easing of monetary policy from November 2011 to December 2013.

**Figure 20: Automated weighted media-based Monetary Policy Communication**

As mentioned in the first section, the 2006-2008Q3 period shows an overheating economy with strong growth (GDP growth annually higher than 10%) and growing inflationary pressures (from 2.2% in January 2007 to 8.7% in February 2008) explained by the commodity price boom. Therefore, the central bank explained in a statement at end-February 2008 “its priority to keep inflation under control, despite a possible global slowdown that may drag down China’s economy, and that although economic growth is stable, the country faces increasing pressure from a potential investment upswing, excessive lending and liquidity[…]."

Then, the economic growth slowdown from early 2008 amplified by the negative impact of the GFC led China to implement an extraordinary loosening of monetary policy and active fiscal policy from 2008Q3 to stimulate economic growth. The People’s Bank of China announced, from September 2008 to December 2008, several cuts in the benchmark one-year lending and deposit rate as well as its reserve requirement ratio “in an apparent bid to spur the economy” (according to an article

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10 While GDP growth and inflation are respectively on a quarterly and monthly basis, we consider same values to allow illustrating the graph on a daily basis.
published on 15\textsuperscript{th} September 2008). However, the dovish stance strengthened at end-October 2008 when the central bank governor Zhou Xiaochuan announced that “it will set up an emergency liquidity plan designed to shield the domestic banking system from the ongoing global financial crisis”. While arguing that current liquidity levels remain satisfactory, Zhou Xiaochuan also said “the central bank will use open market operations and the reserve requirement ratio to ensure that interbank liquidity is maintained at a reasonable level”. Zhou Xiaochuan said also that “the central bank will continue to take a flexible and cautious monetary policy (stance), which will balance the need to respond to changing economic conditions with the stabilization of inflation expectations”. Reiterating previous central bank statements, Zhou Xiaochuan said that “the central bank will use interest rates reasonably to manage market expectations while keeping the yuan basically stable.” From early-2008, the central bank put a more aggressive strategy in place and said “it will enhance window guidance to improve the structure of overall lending, guiding more credit support to small and medium-sized companies as well as the agriculture sector”. It also said “the central bank will encourage financial institutions to provide more export credit.” (article written on 11 November 2008).

The central bank reiterated early 2009 the use of window guidance instead of traditional monetary policy instruments, with the central bank saying in a statement on its website on March 2009 that “the country will enhance support to the financial sectors for economic growth. We will enhance the 'window guidance' and inform financial institutions of the (right) meaning of the central government's macroeconomic regulation to guide reasonable loan extensions. [...] The central bank has also urged local bank branches to strengthen window guidance to ensure ample liquidity to support the country's drive to stimulate economic growth” (article published the 4 March 2009). Therefore, this massive loosening of monetary policy resulted in rapid credit growth helping boost economic growth.

The stance of monetary policy changed from early 2010 with renewed concern over inflationary pressures and the central bank declared that “it faces difficulty in managing a heating-up economy as inflation expectations have kept rising”. The CPI inflation rate steadily increased in 2010 and surpassed the 3.0% official target to reach 6.5% in July 2011. Moreover, previous record credit expansion sparked the risk of asset bubbles and Chinese authorities announced in April 2010 “to take tough steps to cool property market while the State Council said property and land prices were rising
too fast in some cities”. Therefore, the PBC tightened monetary policy to fight against rising inflation and a real estate bubble with successive rises in RRR and increases in deposit and lending rates from mid-2010 to mid-2011. Finally, another round of loosening of monetary policy concerned the period from end-2011 to end-2013, with a more visible stance in 2012. Indeed, in the background of a gradual economic slowdown, the Premier Wen Jiabao announced in May 2012 “that China will step up policy fine-tuning to support the economy”. Then, the central bank used a more “prudent” monetary policy in 2012 and 2013 fine-tuning liquidity through multiple central bank bills injections and withdrawals.

1.5. Validation, cross checking of our two approaches

Our two alternative approaches to measure monetary policy in China, one instrument-based and the second based on official speeches, have provided reliable information about the PBC behavior since the mid-1990s. This sections aims at validating and comparing our two approaches to evaluate if both indicators are equivalent and if the speech-based indicator enhances the predictability of monetary policy. To compare both indicators, the speech-based indicator is converted into “27bp equivalent change” (using a min-max scale process).

Figure 21 clearly shows that our two measures well identify similarly four distinct monetary policy stance periods and equivalent turning points, validating the consistency of our two approaches.
Moreover, while the construction of an instrument-based index has revealed a number of difficulties from the discontinuous use of tools to the identification of window guidance periods, the speech-based indicator provides evidence of the robustness of the methodology used in the instrument-based approach. Indeed, the extraordinary loose-monetary-policy period is equivalent according to the two indicators. Moreover, this proves that communication can be used as a transparency tool providing useful information about monetary policy actions.

Finally, we find that the speech-based indicator plays a major role in reinforcing PBC actions, particularly during tightening periods. Indeed, monthly changes in the speech-based indicator are generally higher than the ones of the instrument-based index, meaning that communication tends to amplify actions during tightening periods.

Therefore, this analysis contributes to the literature by providing two alternative approaches which are essential to analyze appropriately the monetary policy in China. Finally, Figure 22 shows evidence of the main differences between conventional measures, such as SHIBOR interbank rate and M2 growth, and our instrument-based approach. For instance, the M2 growth indicator does not capture the tightening period in 2007-2008. Moreover, the SHIBOR rate and M2 growth seem to underestimate the easing of monetary policy from 2011 to mid-2012. Moreover, while central bank
communication would play an increasing role in a more market-oriented system, the measure seems to play two crucial roles, one of transparency as a genuine measure of (observed and unobserved) monetary policy, and of a communication device, reinforcing PBC actions particularly during tightening periods.

**Figure 22: Comparison between monetary policy measures in China**

1.6. Conclusion

This chapter aimed at enhancing our understanding of China’s evolving monetary policy over the last decades. The objectives of this chapter were twofold. First, we attempted to explain the specificities of the monetary policy in China in the context of an open-economy in development under financial integration. Indeed, understanding the monetary policy setting in China required to examine in parallel economic reforms and the specificities of the financial system which explain most of the differences with the conduct of monetary policy in Western countries.

We specifically highlighted four different specificities of the China economic development: (1) a trial-and-error economic approach in China leading to excessive economic fluctuations and excessive monetary policy actions, either too loose or too tight. (2) Each crisis period in China, including the GFC period, is characterized by the use of administrative window guidance monetary policy to control over prices and investment. (3) Partial economic reforms and the state-controlled financial
system since 1978 have led to monetary expansion in China driven by bank’s finance for fixed assets investment and as a product of an investment game between the central and local governments (with different investment priorities). (4) An open-door policy leading China to manage global monetary and financial factors and attempting to turn around the trilemma – increasing capital flows mobility, a quasi-pegged currency and an autonomous domestic monetary policy - which is normally impossible in practice.

Then, the understanding of the monetary policy setting helps explaining why the PBC has employed a battery of price- and quantity-based instruments as well as administrative window guidance while their relative importance has varied over time. Therefore, many questions over China’s monetary policy remain open-ended and can lead to wrong perceptions, including the appropriate variable to identify monetary policy. Indeed, the challenges met when trying to assess appropriately the changes in the monetary policy stance in China are considerable because no single policy instrument represents a good proxy of China’s monetary policy. Therefore, we have built two new high-frequency composite monetary policy indicators based on alternative approaches. First, the monthly instrument-based indicator combines price, quantity and administrative tools used by the central bank over the period 1993-2013. Second, the daily speech-based indicator aggregates, through an innovative automated approach, official content in media articles about future monetary policy decisions over 2007-2013. Both indicators are very equivalent and seem to capture the important changes in China’s monetary policy well.

Moreover, they present further advantages: (1) the speech-based indicator provides useful information about the monetary policy stance as a transparency tool by allowing us to take into account unobservable instruments such as administrative window guidance, but also can serve as a proxy of the communication tool as it seems to reinforce monetary policy actions, particularly during tightening monetary policy periods. (2) Since the instrument-based indicator is scaled in policy-rate equivalent terms, it will be possible subsequently to use it in order to interpret its response to macroeconomic variables in line with the conventional Taylor rule based on a target interest rate. In addition, monetary policy indices with alternative weights on underlying instruments were also tested to assess the differences among them and their robustness.

Such an instrument-based indicator led us to identify a major change in 2002 in the conduct of monetary policy in China. By taking into account the magnitude of changes, our research was able to
show that the Chinese monetary policy is featured with dovish changes and a policy style of bigger but infrequent moves before 2002, while afterwards it is characterized with relatively hawkish changes and a smoothing style of frequent but smaller steps. This may reflect a combination of important changes in institutional aspects with the enhancing responsibility of the PBC as a central bank in the monetary policy implementation and also corresponds to the start in 2002 of the new mandate of Governor Zhou Xiaochuan.

Moreover, the acceleration of interest rate liberalization from 2002 (after a first stage of financial reforms in the 1990s) and the rapid, de jure or de facto, opening of cross-border flows following China’s WTO accession in December 2001 are important economic and financial transformations that would lead to a clear change in monetary policy strategy. Therefore, institutional, economic and financial reforms well justify the need for the central bank to change its behavior and to adopt a more predictable monetary policy rule (by enhancing also communication about its monetary policy).
Appendix 1.A: Construction of an automated monetary policy communication index in China

The next table provides some examples of codification of a sample or articles.

<table>
<thead>
<tr>
<th>Date</th>
<th>Code</th>
<th>Information content</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 2008</td>
<td>1</td>
<td>China’s recent decision to raise its domestic fuel prices could require stronger monetary policy measures to contain inflation, said Chinese central bank governor Zhou Xiaochuan</td>
</tr>
<tr>
<td>March 2009</td>
<td>-2</td>
<td>“Chinese officials pledged to increase financial support to SMEs this year through increased bank loans”</td>
</tr>
<tr>
<td>March 2009</td>
<td>-2</td>
<td>“The central bank said it was considering allowing commercial banks to charge less for loans”</td>
</tr>
<tr>
<td>January 2010</td>
<td>2</td>
<td>“The PBoC said Tuesday that it will raise the commercial bank deposit reserve requirement as the government steps up its efforts to take control of rampant loan growth and rising inflationary signals”</td>
</tr>
<tr>
<td>January 2011</td>
<td>2</td>
<td>“Although the deposit reserve ratio is already at a high level, we’ll still rely on the use of this tool and the issuance of central bank paper to sterilize liquidity”, Zhou said in an interview with the official Xinhua News Agency. Zhou also said that liquidity can be controlled via credit growth”.</td>
</tr>
<tr>
<td>January 2011</td>
<td>1</td>
<td>“Zhou said that apart from reducing money supply through usual measures such as raising reserve requirements, the central bank could also soak up excess liquidity by restricting the flow of capital. The PBoC also said on Thursday that it will implement a prudent monetary policy in 2011 to check excessive liquidity and curb inflation”</td>
</tr>
</tbody>
</table>

Source: Authors’ calculation
Appendix 1.A – Construction of an automated monetary policy communication index in China

We have developed our own method to construct an automated program with the R software that builds a monetary policy communication index in China, coded from -2 to 2 as followed:

\[
CB \text{ speech} = \begin{cases} 
1 & \text{or} \ 2 \text{ the more hawkish} \\
0 & \text{if neutral} \\
-1 & \text{or} \ -2 \text{ the more dovish}
\end{cases}
\]

We describe hereunder the methodology based on text mining analysis and developed on the R software.

The first step extracts all press statements from January 2007 to December 2013 from Lexis Nexis and Factiva filtering the research on the “monetary policy” topic in the country “China” and focusing on the keywords “PBC governor”, “Zhou Xiaochuan”, “Prime Minister”, “Wen Jiabao” and “Fan Gang” to select only articles in which Chinese officials speak.

The second step aims at providing a comprehensive framework of articles (saved in html format) inspecting the corpus of each article and identifying items related to the article title, the content, the publication date, the source and an approximation of the official announcement date (can be different from the publication date). Such functions are available in the tm package in R. For the approximation of the date, we revise the publication date if a specific day is specified in the content of the article.

In a third step, we build a function “near20” that allows focusing on the sentence of interest in each article content. This function searches the proximity of words related to Chinese officials presented above and action verbs, which are “said”, “say”, “tell”, “told”, “signal”, to capture the sentence of interest in which officials discuss about monetary policy. If the distance between Chinese official names and the verbs is less than 20 words then the sentence is saved as one providing information about central bank speech.

Fourth, selected sentences are inspected searching a combination of subject, verbs and adjectives that describe a monetary policy decision, as presented in Table 5. The “near20” function is also used to evaluate the proximity between subject and verb words (and consider a distance lower than 10 words). Repetitions are also excluded from the database. Finally, a last handmade check is done with possible fine-tuning to verify the reliability of our indicator.
Consequently, this automated method allows building a benchmark central bank communication index. Finally, an alternative indicator is also suggested weighing the benchmark one by the number of articles that translate the same information during the week with the rationale that higher is the number of articles, the more relevant is the information and higher the likelihood of further policy actions. The method simply counts the number of articles each week and multiplies the benchmark indicator by 1 if there are less than 5 articles mentioning the same information during the week, 2 if there are between 5 and 10 registered articles and 3 if there are more than 10 articles in our media-based information sample. Consequently the alternative indicator is coded from -6 to 6.
Appendix 1.A – Construction of an automated monetary policy communication index in China
Chapter 2
Understanding the monetary policy rule in China: what is the role of inflation?
Chapter 2 – Understanding the monetary policy rule in China: what is the role of inflation?

The research in this chapter has been done in collaboration with Dr Eric Girardin, my PhD supervisor and professor of economics at Aix-Marseille University, Dr. Guonan Ma, senior economist at the Bank for International Settlements (BIS). Moreover, preliminary results of the research conducted in this chapter has been published in BIS papers n°77 (2014) following the research conference on “Globalisation, inflation and monetary policy in Asia and the Pacific” on September 2013 in Beijing.

2.1. Introduction to chapter 2

China plays a rising role in the global economy while facing some key challenges in terms of economic transformation and liberalization. These represent at least two reasons explaining why economists attach increasing attention to the way in which Chinese authorities manage monetary policy. A central issue concerns the role of inflation in China’s monetary policy decisions, while policy is not officially targeting inflation but has helped deliver good inflation performance in the new millennium, with low inflation (2.3% on average) and a fall in inflation persistence\(1\), in contrast to high inflation during the 1990s (8.4% on average). This is not a unique case. Filardo and Genberg (2009), examining the inflation performance in the Asia-Pacific region, argue that formal inflation targeting is not the only monetary policy framework capable of delivering price stability.

However, the monetary policy framework and objectives in China may have changed over the past two decades. The theoretical formulation of the ‘inflation targeting problem’ introduced by Svensson (1997) helps understand potential sources of instability in a central bank’s reaction function. Indeed, he argues that since the Taylor rule is the solution of the central bank minimization of its loss function under the constraint of the structure of the economy, changes in the reaction function can be explained through changes in the preference function of the authorities and/or the structure of the economy.

Such sources of instability clearly point to the potential importance of three key historical transformations in China. The first one refers to institutional reforms with the enhanced responsibility of the People’s Bank of China (PBC) as a central bank, legally decreed in 1995. Monetary policy settings may also have changed with China’s financial integration in the world through a rapid

\(^{11}\) More details in Filardo and Genberg, 2009. The persistence of inflation is defined as the tendency for inflation to stay away from its average level for a protracted period when perturbed.
increase in trade and financial opening, particularly since WTO accession in December 2001. Moreover, the PBC may have had to take global financial forces into account when navigating the trilemma through capital flows regulation and foreign exchange reserve inflows sterilization, particularly with the switch back and forth of exchange rate regime from a de facto dollar peg to a managed float (Ma and McCauley, 2011). Finally, the rapid development of the private sector in the 1990s (with SOEs privatisations, new wage setting rules, increasing job creation etc.) should also have increased the sensitivity of investment and consumption to the cost of capital and prices, generating the need for the authorities to take private agents’ expectations into account in monetary policy setting.

Therefore, it is likely that China’s monetary policy rule has also evolved as a by-product of the liberalisation and transformation in the Chinese economy since the early 1990s. Among a large number of studies, Cogley and Sargent (2001, 2005), Kim, Kishor and Nelson (2006) and Boivin (2006)\(^\text{12}\) have highlighted structural changes in the US monetary policy rule, estimating the well-known Taylor rule (1993) that relates a policy rate to the output gap and inflation. Few papers have turned to China’s experience. Among them, Zheng et al (2012) conclude that the magnitude of the response to inflation was larger during 1998-2002 than during previous periods, meaning that the PBC attached increasing attention to inflation. Chen and Huo (2009) find two structural changes in the Chinese monetary policy rule, around 1998 and 2002-2003. Moreover, they conclude that the monetary policy rule is both characterized by a backward- and forward-looking behaviour. Finally, the literature lacks a comprehensive analysis of the influence of external factors, typically foreign interest rates, on China monetary policy decisions while it often concludes to its significant role in advanced economies (see for instance Ball, 1999 and Svensson, 2000; and Adam, Cobham and Girardin in the case of the UK, 2005). In addition, a recent and rich literature has investigated the sensitivity of movements of policy interest rates in developing and emerging market countries to those of the major economies, i.e. monetary policy spillovers, in the aftermath of the Global Financial Crisis (GFC) (Chen, Filardo, He and Zhu (2012), Rey (2013), Aizenman, Chinn, Ito (2015), Lombardi, Siklos and Amand (2015))

However, to well understand the evolving monetary policy in China, a good measurement of monetary policy is crucial. We have enhanced in the first chapter the necessity of constructing new

\(^{12}\) For a survey, see Yüksel, et al., 2012
indicators to measure properly the monetary policy in China. We have particularly shown that our instrument-based indicator, named monetary policy index (MPI) in this chapter, well captures the gradual change towards a more-market oriented system, the evolving mix of policy instruments, as well as liquidity management tools and provides a way to take administrative window guidance into account. Moreover, we argue that our measure goes one-step further by taking into account the magnitude of monetary policy changes through converting each instrument change in terms of a “27 basis point equivalent” change. Indeed, it highlights two contrasting regimes before and after 2002 under the Governorship of Zhou Xiaochuan. We find that the PBC monetary policy during 1993-2001 is characterised by relatively dovish changes and a policy style of big but infrequent moves, while that under the Zhou Xiaochuan Governorship of 2002-2013 features relatively hawkish changes and a style of small but frequent steps. Finally, it is highly relevant in this chapter since our monetary policy index (MPI) is scaled in policy-rate equivalent terms and can be interpreted in line with the conventional Taylor rule based on a target interest rate.

Therefore, we use our new monetary policy index (MPI) to estimate a dynamic monetary policy rule using the Bayesian method proposed by Dueker (1999) and Monokroussos (2011), combining data augmentation and single-move Gibbs sampling of the Markov-Chain Monte Carlo literature. This approach has many advantages, such as taking into account the discrete nature of the monetary policy instrument. Moreover, it allows us to interpret and compare long-term coefficients to standards (1.5 for inflation and 0.5 for the output gap) suggested by Taylor (1993) in analyzing the US monetary policy rule (which uses a target rate). We also examine the relative weight of the backward- and forward-looking aspects in the Chinese monetary policy rule along with the effect of foreign, typically US, monetary policy.

This chapter contributes to the literature via the estimation of the rule adopted by the PBC using our novel monetary policy index (MPI). Then, our research provides empirical evidence that the two contrasting periods over the MPI are identifiable with a different monetary policy rule. The PBC steadily engaged after 2001 in a regime that looks a lot like informal inflation targeting, with a weight on inflation higher than unity, and a hybrid reaction function taking into account forward-looking aspects of inflation. The change of behaviour of the PBC exhibits similarities with prior changes by central banks in developed economies. Despite considerable differences in the economic context, this contrast is indeed strikingly similar to the pre- and post-1979 contrasts for the G3 central banks, moving from an inflation-accommodating to a much more anti-inflationary policy. It
results that the era of *Great Inflation* in China contrasts starkly with what followed after Zhou Xiaochuan’s appointment, a period of low inflation and strong growth. Finally, we contribute to the actual debate on global monetary spillovers. Indeed, we find that constraining the estimated monetary policy to a closed-economy case (only with domestic factors) leads to wrong perceptions with an over-estimated output coefficient. We show evidence of the impact of US monetary policy on China. Indeed, the US shadow Fed Funds rate appears to have played a significant role in China’s monetary policy decisions since 2002, consistently with the increasing de jure and de facto financial openness following China’s WTO accession in late 2001.

The rest of the paper is organised as follows. Section 2 examines the literature review. Section 3 discusses the estimation method and data, while section 4 presents the estimation results and robustness tests. The final section concludes.

### 2.2. Lessons from the monetary policy rule literature

This section first reviews the literature on the theoretical framework of the Taylor-rule reaction function and the main empirical studies of China’s monetary policy rule, before summarizing the implications of China’s economic reforms for its monetary policy rule.

#### 2.2.1. Taylor-rule reaction function

A large part of the literature has been devoted to the understanding of the monetary policy rules employed by major central banks. The obvious starting point is the famous Taylor rule (1993), expressed as:

\[ i_t^* = r^* + \delta_1 y_t + \delta_2 \pi_t \]

This rule models the desired or targeted nominal short-term interest rate \( i^* \) as a function of output \( y_t \) and inflation \( \pi_t \) and \( r^* \) is the equilibrium level of the real interest rate. Accordingly, since the real interest rate actually drives private decisions, the size of the coefficient on inflation, \( \delta_2 \), needs to ensure that the nominal interest rate is raised enough to increase the real interest rate as a response to a rise in inflation (Taylor 1999, and Woodford 2001). This so-called ‘Taylor principle’ implies that
$\delta_2$ should exceed unity. Conversely, $\delta_2$ lower than 1 would indicate an accommodative behavior of the interest rate to inflation which may result in self-reinforcing inflation. In parallel, the coefficient of output, $\delta_1$, should be positive, around 0.5.

Over the past two decades, the literature has expanded to include various new applications and extensions of the Taylor rule. One best known strand is represented by the papers of Evans (1998), Clarida, Gali and Gertler (2000), Rudebusch (2002) and Ang, Dong and Piazzesi (2007). Specifically, they modify the Taylor rule to better correspond to the practical uses of central banks, for instance, extending the specification from a contemporary ($\pi_t$) model, as in (1), (or a backward-looking by replacing ($\pi_t$) by ($\pi_{t-1}$)) to a forward-looking specification (2):

$$i_t^* = r^* + \delta_1 y_t + \delta_3 E\pi$$ (2)

where $E\pi$ stands for expected future inflation. As pointed out by Cunningham, Desroches and Santor (2010), inflation expectations play a key role in the conduct of monetary policy since they provide useful signals with respect to the credibility of the central bank and its long-run inflation objective. Indeed, if economic agents view the central bank as credible, inflation expectations are more likely to be well anchored, further enhancing the effectiveness of monetary policy. Moreover, inflation expectations are one of the main drivers of current inflation, because expected inflation influences current wage negotiations, price setting and financial contracting for investment. Our paper explores the evolving roles of both past and expected inflation in China’s case.

A second major strand of new contributions concerns the introduction of the “interest rate smoothing” aspect in the specification. Indeed, it is generally recognized that central bank behaviour is less destabilising when it tends to change the short-term interest rate by multiple small steps in the same direction, rather than using large changes.\(^\text{13}\) Therefore, Clarida, Gali and Gertler (2000) relax the rule by specifying the following relationship for the actual nominal interest rate, $i_t$:

$$i_t = \rho(L)i_{t-1} + (1 - \rho)i_t^*$$ (3)

where $\rho(L) = \rho_1 + \rho_2 L + \cdots + \rho_n L^{n-1}$ and $\rho \equiv \rho(1)$. Equation (3) postulates partial adjustment of the interest rate to the target $i_t^*$. Specifically, the interest rate $i_t$ is adjusted each period to eliminate a fraction $(1 - \rho)$ of the gap between its current target level and some linear combination of its past

\(^{13}\) However, Rudebusch (2002) disagrees with the interest rate smoothing interpretation of the partial adjustment rule arguing that the illusion of monetary policy inertia likely reflects the persistent shocks that central bank face.
values. We interpret \( \rho \) as an indicator of the degree of smoothing of interest rate changes. \( \rho \) close to zero (unity) suggests little (lots of) smoothing of policy rates. Moreover, Woodford (2001) and Sack and Wieland (1999) argue that the observed smoothing of the interest rate may indeed be optimal, even if the central bank is not explicitly concerned with interest rate volatility. Our paper attempts to identify whether the PBC embraces such policy smoothing as commonly observed among most major central banks.

Thus, by combining Equation (1) to (3), the following specification expresses a smoothed (or dynamic) hybrid (backward- and forward-looking) rule:

\[
i_t = \rho(L)i_{t-1} + (1 - \rho)[r^* + \delta_1 y_t + \delta_2 \pi_{t-1} + \delta_3 E\pi]
= \beta_0 r^* + \beta_1 i_{t-1} + \beta_2 y_t + \beta_3 \pi_{t-1} + \beta_4 E\pi
\]

A third strand of the literature has taken into account the discrete nature of the monetary policy instruments. Hu and Phillips (2004) and Dueker (1999) suggest a methodology relying on the estimation of a discrete-choice model by classifying the Fed decisions to change the Fed Funds target rate in three categories: ‘increase’, ‘decrease’ or ‘no change’. Monokroussos (2010) also suggests a forward-looking and discrete-choice monetary policy reaction function for the US economy, using a much richer methodology, referred to as the Markov Chain Monte Carlo simulation. This paper aims at testing such an approach in the case of China, allowing us to combine dynamic backward- and forward-looking aspects as well as to take into account the discrete nature of monetary policy instruments.

Another interesting line of recent works concerns the potential changes in the monetary policy rule (for instance changes in the coefficients in the above reaction function equations). An increasing number of studies have turned to nonlinear specifications to take into account such aspects, such as Cogley and Sargent (2001, 2002), Kim and Nelson (2006) and Boivin (2006), who suggest a forward-looking time-varying parameter specification to highlight structural changes in the conduct of US monetary policy (for a survey, see Yüksel, Ozcan and Hatipoglu, 2012).

Finally, Ball (1999) and Svensson (2000) have investigated the development of similar rules but in open economy models (survey of theoretical foundations, see Corsetti, Dedola and Leduc, 2010). Adam, Cobham and Girardin (2005) have also estimated monetary policy reaction functions for the UK by including external factors such as the US as well as German interest rates. Most empirical works have found that external factors, typically foreign interest rates play a significant role. Some
recent papers have also considered the effect of US monetary policy on emerging markets. Among others, He and McCauley (2013) argue that central banks have kept policy rates low in response to global monetary accommodation and show that estimated open economy Taylor rules suggest central banks in Asia react to the federal funds rate.

The theoretical formulation of the ‘inflation targeting problem’ introduced by Svensson (1997) helps to understand potential sources of instability in the central bank reaction function. Indeed, the Taylor rule can initially be expressed as the reduced form of Svensson’s model. Accordingly, the reaction function results from the solution of an optimization problem in which the quadratic loss function of the authorities is expressed as:

\[
Min L(\pi_t, y_t) = \frac{1}{2} [(\pi_t - \pi^*)^2 + \lambda y_t^2] \tag{5}
\]

where \(\pi^*\) is the inflation target, \(\pi_t\) the inflation rate and \(y_t\) is the output gap in period \(t\), and \(\lambda\) reflects the relative weight that is put on deviations of economic activity from potential output in the loss function. This loss function sometimes referred to as reflecting ‘flexible inflation targeting’, since the objective function includes output stabilization in addition to inflation stabilization.

In order to obtain the Taylor rule, the quadratic loss function is minimized under the constraint of the structure of the economy (6):

\[
\begin{align*}
\pi_{t+1} &= \pi_t + \alpha_1 y_t + \varepsilon_{t+1} \\
y_{t+1} &= \beta_1 y_t - \beta_2 r_t + \eta_{t+1} \\
r_t &\equiv \frac{1 + i_t}{1 + E_t \pi_{t+1}} - 1 = i_t - E_t \pi_{t+1} \\
(\alpha_1, \beta_1, \beta_2 > 0, \beta_1 < 1)
\end{align*}
\tag{6}
\]

where \(\varepsilon_{t+1}, \eta_{t+1}\) are shocks to aggregate supply (the Phillips curve) and aggregate demand respectively. Both are assumed to be i.i.d. and are not observed until period \(t+1\). \(\pi_t\) is the inflation rate of period \(t\), \(y_t\) is the output gap, \(i_t\) the nominal interest rate and \(r_t\) the real interest rate. \(E_t \pi_{t+1}\) is the expected inflation rate for period \(t+1\) based on the information available at time \(t\).

From this theoretical formulation, the instability of the reaction function can potentially arise from: i) the preference function of the authorities; or ii) the structure of the economy (with model uncertainty). Such sources of instability of course include reforms and deregulation, which are particularly relevant for a fast transforming Chinese economy. In this paper, therefore, we aim to allow for time-varying coefficients in our estimation of the Chinese monetary policy rule.
2.2.2. Cases studies on China’s monetary policy rule

As pointed out by Pang and Siklos (2015), a minor part of the literature have tried to evaluate the conduct of monetary policy in China using a policy rule (e.g. a Taylor rule) while routinely estimated for central banks around the world. Indeed, Burdekin and Siklos (2008), Mehrotra and Sanchez-Fund (2010), Koivu (2009) have argued that a rule based on developments in monetary aggregates (i.e. McCallum’s rule) is more suitable for assessing the conduct of monetary policy in China. However, Fernald, Spiegel and Swanson (2014) argue that the undergoing financial liberalization process in China from the mid-1990s appeared to have increased the impact of monetary policy with an increasing role played by price instruments, in parallel to the use of quantity instruments.

Therefore, this chapter builds in part on the existing literature of empirical research on the conduct of monetary policy in China using a Taylor (or extended hybrid) policy rule, which can be divided into two main categories. The first category of works tries to transpose a specification standard for advanced countries to the case of China. This strand of research typically models the interbank interest rate in line with the methodology of Clarida, Gali and Gertler (2000). Xie and Luo (2002) is probably the first paper formally applying the Taylor rule to the case of China in the 1990s. The paper takes a standard Taylor rule (1993) to compute the implied policy rate and compares it to the actual interest rate. They conclude that the two broadly track each other in most cases but policy responses sometimes lagged behind the business cycle. Moreover, during 1992-2001, they find an accommodating reaction (with an inflation coefficient close to 0.8) and a strong reaction to output (close to 2.8).

A number of works turn to nonlinear specifications because of changes in the economic and policy environments. Zheng et al (2012) also introduce a regime-switching forward-looking Taylor rule by using the two-step maximum likelihood procedure of Kim and Nelson (2006). Both papers find that the response of interest rate policy to inflation and output is time-varying. Zheng et al. (2012) particularly conclude that the magnitude of the response to inflation was larger during 1998-2002 than during previous periods, meaning that the PBC paid increasing attention to inflation. Also, Chen and Huo (2009) consider a forward-looking Markov-switching and a time-varying parameter model to estimate the changing coefficients of the monetary policy reaction function in China. They assume that the PBC adjusts the M2 growth rate in response to inflation and the output gap and find two
structural changes in the Chinese monetary policy rule, the first one around 1998 and the second around 2002-2003. Moreover, they conclude that a pure forward-looking monetary policy rule cannot fully explain the Chinese situation and that the PBC is partly backward-looking. Indeed, they show that the responses to the lagged inflation variables are statistically significant after 2002.

However, one drawback of the analyses in this category is their questionable measures of the monetary policy in China. Zheng et al (2012) choose China’s inter-bank offered rate (CHIBOR) as the policy rate, along with Xie and Luo (2002). As Garcia-Herrero and Girardin (2013) argue, the liquidity in the CHIBOR (or even the Shanghai Interbank Offered Rate (SHIBOR)) may not be deep enough, at least initially, to be regarded as a good signal of the functioning of money markets. He and Pauwels (2008) also argue that short-term interbank interest rates are not a good measure of policy stance due to the segmentation of credit markets. In addition, interbank rates in China are not directly controlled by the PBC, in contrast with Eonia, or the Fed Funds rate, the official targets of Euro area and US monetary policies. Finally, Guo and Chen (2012) test different instruments individually (the regulated bank deposit rate, reserve requirement rate, loan size, the short-term interbank market rate and monetary base), but conclude that none of these policy tools on its own is a good measure of monetary policy stance.

The second category of works aims at better measuring the monetary policy stance, using an approach pioneered by Gerlach (2004) to construct an implicit index of the ECB’s monetary policy stance from the observed changes in the policy instruments. It takes the form of a discrete variable with three classes: “hawkish”, “neutral” and “dovish”. Then ordered-probit techniques are used to estimate the reaction function. In the case of China, He and Pauwels (2008) compute a measure of PBC’s policy stance by studying changes in various PBC policy instruments\textsuperscript{14} over the period 1992-2007. Their monetary policy rule estimation reveals that deviations of CPI inflation from an implicit target and deviation of broad money growth from the announced targets figure significantly as determinants of PBC’s policy changes, but not the output gap. They conclude that these findings are consistent with a characterization of the monetary policy framework in China as one of ‘implicit inflation targeting’.

\textsuperscript{14} Their measure is based on changes in the lending and deposit rates, changes in the reserve requirement ratio, and open market operations as measured by the changes in the outstanding central bank bills.
Xiong (2011) follows the methodology of He and Pauwels (2008) and also tests a forward-looking specification by examining the PBC’s statements in its quarterly Monetary Policy Executive Report from 2001 to 2010. He concludes that, in a backward-looking model, monetary policy reacts to actual output growth. But when deviations from trend levels are considered, the PBC responds more to inflation. In the forward-looking model, he finds that inflation plays a key role in determining the PBC’s policy stance. Finally, Shu and Ng (2010) suggest a narrative approach by compiling indices of the PBC’s policy stance on the basis of meeting notes and the policy statements, which differs from He and Pauwels’ (2008) measure. The paper tests various objective variables, such as deviations from official targets and trends for growth, inflation, monetary and credit growth. The authors find that growth and inflation are key monetary policy determinants and that the PBC appears to follow a rule of thumb, using historical averages as target rather than official targets. Both strands of the empirical studies of China’s monetary policy have their own advantages and drawbacks. In this paper, we build on the existing literature of these two strands to estimate China’s monetary policy rule by combining the construction of an improved monetary policy index, a hybrid specification taking into account both backward- and forward looking aspects as well as examining how the conduct of monetary policy has evolved over the last two decades.

### 2.2.3. Implications of the Chinese economic transformation

Discussion of sources of instability in the policy reaction function points to the potential importance of economic reforms, structural transformation, increased openness and institutional evolution in the Chinese economy. This section briefly sketches some of the key reforms and structural and institutional changes potentially more relevant for the possible evolution of China’s policy reaction function.

Two key developments are noticeable over the 1990s. First, the Chinese labour market has evolved over the past two decades, with large-scale labour migration from agriculture to industry and from rural to urban areas. The government began in 1994 a policy of privatizing and downsizing small- and medium-size state-owned enterprises (SOEs) while protecting larger SOEs. It was followed by new rules allowing most SOEs to set their own wages. Meanwhile, more jobs have been created outside the state sector since the mid-1900s. Therefore, private agents’ expectations have gained
importance and their behaviour may have become more forward-looking, thus influencing both monetary policy transmission and policy effectiveness, and highlighting the need for the authorities to be themselves increasingly forward looking.

Second, the 1990s were also a period of substantial price liberalization of goods and services that would have affected the inflation dynamics in China (Kojima, Nakamura and Ohyma, 2005). One noted change has been the absence of episodes of double-digit inflation after 1995, as the inflation cycles have become less volatile, in contrast to those in the 1980s and early 1990s. Indeed, we have witnessed three episodes of outright deflation (1998-1999, end 2001-2002 and 2009). This new inflation pattern may relate to a combination of domestic forces, including fuller price liberalization, “hardened” budget constraints of SOEs, the state banks’ reluctance to grant loans before the 2003 recapitalization and the expanding supply capacity in more sectors. Thus inflation in China may respond more normally to market demand and supply shocks. Our chosen data sample for empirical estimation corresponds to this period.

Then, the new millennium is characterized by increasing financial and trade openness as well as financial liberalization in the aftermath of China’s WTO accession in December 2001. Firstly, progress in financial and trade openness since 2002 is likely to be a major factor influencing the domestic inflation cycles and monetary policy rules. China’s total trade (exports plus imports) rose from 43% of GDP in 2001 to a peak of 71% in 2006 (before falling to a still high level of 55 % in 2011) against a backdrop of advancing globalization. In addition, China has, over the years, interacted more intensively with global commodity markets. Moreover, China’s WTO entry required policymakers to modernize the financial system and enhance the competitiveness of Chinese banks, committed to opening up the country’s financial services sector to foreign competitors within five years.

Therefore, as pointed out in the first chapter, the post-2002 period marked a new step towards financial liberalization with more specifically further interest rate liberalization and the development of security markets. The Chinese bond market has emerged very rapidly from early 2000s, opened to an increasing number of domestic investors but Chinese authorities have also gradually relaxed regulation of the regulation of foreign investors’ entry from late 2002 with the launch of the
Qualified Foreign Institutional Investor (QFII) scheme offering foreign capital an opportunity to invest in the Chinese bond market.\footnote{More details about the development of the Chinese bond market in Chapter 3 section 2.}

Then, China has embarked into deposit and lending rates liberalization from 2003. The PBC began removing all ceilings on lending rates and all floors on deposit rates and reduced the lending rate floor to 0.9 times the benchmark rates. It continued gradual reforms until fully liberalizing lending rates in 2013.

The evolving Chinese exchange rate regime may also have influenced the conduct of monetary policy or even sometimes become an important part of monetary policy itself. The management of the Chinese currency experienced a switch from a dollar peg during 1994-2005 to a managed floating from July 2005 through July 2008 and since June 2010 (Ma and McCauley, 2011). To maintain relative monetary policy independence under a still heavily managed currency, China often has to regulate capital flows and sterilize foreign exchange interventions. Large balance of payment surpluses on occasions prompted the PBC to resort to a variety of monetary policy instruments, while the dollar peg forced the trade-weighted renminbi to first depreciate considerably in the early 2000s and then to appreciate substantially between 2008 and 2010 (Ma, et al, 2011; Ma and McCauley, 2011).

Finally, the post-1995 period witnessed a more enhanced role of the PBC as a central bank. Indeed, although the PBC assumed its responsibility as a central bank in 1983, its status as a central bank was not legally confirmed until 1995. The PBC rolled out additional policy instruments such as central bank bills and reserve requirements, introduced quarterly monetary policy committee meetings and quarterly monetary policy reports from 1997 onwards. All these would likely affect both the PBC’s monetary policy framework as well as its implementation style.

Consequently, one would expect these changes to impact the supply and/or demand equations in system (6). Empirical estimates on changes in inflation persistence help bring useful lights on such potential instability, which highlight the changes in inertia in the inflation process. Interestingly, Zhang (2011), estimating the persistence of inflation in China since the early 1980s, finds a structural break in 1995, which could be associated with a policy regime shift. Such a break corresponds to a substantial fall in inflation persistence (from 0.9 to 0.8 or 0.7). A second (though possibly less robust)
break is detected in late 2003. Also, Filardo and Genberg (2009) detect a fall in persistence from 0.81 to 0.55 in the new millennium. The first break in inflation persistence in 1995 is attributed by Zhang (2011) (as well as by Zhang and Clovis, 2010) to changes in monetary factors, a useful reminder that coefficients in system (6) may themselves depend on the policy regime.

### 2.3. Methodology and data

This section describes the data issues and discusses the methodology which allows us both to deal with the discrete nature of MPI changes and to interpret our findings along the Taylor-rule specification in the case of China.

#### 2.3.1. Estimating the hybrid monetary policy rule with a discrete variable

Our empirical analysis is based on the methodology of Monokroussos (2011), which is itself an extension of the approach suggested by Dueker (1999). The main benefit of this approach is to take into account the discrete nature of monetary policy changes which, as pointed out by Dueker (1999), poses special challenges to empirical analysis. Such an approach belongs to the family of multinomial ordered probit models because the monetary policy interventions in China are multiples of 27 basis points and can be ranked (a 54 basis-point change is considered as more restrictive than a 27 basis-point change).

As in probit models in general, one models a continuous latent variable, the PBC’s desired level of the MPI, which determines the behaviour of the observed discrete variable. The standard specification of the hybrid (both backward- and forward-looking in terms of inflation) Taylor rule is described as follows:

\[
\text{MPI}_t^* = \beta_0 + \beta_1 \text{MPI}_{t-1}^* + \beta_2 \pi_{t-1} + \beta_3 y_{t-1} + \beta_4 E_{t-1} \pi_{t+1} + \beta_5 X_{t-1} + \varepsilon_t \tag{7}
\]

\[\varepsilon_t \sim N(0, \sigma_t^2)\]

---

16 In contrast, Gerlach and Tillman (2011) find no significant break in China’s inflation persistence, but they use year on year data, which may bias the estimates.
where $MPІ_t^*$ is the desired level of the $MPI_t$, $\pi_{t-1}$ is lagged inflation, $E_{t-1}\pi_{t+1}$ is the expectation of future inflation, $y_{t-1}$ is lagged output and $X_{t-1}$ denotes lagged external factors, typically foreign policy rates.\(^7\) $\varepsilon_t$ is a normally distributed, mean-zero error term. $\beta_1$ represents an indicator of the degree of smoothing of interest rate changes. $\beta_1$ close to zero (unity) suggests little (lots of) smoothing of policy rates. If $\beta_4 = 0$, equation (7) is reduced to a pure backward-looking monetary policy rule. We will estimate both the pure backward-looking and hybrid specifications.

In this framework, monetary policy decisions are made when the latent variable $MPI_t^*$ moves enough away from the observed policy instrument. Moreover, such a difference governs which changes, among the limited number of possibilities, have to be applied:

$$\Delta MPI_t \in \text{category } j \text{ if } MPI_t^* - MPI_{t-1} \in [c_{j-1}, c_j], j = 1, \ldots, J$$ \hspace{1cm} (8)

where $MPI_t$ is the observed instrument which changes by only one of $J$ possible values at discrete points in time, and $c_0, c_1, \ldots, c_J$ are the threshold coefficients for movement between the $J$ possible categories of changes. Therefore, the difference between $MPI_t^*$ and the last observed instrument $MPI_{t-1}$ provides a pressure index for the central bank to make potential monetary policy decisions while the intensity of changes is taken into account by the threshold coefficients. Since the majority of policy changes are of two sizes (27bp and 54bp), we assume four threshold coefficients to make sure to capture such changes: {-0.5, -0.10, 0.10, 0.5}\(^8\).

As explained in details in Monokroussos (2011), the estimation of such a dynamic probit model is complex and requires a difficult computational exercise (with high-order multiple integrals with no closed-form solution). In general, the most appropriate way to estimate the model is the maximum likelihood technique. The likelihood is the probability of the joint $T$-period event that has been observed, given $\bar{X}_T$:

$$Pr[\Delta MPI_1 \in \text{category } j_1, \Delta MPI_2 \in \text{category } j_2, \ldots, \Delta MPI_T \in \text{category } j_T | \bar{X}_T]$$ \hspace{1cm} (9)

Thus, this likelihood is a $T$-dimensional multiple integral with a $T$-variate Gaussian density. In addition, let $\Omega_t$ denote the information set at period $t$, including the explanatory variables up to

\(^7\) We have also tried to evaluate the effect of other external factors (such as the effective exchange rate and foreign exchange reserves). However, results are not presented in the chapter as their coefficients were insignificant.

\(^8\) Alternative threshold coefficients have been tested and do not significantly impact results of the estimation.
period $t$ and the observed dependent variable up to period $t-1$. Then, the conditional event probability for period $t$ is:

$$
\Pr[\Delta MPI_t \in \text{category } j \mid \Omega_t] = \Pr[MPI_t - MPI_{t-1} \in [c_{j-1}, c_j] \mid \Omega_t] \\
= \Pr[c_{j-1} + MPI_{t-1} < MPI_t < c_j + MPI_{t-1} \mid \Omega_t, j = 1, \ldots, T] \quad (10)
$$

Solving equation (8) by backward substitution, we have:

$$
MPI_t = \mu_t + \Gamma_t + \zeta_t MPI_0 + \xi_t \quad (11)
$$

where $\mu_t$ is a sum of constants, $\Gamma_t$ also a sum containing lags of the explanatory variables, $\zeta_t$ a function of the lagged MPI, $MPI_0$ the dependent variable for the initial period, and $\xi_t$ a sum containing the error terms multiplied by the coefficient of lagged MPI. By substituting (5) in (4), we obtain:

$$
\Pr[\Delta MPI_t \in \text{category } j \mid \Omega_t] \\
= \Pr[c_{j-1} + MPI_{t-1} - \mu_t - \Gamma_t - \zeta_t MPI_0 < \xi_t \mid \Omega_t, \xi_t = c_j + MPI_{t-1} - \mu_t - \Gamma_t - \zeta_t MPI_0] \quad (12)
$$

Such a sophisticated equation provides some intuition on the multiple integral problem which exists in this context and complicates the estimation task.\(^{19}\) To overcome this issue, we adopt the same methodology as Monokroussos (2011), relying on the Markov-Chain Monte Carlo literature (MCMC) through a Gibbs sampling algorithm with data augmentation, whereby simulated samples of the latent variable are generated through their model-implied conditional distributions.

This MCMC estimation strategy consists in dividing the set of parameters into a multi-block setup of one block per latent variable, $\lambda_1 = \{MPI_t^2\}, t = 1, \ldots, T$, one block for the variance, $\lambda_2 = \{\sigma^2\}$, and one block for the coefficients of the explanatory variables, $\lambda_3 = \{\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5\}$. Then, the first step consists in specifying initial values of the coefficients of the explanatory variables using ordinary least squares (OLS) estimation. Then, the second step consists in cycling through the following conditional distributions:

$$
\lambda_1^{(i+1)} \text{ from } p_{mpi^2}(\lambda_1^{(i)}, \lambda_2^{(i)}, \lambda_2^{(i)}, \lambda_3^{(i)}, Y_T), \\
\vdots \\
\lambda_T^{(i+1)} \text{ from } p_{mpi^2}(\lambda_T^{(i)}, \lambda_1^{(i)}, \lambda_2^{(i)}, \lambda_3^{(i)}, Y_T) \\
\lambda_2^{(i+1)} \text{ from } p_2(\lambda_2^{(i+1)}, \lambda_1^{(i)}, \lambda_3^{(i)}, Y_T) \text{ and} \\
\lambda_3^{(i+1)} \text{ from } p_3(\lambda_3^{(i+1)}, \lambda_1^{(i)}, \lambda_2^{(i)}, Y_T) \quad (13)
$$

\(^{19}\) For complementary details on the multiple integral problem, see the appendix of the paper of Monokroussos (2011).
where $Y_T$ denotes the entire history of the data for periods 1,...,T and $i$ indicates the iteration of the Gibbs sampler. The multiblock setup of one block per latent variable is employed to implement the technique of *data augmentation* whereby the latent variables are generated from their model implied conditional distributions $p_{mpi_1},...,p_{mpi_T}$. The point estimates and confidence intervals of the parameters of this paper are based on the means and the quantiles of their simulated marginal posterior distributions.

2.3.2. Data

**Domestic variables**

The monetary policy index (MPI) uses the instrument-based approach developed in Chapter 1. However, robustness tests will be done using each main traditional monetary instrument separately, i.e. the lending rates and the RRR, to evaluate whether they can reflect appropriately the monetary policy stance and be used in a monetary policy rule in China.

The data series used span the period from January 1993 to May 2013. The end of our sample at mid-2013 is dictated by the introduction around this date of a number of new monetary policy instruments such as the standing lending facility (SLF) and short-term liquidity (SLO), and the fact that the post-2013 period is too short to be examined.

The CPI index is obtained from OECD’s Main Economic Indicators website. For the economic activity variable, the level of industrial output is used in constant renminbi as reported by CEIC. As the year-on-year series precisely matches the IMF reported annual industrial output growth series (collected from China’s National Bureau of Statistics) from January through December 2001, we took these twelve months as benchmark levels from which we obtained the levels of industrial output for subsequent and previous months by applying the IMF year-on-year growth rates.

---

20 For technical aspects of the algorithm (for generating the variance, the coefficients of the explanatory variables and the latent dependent variables, please refer to the appendix of Monokroussos (2011) in https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnxnbfxnZW9yZ2Vtb25va3JvdXNzb3N8Z3g6NWMzMGFkMWYxNjE3OWM3NQ
Chapter 2 – Understanding the monetary policy rule in China: what is the role of inflation?

The Chinese-New-Year effect implies that, for January and February, the year-on-year growth rates are often distorted. We have taken the average of the year-on-year growth rate over January and February, and applied this same rate to the 2001 monthly levels forward and backward. On several occasions, particularly in 2006 and 2007, the National Bureau of Statistics of China (NBS) does not report year-on-year growth rates for January. We then used the same year-on-year growth rate as reported for February. Seasonality in the series thus generated for the level of industrial output did not seem to be invariant over time. Accordingly, we filtered out stochastic seasonality using unobserved component models (with the STAMP module in Ox implementing Harvey’s 1989 approach).

We use raw data on inflation and output growth rather than the usual output gap and deviations from the inflation target. The reason is that, in China, such official targets are not announced as true objectives to be attained but are rather published as guidance. As a result economic growth (inflation) was generally higher (lower) than the targets over the past 20 years, which implies that official targets cannot be considered as good measures of potential or steady-state values.

Table 6: Descriptive statistics of CPI inflation and industrial production growth

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI inflation (% y/y)</td>
<td>3.9 (6.5)</td>
<td>2.5 (2.6)</td>
<td>3.1 (4.7)</td>
</tr>
<tr>
<td>Industrial production growth (% y/y)</td>
<td>12.2 (2.7)</td>
<td>15.0 (2.6)</td>
<td>13.8 (3.0)</td>
</tr>
</tbody>
</table>

(*) standard deviation in brackets

Source: CEIC, NBS and authors’ computation.

Finally, we test three different indicators within a monthly frequency on the expectation of future inflation in China. (1) The first one is published in the PBC depositors’ survey\(^{21}\). The PBC survey series is published quarterly (end of quarter) referring to expectations with respect to the next quarter\(^{22}\). However, its main drawback is its availability on only a short-period, since 2001. Moreover, we

\(^{21}\) The PBC started in 2001 to conduct a quarterly survey on price expectations in China, based on 20,000 person survey as to future price rise expectations one quarter ahead. These surveys are published in the Quarterly China Monetary Policy Report of the PBC.

\(^{22}\) As we assume that this represents expectations for the whole quarter, we need to take its lagged value in the estimation with monthly data. We also tested including that variable with no lag, or using a monthly quadratic interpolation, but both generated very similar results to those presented.
normalize the indicator, constraining it to lie within the same range as inflation.\textsuperscript{23} (2) Besides, we consider the inflation-expectation variable provided by Consensus Forecasts, available since 1995. While available at a higher frequency, the latter is mostly a lagging indicator of inflation (see graphs in Appendix A). Moreover the PBC survey measure is a reflection of consumers’ expectations, while the Consensus Forecast is mostly made by overseas China watchers. (3) Finally, we build a new quarterly indicator of inflation expectation based on business survey data (see appendix B for details) collected by the PBC and available at least since mid-1990s. The main advantage of this indicator is that it enables us to evaluate the hybrid specification since the mid-1990s and compare results based on different inflation expectation indicators since 2002.

Finally, we use changes in the expectation of the future price index from the PBC quarterly depositors’ survey\textsuperscript{24} as our variable of inflation expectations. Since this indicator is only available since 2001, it is introduced as interacting with a multiplicative dummy variable equal to zero from 1995 to 2000, and unity subsequently. Moreover, we normalize the indicator, constraining it to lie within the same range as inflation.\textsuperscript{25} Besides, while the inflation-expectation variable provided by Consensus Forecasts is available since the mid-1990s, it is mostly a lagging indicator of inflation. Moreover the PBC survey measure is a reflection of consumers’ expectations, while the Consensus Forecast is mostly made by overseas China watchers. The PBC survey series is published quarterly (end of quarter) referring to expectations with respect to the next quarter.\textsuperscript{26}

\textsuperscript{23} However, the unavailability of the series prior to 2001 could potentially be a source of omitted variable bias, as pointed out by James Yetman.

\textsuperscript{24} The PBC started in 2001 to conduct a quarterly survey on price expectations in China, based on 20,000 person survey as to future price rise expectations one quarter ahead. These surveys are published in the Quarterly China Monetary Policy Report of the PBC.

\textsuperscript{25} However, the unavailability of the series prior to 2001 could potentially be a source of omitted variable bias, as pointed out by James Yetman.

\textsuperscript{26} As we assume that this represents expectations for the whole quarter, we need to take its lagged value in the estimation with monthly data. We also tested including that variable with no lag, or using a monthly quadratic interpolation, but both generated very similar results to those presented below.
Chapter 2 – Understanding the monetary policy rule in China: what is the role of inflation?

**Foreign variables**

In addition to domestic variables, this chapter aims at evaluating the sensitivity of monetary policy decisions in China to the ones in major advanced and emerging economies. However, the challenging stems from the fact that all of the advanced major economies (the US, the Euro area, and UK) have implemented extraordinary loosening monetary policy using unconventional instruments in the aftermath of the GFC. Considering that central banks have lowered their policy interest rates down to zero or near zero, using official policy interest rates may not capture the actual state of monetary policy.

Therefore, many researchers have estimated “shadow interest rates” to represent the actual availability of liquidity by allowing the estimated shadow rates to be possibly below the zero bound. For the US, the euro area and UK, we use the shadow interest rates estimated by Wu and Xia (2015). Figure 25 shows the shadow policy rates for the three economies as well as policy rates in Japan and major emerging economies, Brazil, India, Indonesia and Russia. Altogether, those 8 policy rates approximate well the movement in the policy rate in the world as these economies represent 50% of world economy, based on the IMF purchasing-power-parity valuation of

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27 Wu-Xia shadow interest rates are constructed with underlying input data for Gurkaynak, Sack and Wright yield curve estimates. More information is available at [http://faculty.chicagobooth.edu/jing.wu/](http://faculty.chicagobooth.edu/jing.wu/). For the US, the euro area and the UK, we use the shadow rate from the GFC and observed policy rates before the crisis.

28 While the Bank of Japan also relied on quantitative easing over the past, the policy rate is considered as no shadow rate is available on a similar methodology than those developed by Wu and Xia.
economies’ GDP. This allows us to approximate an “advanced-countries” shadow policy rate and also a “world” shadow policy rate aggregating those policy rates (shadow rates for advanced and observed for emerging economies) weighted by their GDP share in the world economy, as shown in details in Figure 25.

Figure 25: (Shadow) policy rates in advanced and emerging economies (%)
2.4. **The estimation results of China’s monetary policy rule**

This section presents our estimation results of China’s monetary policy rule into four steps. The first step compares the estimated monetary policy rules before and after 2002 to take into account the identified change in style in the PBC conduct of monetary policy in the first chapter and to evaluate a possible hybrid monetary policy rule by including both backward- and forward-looking aspects. In the second step, we put China’s monetary policy rule into an international perspective. The third step considers an open-economy monetary policy reaction function by introducing foreign actual or shadow policy interest rates. The final step provides some robustness tests based on alternative MPIs. Our discussion here mostly focuses on the long-term estimated coefficients of the monetary policy rule, while Appendix 2.C presents detailed results of the estimated short-term coefficients.

### 2.4.1. **From an accommodating-inflation to anti-inflationary policy**

A comparison of the monetary policy rules before and after 2002 will help highlight the evolving nature of PBC’s policy. Indeed, the first chapter has shown evidence of the distinct policy styles of the PBC pre- and post-2002 in terms of the instruments used, as well as their magnitude and frequency of changes. Moreover, we have argued that change in monetary policy can be explained by a number of institutional, economic and financial reforms early 2000s. Indeed, 2002 marks a possible new start for Chinese monetary policy in the wake of China’s WTO entry, increasing trade and
financial openness, further interest rate liberalization process, the Zhou Xiaochuan PBC governorship and the growing private sector.

Table 7 summarizes the long-term estimated coefficients of the monetary policy rule over the following two sub-periods within the sample of January 1993-December 2013: (i) January 1993-December 2001 and (ii) January 2002-May 2013. For each sub-period, we examine both backward- ($\beta_4 = 0$ in Equation (1)) and forward-looking aspects ($\beta_4 <> 0$ in Equation (1)) using three different expected inflation indicators: (A) extracted from the PBC depositor survey on expected future prices,29 (B) estimated based on business survey indicators, and (C) based on the Consensus Forecast (see Appendix 2.B for details). Table 7 presents the closed-economy Taylor rule estimates by including only the domestic variables (inflation and economic activity).

### Table 7: Implied long-term coefficients of the reaction function - Closed economy

<table>
<thead>
<tr>
<th>PBC monetary policy</th>
<th>Inflation (1)</th>
<th>Expected inflation (2)</th>
<th>Total inflation (1)+(2)</th>
<th>Output (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PBC(A)</td>
<td>Estim.(B)</td>
<td>Cons.(C)</td>
<td></td>
</tr>
<tr>
<td>Pre-Zhou period (1993-2001)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Backward-looking rule</td>
<td>0.1</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>(b) Hybrid rule B</td>
<td>-0.2</td>
<td>...</td>
<td>0.6*</td>
<td>...</td>
</tr>
<tr>
<td>(c) Hybrid rule C</td>
<td>-0.1</td>
<td>...</td>
<td>...</td>
<td>0.7</td>
</tr>
<tr>
<td>Zhou Governorship (2002-May 2013)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) Backward-looking rule</td>
<td>2.0</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>(e) Hybrid rule A</td>
<td>1.1</td>
<td>1.0</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>(f) Hybrid rule B</td>
<td>0.5*</td>
<td>...</td>
<td>1.6</td>
<td>...</td>
</tr>
<tr>
<td>(g) Hybrid rule C</td>
<td>1.4*</td>
<td>...</td>
<td>...</td>
<td>1.0</td>
</tr>
</tbody>
</table>

(1) equals $\beta_2/(1 - \beta_1)$, (2) for $\beta_4/(1 - \beta_1)$, (3) $\beta_3/(1 - \beta_1)$ and (4) $\beta_5/(1 - \beta_1)$ in equation (1).

Significant coefficients are in bold. * means significant at 10%.

Estimation with the expected inflation indicator from Consensus Forecast starts in 1995.

The hybrid rule A, B, C respectively use three different expected inflation indicators: the PBC depositor survey on expected future prices, our estimation based on business survey indicators and the Consensus Forecast one.

Source: Authors’ computation.

29 As the PBC survey on expected future prices is only available since 2001, the introduction of this variable in the monetary policy rule is only possible over the second sub-period.
Our empirical results convey a number of key messages. First, they highlight the substantial differences in the determinants and their respective influence on the Chinese monetary policy rule between the pre- and post-2002 periods. The 1993-2001 period is characterized by an inflation-accommodating policy with inflation coefficients not significantly different from 0 (as shown in Appendix 2.C) or weakly significant (at 10%) when including inflation expectations. In all cases, the implied long-term inflation coefficient appears on average much lower than unity. Conversely, output growth seems to play a dominant role in the conduct of monetary policy in China over 1993-2001 (except in equation c) with an implied average long-run coefficient significant close to or higher than unity (in the range 0.9-1.3). It is important to remember that the PBC was fighting against the economic slowdown then, owing to the stabilization policy in 1993, domestic corporate restructuring, and the Asian Financial Crisis. This heritage from the 1990s mostly explains the higher weight given to output growth.

Second, a noticeable shift in the conduct of monetary policy is observable after 2002 with almost all coefficients significantly different from 0 and a substantial increase in the long-term inflation coefficient (now close to 2), consistent with the so-called Taylor principle. While expected inflation did not seem to play any role during 1993-2001, the PBC appears to have used a hybrid reaction function since 2002 by taking into account equally backward- and forward-looking aspects in its monetary policy decisions. Interestingly, the response to overall inflation is quite similar for all three inflation expectation proxies. Moreover, the long-term response to expected inflation is in each case close to or higher than unity. This is not a surprise to the extent that a central bank implicitly targeting inflation has to take into account inflation expectations, since these expectations provide useful signals with respect to the credibility of the central bank and its long-run inflation objective. If economic agents view the central bank as credible, inflation expectations are more likely to be well anchored. Therefore, our results show that, with price liberalization and labour market reforms, inflation expectations play a role because they may start to directly influence wage and price setting in China in an increasing number of sectors, which in turn drive current inflation. These may help explain the PBC’s move from 2002 towards a hybrid reaction function that takes into account both expected and past inflation.

Third, the response to output from 2002 onwards is more ambiguous than over the previous period, with the long-term output coefficient generally above unity when including only domestic variables.
(except f, wherein it is 0.7). This weight on output is larger than in mature economies but largely in line with the estimates for emerging economies in general (Hofmann and Bogdanova, 2012) and India in particular (Singh, 2010, and Patra and Kapur, 2012). It may reflect both a high preference for output and the structure of the economic transmission mechanism (see Hayo and Hofmann, 2006).

### 2.4.2. China’s policy rule in international perspective

As we saw in Table 7 for China, the period of 1993-2001 is characterized by a dominant overall response to output and a weak response to inflation. During the subsequent period of 2002-13, the PBC appears to turn more anti-inflationary, with inflation (both backward- and forward-looking) playing a bigger role in its conduct of monetary policy (close to 2).

It is instructive to compare the Chinese experience with that of other major central banks across different periods. Indeed, a large number of important researches have analyzed the effects of financial liberalization or changes in central bank governor on the conduct of monetary policy. Table 8 summarizes the comparable results for G3 central banks. They include the results by Monokroussos (2011) for the US Fed during the pre- and post-Volcker periods, the results by Clarida, Gali and Gertler (1998) for the Fed during the periods of before and after October 1982 (the start of new operating procedure), the Bundesbank (after the founding of the EMS in March 1979) and the Bank of Japan (after April 1979, a period of significant financial market deregulation).
Table 8: Long-term coefficients in G3 reaction functions

<table>
<thead>
<tr>
<th>Reaction Function</th>
<th>Inflation</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>US Fed reaction function</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Volcker period (1969–August 1979)</td>
<td>0.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Volcker-Greenspan period (August 1979–mid-1998)</td>
<td>1.9</td>
<td>0.5</td>
</tr>
<tr>
<td>Volcker-Greenspan period (October 1982–December)</td>
<td>1.8</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Other G3 reaction functions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bundesbank (April 1979–December 1993)</td>
<td>1.3</td>
<td>0.25</td>
</tr>
<tr>
<td>Bank of Japan (April 1979–December 1994)</td>
<td>2.0</td>
<td>0.1</td>
</tr>
</tbody>
</table>

1 Expected inflation as independent variable. 2 Output gap as independent variable. 3 MCMC estimation by Monokroussos (2011). 4 GMM estimation by Clarida, Gali and Gertler (1998).

Sources: Clarida, Gali and Gertler (1998) and Monokroussos (2011).

As Clarida, Gali and Gertler (1998) show, all the G3 central banks started targeting inflation in an implicit way from the late 1970s onward, after a decade of high inflation. The subsequent Great Moderation was interpreted then as a sign of “the broad success of monetary policy in these countries over this time period” (Clarida, Gali and Gertler, 1998).

Despite major differences in the economic context between the late 1970s and early 2000s, a comparison of the Chinese and G3 reaction functions shows some interesting similarity. Firstly, the pre-2002 period in China is quite similar to the pre-1979 period in the G3 countries (as represented here by the United States), with a relatively weak overall response to inflation, of around 0.5. Thus monetary policies during these initial periods accommodated inflation, typically raising the nominal interest rate by less than the increase in inflation, thus resulting in a lower real interest rate.

Secondly, the estimated responses to inflation by the G3 central banks during the post-1979 period, and by the PBC during the post-2002 period, also contrast starkly with the earlier episodes. Indeed, for both China and the G3, the long-term inflation coefficients for these subsequent periods appear substantially higher relative to those of the initial periods. In fact, these subsequent weights on inflation are close to 2.0 in both the G3 and China, meaning that central banks became much

---

30 Interestingly, the estimation results for the post-1997 reaction function of the Bank of England similarly grant a large long-run coefficient for inflation (1.8, as reported by Adam et al, 2005).
more anti-inflationary in the latter episodes. These comparative findings strengthen the argument that the PBC may have, over time, aimed at adopting a “state of the art” monetary policy rule, with the long-term coefficients in its reaction function converging towards international benchmark values typical of major central banks. Moreover, we find that central bank motives to change its policy towards a more anti-inflationary one after 2002 are similar to those in G3 central banks, meaning both a change in central bank Governor behavior and a new step towards financial liberalization.

2.4.3. China sensitivity to foreign monetary policies

It may be questionable that the PBC only includes domestic variables in monetary policy decisions, particularly since 2002 as China has rapidly opened its door. More specifically, given the Chinese currency’s managed peg to the US dollar, and in spite of still binding Chinese capital control, the influence of US monetary conditions on China’s monetary policy decisions remains an open issue (Ma and McCauley, 2008 and 2011). All the more so since China’s WTO accession late 2001, to the extent that high trade openness is known to enable agents to sidestep capital controls leading to de facto financial opening (Aizenman, 2004; Ma and McCauley, 2014). To shed light on this question empirically, Figure 26 illustrates the 36-month rolling correlations of our China Monetary Policy Index (MPI) with the US shadow interest rate, our proxy of “advanced economies” and of “world” shadow rate.
First, the relationship between China and US or "advanced economies" shadow interest rates appear unstable and relatively limited during the 1990s. However, the correlation between China's and foreign monetary policy rates (particularly with the US and advanced economies shadow rates) strongly increased from the new millennium and stayed at relatively high levels from 2003 to 2009. Then, the correlations sharply declined in the aftermath of the financial crisis before increasing again after 2010 between the China MPI and the "world" policy rate while it declined a second time between the China MPI and the US and advanced ones, explained by the Quantitative Easing implementation. Finally, except over the end of sample period, it is difficult to explicitly distinguish between specific actions of the United States and common global shocks (measured through either the "world" or "advanced economies" shadow policy rates) as correlations of the latter two with our China MPI evolve very similarly, potentially revealing a global sensitivity to US monetary policy.

Therefore, this analysis provides evidence of the likely sensitivity of China's monetary policy to US or global monetary policy and suggests the need of taking such aspects into account in the estimation of the hybrid monetary policy in rule in the case of China, specifically over the post-2002 period. This is consistent with Aizenmann, Chinn and Ito (2015) who pointed out that an economy that pursues greater financial openness and exchange rate stability would face a stronger link with the center economies through policy interest rates.
Table 9 explores the relevance of an open-economy Taylor rule formulation whereby the Chinese monetary policy responds also to international variables such as the shadow US Fed Funds rate and the world shadow interest rate.

### Table 9: Implied long-term coefficients of the reaction function - Open economy

<table>
<thead>
<tr>
<th>PBC monetary policy</th>
<th>Inflation (1)</th>
<th>Expected inflation (2)</th>
<th>Total Inflation (1)+(2)</th>
<th>Output (3)</th>
<th>Shadow interest rate (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estim.(B)</td>
<td>Cons.(C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Zhou period (1993-2001)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Backward-looking rule</td>
<td>0.1</td>
<td>...</td>
<td>...</td>
<td>0.1</td>
<td>1.3</td>
</tr>
<tr>
<td>(b) Hybrid rule B</td>
<td>-0.2</td>
<td>...</td>
<td>0.6*</td>
<td>0.4</td>
<td>0.9</td>
</tr>
<tr>
<td>(c) Hybrid rule C</td>
<td>-0.1</td>
<td>...</td>
<td>0.8</td>
<td>0.7</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Zhou Governorship (2002-May 2013)

<p>| | | | | | |</p>
<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(d) Backward-looking rule</td>
<td>1.8</td>
<td>...</td>
<td>...</td>
<td>1.8</td>
<td>0.8</td>
</tr>
<tr>
<td>(e) Hybrid rule A</td>
<td>1.1</td>
<td>0.9</td>
<td>...</td>
<td>2.0</td>
<td>0.5*</td>
</tr>
<tr>
<td>(f) Hybrid rule B</td>
<td>0.5*</td>
<td>...</td>
<td>1.3</td>
<td>1.8</td>
<td>-0.3</td>
</tr>
<tr>
<td>(g) Hybrid rule C</td>
<td>1.1</td>
<td>...</td>
<td>1.3</td>
<td>2.4</td>
<td>0.8</td>
</tr>
</tbody>
</table>

With World shadow interest rate

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(h) Hybrid rule A</td>
<td>0.9</td>
<td>0.6</td>
<td>...</td>
<td>1.5</td>
<td>0.6</td>
</tr>
<tr>
<td>(i) Hybrid rule B</td>
<td>0.4*</td>
<td>...</td>
<td>1.4</td>
<td>1.8</td>
<td>0.0</td>
</tr>
<tr>
<td>(j) Hybrid rule C</td>
<td>1.0*</td>
<td>...</td>
<td>1.4</td>
<td>2.4</td>
<td>1.1</td>
</tr>
</tbody>
</table>

(1) equals $\beta_2/(1 - \beta_1)$, (2) for $\beta_4/(1 - \beta_1)$, (3) $\beta_3/(1 - \beta_1)$ and (4) $\beta_5/(1 - \beta_1)$ in equation (1). Significant coefficients are in bold. * means significant at 10%.

Estimation with the expected inflation indicator from Consensus Forecast starts in 1995.

The hybrid rule A, B, C respectively use three different expected inflation indicators: the PBC depositor survey on expected future prices, our estimation based on business survey indicators and the Consensus Forecast one.

Source: Authors’ computation.

Results over the 2002-2013 period reveal that the long-term output coefficient becomes weakly significant and close to 0.5-0.8 in (d), (e), (g) and (h) (and exceptionally higher at 1.1 in (j)) while not
significant in (f) and (i). Moreover, the decline in the output coefficient over the second period (compared to the closed economy cases) is accompanied by significant coefficients of the shadow interest rates, close to unity when using the US shadow Fed Funds rate, and between 1.2-1.5 with the world shadow interest rate. This means that the external factors, as represented by the US or world shadow interest rates, appear to have played a more significant role post-2002 in Chinese monetary policy decisions, consistent with increasing trade (and thus financial) openness and changing monetary policy management in China. The management of currency appreciation and capital inflows (through foreign exchange intervention), when navigating the trilemma, can in part explain the influence of the US policy rate in the monetary policy function reaction. As Table 9 shows, the coefficients on the US or world shadow rates are estimated to be positive in all cases, against a backdrop of currency appreciation expectations, a crawling dollar peg (July 2005-July 2008) and large external surpluses before the Fed funds rate hit the zero lower bound in 2008. One possible explanation is that the China-US rate differential was an important factor influencing carry-trade hot money flows during 2002-2013. In response, the PBC tended to avoid moving against the US Fed funds rate, hence the positive coefficient on the latter variable. By contrast, currency expectations were more volatile in the period of 1993-2001, thus the smaller estimated coefficient for this episode.

Finally, Figures 27 illustrate the changing PBC behaviour by plotting the fitted MPI from estimating the closed- (graphs on the left) and open-economy (graphs on the right) hybrid reaction function with our proxy of inflation expectations over the pre- and post-2002 periods. First, this highlights the good accuracy of our estimation plotted over the two sample periods, over 1993-2001 and over 2002-2013. Second, it clearly emphasizes the change in PBC behaviour particularly during tightening monetary policy periods. Indeed, the post-2002 behaviour would suggest a more anti-inflationary policy than observed mid-1995 when inflation exceeded 20%. Similarly, the pre-2002 policy style would have resulted in a more gradual increase of interest rates during the commodity price boom (around 2003-2008). Thus, our empirical evidence lends support to the argument that the PBC has moved from an inflation-accommodating policy before 2002 to an anti-inflationary policy thereafter. In other words, the monetary policy of the PBC looks more like that of an informal inflation targeter starting around 2002.

\[\text{31 \ The initial point for fitted MPI (because of a lagged MPI coefficient) is the value observed on MPI at the first date of the sample period (i.e. January 1993 and January 2002).}\]
Figure 27: Fitted MPI over 1993-2001 and 2002-2013

Over the period 1993-2001

- Backward model - Closed economy
- Hybrid model - Open economy

Over the period 2002-2013

- Backward model - Closed economy
- Hybrid model - Open economy

The initial point for fitted MPI (because of a lagged MPI coefficient) is the value observed on MPI at the first date of the sample period (i.e. January 1993 and January 2002).

Source: Authors' calculation

Finally, Table 10 evaluates the predictive accuracy of the different specifications of the monetary policy rules to determine whether open-economy hybrid rules are more informative and outperform those estimated with a closed-economy specification. To do it, we calculate the Mean Absolute Error (MAE) for each rule. Overall, we find that the backward and hybrid models are equivalent in minimizing the errors over the 1993-2001 period. Then, while forward-looking aspects are not significant in the pre-2002 estimation, the backward model appears as the appropriate specification in the pre-2002 period. Then, the hybrid specifications considering external factors and forward-looking aspects clearly outperform the backward model over the post-2002 period by minimizing the mean absolute errors, confirming the changing monetary policy behavior after 2002 by taking into account...
account forward-looking aspects and also the US monetary policy. More precisely, the PBC survey and our estimated inflation expectations proxy in China seem to outperform the inflation expectation indicator provided by the Consensus.

Table 10: Mean Absolute Error (MAE) of estimated rules

<table>
<thead>
<tr>
<th></th>
<th>1993-2001</th>
<th>2002-2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-2002 estimation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closed economy – Backward model</td>
<td>0.59</td>
<td>1.96</td>
</tr>
<tr>
<td>Open economy – Hybrid B (Estim.)</td>
<td><strong>0.64</strong></td>
<td>1.83</td>
</tr>
<tr>
<td>Open economy – Hybrid C (Consensus)</td>
<td><strong>0.51</strong></td>
<td>2.21</td>
</tr>
<tr>
<td><strong>Post-2002 estimation (with US shadow rate)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closed economy – Backward model</td>
<td>3.91</td>
<td>0.90</td>
</tr>
<tr>
<td>Open economy – Hybrid A (PBC)</td>
<td>2.39</td>
<td><strong>0.61</strong></td>
</tr>
<tr>
<td>Open economy – Hybrid B (Estim.)</td>
<td>6.42</td>
<td><strong>0.57</strong></td>
</tr>
<tr>
<td>Open economy – Hybrid C (Consensus)</td>
<td>8.17</td>
<td>0.79</td>
</tr>
<tr>
<td><strong>Post-2002 estimation (with World shadow rate)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open economy – Hybrid A (PBC)</td>
<td>n.a.</td>
<td><strong>0.59</strong></td>
</tr>
<tr>
<td>Open economy – Hybrid B (Estim.)</td>
<td>n.a.</td>
<td>0.71</td>
</tr>
<tr>
<td>Open economy – Hybrid C (Consensus)</td>
<td>n.a.</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Source: Authors’ computation

2.5. Robustness tests

As our final step, Table 11 and 12 test the hybrid monetary policy rule in open-economy with alternative endogenous variables. The first table analyzes the rule if individual monetary policy instruments, the lending rates and the RRR, are used as a proxy of the monetary policy stance in China. We find that the results of the estimated monetary policy rule change significantly and are not satisfying with the coefficients found to be far from standard Taylor rule principle. Indeed, using the lending rates, coefficients on inflation, output and the US shadow interest rate appear extremely low. Conversely, RRR change appears to overreact to inflation and economic growth with coefficients abnormally highs.
Table 11: Implied long-term coefficients based on individual instruments

<table>
<thead>
<tr>
<th>Over the period 2002-May 2013</th>
<th>Inflation (1)</th>
<th>PBC expected inflation (2a)</th>
<th>Total inflation (1) + (2a)</th>
<th>Output</th>
<th>US Shadow Fed Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark MPI</td>
<td>1.1</td>
<td>0.9</td>
<td>2.0</td>
<td>0.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Lending rates</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>RRR</td>
<td>1.2</td>
<td>5.8</td>
<td>7.0</td>
<td>1.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Source: Authors’ computation.

Table 12 shows the long-term coefficients of the hybrid reaction function with alternative monetary policy indicators, which can be compared with the estimation results using the benchmark MPI presented in Table 9. Such a test of alternative scenarios with respect to MPI measures is surprisingly absent from existing literature. The necessity of this step is due to the challenging task of combining the multiple instruments used by the PBC. Details of constructing these alternative MPIs are discussed in the Appendix 2.A, which particularly highlights the benchmark MPI as the central scenario, representing approximately the average of the alternative MPIs. Moreover, differences between MPIs are ultimately noticeable from mid-2000s onwards, particularly during monetary policy tightening periods, in 2007/2008 and end-2010/2011, when the PBC faced an unfavourable combination of upward inflation pressures and economic slowdown.

As shown in Table 12, the estimated output and inflation coefficients obtained with the alternative MPIs are quite similar to our benchmark estimates. Overall, our benchmark MPI provides coefficients in the middle of those estimated with alternative MPIs. Interestingly, the estimated expected-inflation coefficients are the main drivers of differences among results with a substantially larger coefficient using MPI-A (1.7), but a lower one using MPI-C (0.3) than the one obtained with the benchmark MPI (equal to 0.9) over the period 2002-May 2013. As mentioned in the Appendix 2.A, the alternative MPIs differ mostly during periods with upward-inflation pressures in 2007/2008 and end-2010/2011, with MPI-A implying a tighter monetary policy than alternative MPIs, while MPI-C reveals a more prudent monetary policy. So, it is not surprising to find a different impact of the expected-inflation coefficient when using these alternative MPIs.

A few interesting observations are worth highlighting. First, the long-term inflation coefficient is almost identical across these MPI measures, in the range 0.9-1.6 over the 2002-May 2013 period. Second, the long-term coefficients on inflation and Fed Funds rate appear rather implausibly large.
Chapter 2 – Understanding the monetary policy rule in China: what is the role of inflation?

for MPI-A (3.3 for inflation as compared to 2.0 based on the benchmark MPI and 1.5 for shadow Fed funds compared to coefficients close to 1.0 with other MPIs).

<table>
<thead>
<tr>
<th>Over the period</th>
<th>Inflation (1)</th>
<th>PBC expected inflation (2a)</th>
<th>Total inflation (1) + (2a)</th>
<th>Output</th>
<th>US Shadow Fed Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002-May 2013</td>
<td>1.1</td>
<td>0.9</td>
<td>2.0</td>
<td>0.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Benchmark MPI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPI-A</td>
<td>1.6</td>
<td>1.7</td>
<td>3.3</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>MPI-B</td>
<td>1.3</td>
<td>1.0</td>
<td>2.3</td>
<td>0.6</td>
<td>1.0</td>
</tr>
<tr>
<td>MPI-C</td>
<td>0.9</td>
<td>0.3</td>
<td>1.2</td>
<td>0.3</td>
<td>1.0</td>
</tr>
<tr>
<td>MPI-D</td>
<td>1.1</td>
<td>0.7</td>
<td>1.8</td>
<td>0.5</td>
<td>1.3</td>
</tr>
</tbody>
</table>

See the Appendix for the construction of alternative MPIs
Source: Authors’ computation.

2.6. Conclusion

This paper aimed at enhancing our understanding of China’s evolving monetary policy during 1993-2013, specifically attempting to test the shadow inflation-targeting hypothesis (through lagged or expected future inflation).

The challenges met when trying to assess the changes in the monetary policy stance in China and to relate them to macroeconomic developments are multi-faceted. Using our new composite monetary policy index (MPI) combining many price, quantity and administrative tools, we have used a Bayesian method proposed by Dueker (1999) and refined by Monokroussos (2011) to estimate a dynamic hybrid (both backward- and forward-looking) discrete-choice model. The model is estimated over two sub-samples, before and after 2002 to take into account the major change in the conduct of monetary policy over this period.

Our approach allows us to identify a major change in the determinants of monetary policy. Indeed, following the inauguration of the Governorship of Zhou Xiaochuan in 2002, the PBC appears to
attach a greater weight on inflation, lending support to the argument, mentioned by He and Pauwels (2008), that its policy is similar to informal inflation targeting. This is also consistent with Zheng et al. (2012) mentioning that the PBC paid increasing attention to inflation.

Moreover, our paper highlights that the PBC seems to have gradually aimed at following a “standard” monetary policy rule, with coefficients of inflation converging towards those of China’s peers. Indeed, after 2002, the long-term coefficient on inflation in the PBC reaction function rises and converges towards the similar levels of the G3 central banks prevailing in the post-1979 period. Moreover, external factors, such as the US Fed funds rate, appear to play a significant role in Chinese monetary policy decisions since 2002, in line with the economic transformation of China. Indeed, the last decade in China is associated with increasing trade (and thus financial) openness associated with WTO entry late 2001. Moreover, the evolving Chinese exchange rate regime may have influenced the conduct of monetary policy and the attempt to avoid large currency appreciation and massive capital inflows may explain the influence of the US Fed funds in the conduct of monetary policy in China.

Going forward, our research can be extended into a number of directions. First, some of the liquidity-management tools could be assessed relative to the scale of foreign exchange interventions so as to better differentiate between a change of monetary policy and a simple sterilisation operation. Second, we may wish to explore the potential role of the renminbi exchange rate as a direct component of China’s monetary policy.
Appendix 2.A: Construction of inflation expectation indicators based on business survey data and the Consensus Forecast

Long time series of inflation expectation surveys do not exist in the case of China. The PBC has only compiled a quarterly index of future price expectations since 2001. Therefore, based on the work of Kaaresvitra and Mehrotra (2008), we suggest estimating an index of future price pressures based on published surveys on industrial firms’ assessment of the economies situation collected by the central bank. Our methodology consists in estimating CPI inflation with 16 different survey indicators related to price level sales, general business condition, energy supply, raw material supply, production capacity utilization, product sales, inventory level, domestic and overseas orders levels, fund turnover, cash inflow for sales, profitability, lending attitude of banks, fixed asset investment and equipment investment. Then, we filter indicators with a stepwise method (based on information criteria). As shown in Table 13, the method retains five relevant indicators.

<table>
<thead>
<tr>
<th>Table 13: Estimation of future inflation over 1993(1)-2013(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>Interception</td>
</tr>
<tr>
<td>Lag(PriceLevelSales,-1)</td>
</tr>
<tr>
<td>Lag(EnergySupply,-1)</td>
</tr>
<tr>
<td>Lag(DomesticOrder,-1)</td>
</tr>
<tr>
<td>Lag(OverseasOrder,-1)</td>
</tr>
<tr>
<td>Lag(FundTurnover,-1)</td>
</tr>
</tbody>
</table>

$R^2=85.3; \text{RMSE}=2.5; \text{MAE}=1.7$

$SCtest=0.95, p-value=0.33$

Source: authors’ computation
This estimated expected inflation indicator is compared with the ones published by the PBC and Consensus Forecast\(^3\) (Graph A.1). Graphically, our estimation and the PBC indicators appear to lead observed inflation (with a few months) while the Consensus Forecast indicator appears to lag behind it. Then, Table 14 compares the predictive accuracy of our estimated inflation expectation indicator with the one published by the PBC (with one lag) to forecast inflation. The Mean Absolute Error (MAE) criterion indicates that our estimated indicator outperforms the indicators published by the PBC and Consensus Forecast over the in-sample while the Consensus Forecast outperform appears to outperforms over the out of sample. Then, the Diebold-Mariano tests reject the alternative hypothesis that the PBC and Consensus Forecast indicators forecast better inflation than our estimated indicator. Finally, Table 15 evaluates the relationship between our estimated inflation expectation indicator and the one published by the PBC over the sample from 2001 to 2013 (the

\[ n_{m,t}^{FH} = \left[ \frac{13-m}{12} \right] n_{m,t}^{FE} + \left[ \frac{m-1}{12} \right] n_{m,t+1}^{FE} \]
common sample for both indicators). We find that our estimated indicator on expected inflation captures quite well the evolution of the one published by the PBC.

Table 14: Predictive accuracy to forecast inflation

<table>
<thead>
<tr>
<th>MAE</th>
<th>In-sample(*)</th>
<th>Out sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated indicator (1)</td>
<td>1.06</td>
<td>1.84</td>
</tr>
<tr>
<td>PBC indicator (2)</td>
<td>1.23</td>
<td>1.68</td>
</tr>
<tr>
<td>Consensus Forecast (3)</td>
<td>1.68</td>
<td>1.23</td>
</tr>
</tbody>
</table>

Diebold-Mariano test (p-value):

| (1) vs. (2) | 0.98 | 0.10 |
| (1) vs. (3) | 0.99 | 0.21 |


Source: Authors’ computation

Table 15: Estimation of PBC inflation expectation over 2001(1)-2012(4)

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>T-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.78</td>
<td>0.34</td>
<td>0.02</td>
</tr>
<tr>
<td>Lag(expinfl,0)</td>
<td>0.49</td>
<td>0.08</td>
<td>0.00</td>
</tr>
<tr>
<td>Lag(expinfl,2)</td>
<td>0.35</td>
<td>0.08</td>
<td>0.00</td>
</tr>
</tbody>
</table>

\[ R^2=0.65; \text{ RMSE}=1.7 \]

expinfl represents our estimated inflation expectation indicator

Source: Authors’ computation.

Appendix 2.B: Detailed results based on the benchmark MPI

Table 16, 17 and 18 presents short-term estimated coefficients based on the benchmark MPI, respectively for the periods 1993-2001 and 2002-May 2013. The variable “variance” refers to the variance of the error of equation. When explanatory variables are significant they appear in bold characters. The last two columns are the 5% and 10% quantiles of the posterior distribution.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std.dev</th>
<th>Median</th>
<th>5%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Backward-looking rule – 1993-2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.108</td>
<td>0.017</td>
<td>0.106</td>
<td>0.081</td>
<td>0.087</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.514</td>
<td>0.161</td>
<td>-0.522</td>
<td>-0.798</td>
<td>-0.722</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.962</td>
<td>0.012</td>
<td>0.962</td>
<td>0.942</td>
<td>0.947</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>0.003</td>
<td>0.009</td>
<td>0.003</td>
<td>-0.011</td>
<td>-0.008</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>0.049</td>
<td>0.014</td>
<td>0.049</td>
<td>0.026</td>
<td>0.032</td>
</tr>
<tr>
<td>(b) Hybrid rule 2 – 1993-2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.106</td>
<td>0.017</td>
<td>0.104</td>
<td>0.082</td>
<td>0.086</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.368</td>
<td>0.184</td>
<td>-0.367</td>
<td>-0.675</td>
<td>-0.598</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.963</td>
<td>0.012</td>
<td>0.962</td>
<td>0.943</td>
<td>0.948</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>-0.009</td>
<td>0.011</td>
<td>-0.008</td>
<td>-0.027</td>
<td>-0.024</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>0.033</td>
<td>0.017</td>
<td>0.033</td>
<td>0.009</td>
<td>0.013</td>
</tr>
<tr>
<td>Estimated expected inflation (2b)</td>
<td>0.024</td>
<td>0.016</td>
<td>0.025</td>
<td>-0.002</td>
<td>0.003</td>
</tr>
<tr>
<td>(c) Hybrid rule 3 – 1995-2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.105</td>
<td>0.019</td>
<td>0.103</td>
<td>0.077</td>
<td>0.082</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.198</td>
<td>0.358</td>
<td>-0.189</td>
<td>-0.796</td>
<td>-0.685</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.930</td>
<td>0.026</td>
<td>0.931</td>
<td>0.887</td>
<td>0.896</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>-0.004</td>
<td>0.022</td>
<td>-0.003</td>
<td>-0.041</td>
<td>-0.034</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>0.019</td>
<td>0.036</td>
<td>0.018</td>
<td>-0.040</td>
<td>-0.025</td>
</tr>
<tr>
<td>Consensus expected inflation (2c)</td>
<td>0.051</td>
<td>0.044</td>
<td>0.049</td>
<td>-0.024</td>
<td>-0.005</td>
</tr>
<tr>
<td>(d) Backward-looking rule – 2002-2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.075</td>
<td>0.012</td>
<td>0.074</td>
<td>0.058</td>
<td>0.061</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.615</td>
<td>0.146</td>
<td>-0.612</td>
<td>-0.862</td>
<td>-0.803</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.977</td>
<td>0.012</td>
<td>0.977</td>
<td>0.957</td>
<td>0.962</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>0.047</td>
<td>0.013</td>
<td>0.047</td>
<td>0.025</td>
<td>0.031</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>0.040</td>
<td>0.010</td>
<td>0.040</td>
<td>0.026</td>
<td>0.028</td>
</tr>
<tr>
<td>(e) Hybrid rule 1 - 2002-2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.071</td>
<td>0.011</td>
<td>0.071</td>
<td>0.054</td>
<td>0.058</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.564</td>
<td>0.144</td>
<td>-0.562</td>
<td>-0.808</td>
<td>-0.754</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.973</td>
<td>0.012</td>
<td>0.973</td>
<td>0.954</td>
<td>0.958</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>0.030</td>
<td>0.014</td>
<td>0.030</td>
<td>0.007</td>
<td>0.012</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>0.035</td>
<td>0.010</td>
<td>0.035</td>
<td>0.019</td>
<td>0.023</td>
</tr>
<tr>
<td>Lag(t-1) PBC expected inflation</td>
<td>0.028</td>
<td>0.011</td>
<td>0.028</td>
<td>0.010</td>
<td>0.013</td>
</tr>
<tr>
<td>(f) Hybrid rule 2 – 2002-2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.064</td>
<td>0.010</td>
<td>0.063</td>
<td>0.050</td>
<td>0.052</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.342</td>
<td>0.158</td>
<td>-0.340</td>
<td>-0.614</td>
<td>-0.546</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.971</td>
<td>0.012</td>
<td>0.971</td>
<td>0.952</td>
<td>0.957</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>0.014</td>
<td>0.014</td>
<td>0.015</td>
<td>-0.010</td>
<td>-0.004</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>0.021</td>
<td>0.011</td>
<td>0.021</td>
<td>0.004</td>
<td>0.008</td>
</tr>
<tr>
<td>Estimated expected inflation (2b)</td>
<td>0.045</td>
<td>0.011</td>
<td>0.045</td>
<td>0.027</td>
<td>0.030</td>
</tr>
<tr>
<td>(g) Hybrid rule 3 – 2002-2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.075</td>
<td>0.011</td>
<td>0.075</td>
<td>0.059</td>
<td>0.062</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.655</td>
<td>0.166</td>
<td>-0.654</td>
<td>-0.931</td>
<td>-0.864</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.976</td>
<td>0.012</td>
<td>0.976</td>
<td>0.955</td>
<td>0.960</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>0.034</td>
<td>0.025</td>
<td>0.033</td>
<td>-0.006</td>
<td>0.002</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>0.041</td>
<td>0.010</td>
<td>0.042</td>
<td>0.024</td>
<td>0.029</td>
</tr>
<tr>
<td>Consensus expected inflation (2c)</td>
<td>0.023</td>
<td>0.041</td>
<td>0.022</td>
<td>-0.044</td>
<td>-0.003</td>
</tr>
</tbody>
</table>

Source: Authors’ computation
Chapter 2 – Understanding the monetary policy rule in China: what is the role of inflation?

### Table 17: Short-term coefficient based on benchmark MPI – Open economy – 1993-2001

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std.dev</th>
<th>Median</th>
<th>5%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Backward-looking rule – 1993-2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.108</td>
<td>0.017</td>
<td>0.106</td>
<td>0.084</td>
<td>0.087</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.626</td>
<td>0.242</td>
<td>-0.627</td>
<td>-1.027</td>
<td>-0.923</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.959</td>
<td>0.013</td>
<td>0.959</td>
<td>0.938</td>
<td>0.943</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>0.004</td>
<td>0.009</td>
<td>0.005</td>
<td>-0.010</td>
<td>-0.007</td>
</tr>
<tr>
<td><strong>Lag(t-1) Output</strong></td>
<td>0.053</td>
<td>0.015</td>
<td>0.053</td>
<td>0.029</td>
<td>0.035</td>
</tr>
<tr>
<td>Lag(t-1) Fed Funds</td>
<td>0.015</td>
<td>0.022</td>
<td>0.014</td>
<td>-0.019</td>
<td>-0.013</td>
</tr>
<tr>
<td>(b) Hybrid rule 2 – 1993-2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.107</td>
<td>0.018</td>
<td>0.105</td>
<td>0.082</td>
<td>0.086</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.531</td>
<td>0.255</td>
<td>-0.519</td>
<td>-0.955</td>
<td>-0.864</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.959</td>
<td>0.013</td>
<td>0.959</td>
<td>0.938</td>
<td>0.942</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>-0.007</td>
<td>0.012</td>
<td>-0.007</td>
<td>-0.026</td>
<td>-0.021</td>
</tr>
<tr>
<td><strong>Lag(t-1) Output</strong></td>
<td>0.039</td>
<td>0.018</td>
<td>0.039</td>
<td>0.010</td>
<td>0.016</td>
</tr>
<tr>
<td>Estimated expected inflation (2b)</td>
<td>0.025</td>
<td>0.017</td>
<td>0.025</td>
<td>-0.002</td>
<td>0.004</td>
</tr>
<tr>
<td>Lag(t-1) Fed Funds</td>
<td>0.022</td>
<td>0.023</td>
<td>0.022</td>
<td>-0.014</td>
<td>-0.007</td>
</tr>
<tr>
<td>(c) Hybrid rule 3 – 1995-2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.106</td>
<td>0.021</td>
<td>0.103</td>
<td>0.077</td>
<td>0.082</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.267</td>
<td>0.395</td>
<td>-0.263</td>
<td>-0.960</td>
<td>-0.805</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.929</td>
<td>0.028</td>
<td>0.929</td>
<td>0.882</td>
<td>0.893</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>-0.005</td>
<td>0.023</td>
<td>-0.005</td>
<td>-0.042</td>
<td>-0.034</td>
</tr>
<tr>
<td><strong>Lag(t-1) Output</strong></td>
<td>0.012</td>
<td>0.039</td>
<td>0.014</td>
<td>-0.056</td>
<td>-0.041</td>
</tr>
<tr>
<td>Consensus expected inflation (2c)</td>
<td>0.055</td>
<td>0.048</td>
<td>0.054</td>
<td>-0.023</td>
<td>-0.006</td>
</tr>
<tr>
<td>Lag(t-1) Fed Funds</td>
<td>0.027</td>
<td>0.059</td>
<td>0.026</td>
<td>-0.066</td>
<td>-0.046</td>
</tr>
</tbody>
</table>

Source: Authors’ computation.

### Table 18: Short-term coefficient based on benchmark MPI – Open economy – 2002-2013

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std.dev</th>
<th>Median</th>
<th>5%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>(d) Backward-looking rule– 2002-2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.073</td>
<td>0.011</td>
<td>0.072</td>
<td>0.057</td>
<td>0.059</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.429</td>
<td>0.181</td>
<td>-0.428</td>
<td>-0.744</td>
<td>-0.657</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.970</td>
<td>0.013</td>
<td>0.970</td>
<td>0.948</td>
<td>0.953</td>
</tr>
<tr>
<td><strong>Lag(t-1) Inflation</strong></td>
<td>0.055</td>
<td>0.014</td>
<td>0.055</td>
<td>0.033</td>
<td>0.037</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>0.025</td>
<td>0.013</td>
<td>0.025</td>
<td>0.006</td>
<td>0.009</td>
</tr>
<tr>
<td>Lag(t-1) Shadow Fed Funds</td>
<td>0.027</td>
<td>0.014</td>
<td>0.027</td>
<td>0.003</td>
<td>0.009</td>
</tr>
<tr>
<td>(e) Hybrid rule 1– 2002-2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.069</td>
<td>0.011</td>
<td>0.068</td>
<td>0.054</td>
<td>0.056</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.353</td>
<td>0.174</td>
<td>-0.350</td>
<td>-0.641</td>
<td>-0.580</td>
</tr>
<tr>
<td>Lag MPI</td>
<td>0.966</td>
<td>0.013</td>
<td>0.966</td>
<td>0.944</td>
<td>0.949</td>
</tr>
<tr>
<td><strong>Lag(t-1) Inflation</strong></td>
<td>0.037</td>
<td>0.015</td>
<td>0.037</td>
<td>0.013</td>
<td>0.019</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>0.017</td>
<td>0.013</td>
<td>0.016</td>
<td>-0.003</td>
<td>0.002</td>
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<tr>
<td>Lag(t-1)PBC expected inflation (2a)</td>
<td>0.030</td>
<td>0.012</td>
<td>0.030</td>
<td>0.012</td>
<td>0.015</td>
</tr>
<tr>
<td>Lag(t-1) Shadow Fed Funds</td>
<td>0.031</td>
<td>0.014</td>
<td>0.031</td>
<td>0.008</td>
<td>0.014</td>
</tr>
<tr>
<td>Variable</td>
<td>Mean</td>
<td>Std.dev</td>
<td>Median</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>-------</td>
<td>---------</td>
<td>--------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td><strong>(f) Hybrid rule 2– 2002-2013</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.058</td>
<td>0.009</td>
<td>0.058</td>
<td>0.044</td>
<td>0.047</td>
</tr>
<tr>
<td>Variance</td>
<td>0.041</td>
<td>0.190</td>
<td>0.047</td>
<td>-0.280</td>
<td>-0.216</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.958</td>
<td>0.012</td>
<td>0.958</td>
<td>0.938</td>
<td>0.942</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>0.020</td>
<td>0.015</td>
<td>0.020</td>
<td>-0.005</td>
<td>0.001</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>-0.011</td>
<td>0.014</td>
<td>-0.011</td>
<td>-0.033</td>
<td>-0.029</td>
</tr>
<tr>
<td>Estimated expected inflation (2b)</td>
<td>0.057</td>
<td>0.011</td>
<td>0.056</td>
<td>0.039</td>
<td>0.043</td>
</tr>
<tr>
<td>Lag(t-1) Shadow Fed Funds</td>
<td>0.046</td>
<td>0.013</td>
<td>0.047</td>
<td>0.025</td>
<td>0.030</td>
</tr>
<tr>
<td><strong>(g) Hybrid rule 3– 2002-2013</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.074</td>
<td>0.012</td>
<td>0.072</td>
<td>0.057</td>
<td>0.060</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.496</td>
<td>0.194</td>
<td>-0.496</td>
<td>-0.814</td>
<td>-0.745</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.969</td>
<td>0.013</td>
<td>0.969</td>
<td>0.946</td>
<td>0.952</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>0.034</td>
<td>0.024</td>
<td>0.033</td>
<td>-0.007</td>
<td>0.002</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>0.026</td>
<td>0.013</td>
<td>0.026</td>
<td>0.004</td>
<td>0.009</td>
</tr>
<tr>
<td>Consensus expected inflation (2c)</td>
<td>0.041</td>
<td>0.040</td>
<td>0.041</td>
<td>-0.024</td>
<td>-0.011</td>
</tr>
<tr>
<td>Lag(t-1) Shadow Fed Funds</td>
<td>0.029</td>
<td>0.014</td>
<td>0.030</td>
<td>0.006</td>
<td>0.011</td>
</tr>
<tr>
<td><strong>(h) Hybrid rule 1– 2002-2013</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.069</td>
<td>0.011</td>
<td>0.068</td>
<td>0.054</td>
<td>0.057</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.505</td>
<td>0.149</td>
<td>-0.504</td>
<td>-0.749</td>
<td>-0.698</td>
</tr>
<tr>
<td>Lag MPI</td>
<td>0.966</td>
<td>0.013</td>
<td>0.946</td>
<td>0.945</td>
<td>0.949</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>0.031</td>
<td>0.014</td>
<td>0.031</td>
<td>0.007</td>
<td>0.013</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>0.019</td>
<td>0.013</td>
<td>0.019</td>
<td>0.000</td>
<td>0.004</td>
</tr>
<tr>
<td>Lag(t-1)PBC expected inflation (2a)</td>
<td>0.035</td>
<td>0.012</td>
<td>0.035</td>
<td>0.016</td>
<td>0.020</td>
</tr>
<tr>
<td>Lag(t-1) World policy rate</td>
<td>0.047</td>
<td>0.023</td>
<td>0.046</td>
<td>0.009</td>
<td>0.018</td>
</tr>
<tr>
<td><strong>(i) Hybrid rule 2– 2002-2013</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.061</td>
<td>0.010</td>
<td>0.060</td>
<td>0.046</td>
<td>0.049</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.225</td>
<td>0.163</td>
<td>-0.219</td>
<td>-0.500</td>
<td>-0.442</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.962</td>
<td>0.012</td>
<td>0.961</td>
<td>0.941</td>
<td>0.945</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>0.014</td>
<td>0.015</td>
<td>0.014</td>
<td>-0.011</td>
<td>-0.005</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>-0.001</td>
<td>0.013</td>
<td>-0.002</td>
<td>-0.023</td>
<td>-0.018</td>
</tr>
<tr>
<td>Estimated expected inflation (2b)</td>
<td>0.055</td>
<td>0.011</td>
<td>0.055</td>
<td>0.037</td>
<td>0.040</td>
</tr>
<tr>
<td>Lag(t-1) World policy rate</td>
<td>0.059</td>
<td>0.020</td>
<td>0.059</td>
<td>0.026</td>
<td>0.033</td>
</tr>
<tr>
<td><strong>(j) Hybrid rule 3– 2002-2013</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.074</td>
<td>0.011</td>
<td>0.074</td>
<td>0.058</td>
<td>0.061</td>
</tr>
<tr>
<td>Variance</td>
<td>-0.657</td>
<td>0.163</td>
<td>-0.657</td>
<td>-0.930</td>
<td>-0.867</td>
</tr>
<tr>
<td>Lag(t-1) MPI</td>
<td>0.971</td>
<td>0.013</td>
<td>0.972</td>
<td>0.949</td>
<td>0.955</td>
</tr>
<tr>
<td>Lag(t-1) Inflation</td>
<td>0.030</td>
<td>0.024</td>
<td>0.030</td>
<td>-0.009</td>
<td>0.000</td>
</tr>
<tr>
<td>Lag(t-1) Output</td>
<td>0.032</td>
<td>0.012</td>
<td>0.032</td>
<td>0.013</td>
<td>0.018</td>
</tr>
<tr>
<td>Consensus expected inflation (2c)</td>
<td>0.039</td>
<td>0.040</td>
<td>0.039</td>
<td>-0.025</td>
<td>-0.012</td>
</tr>
<tr>
<td>Lag(t-1) World policy rate</td>
<td>0.034</td>
<td>0.022</td>
<td>0.034</td>
<td>-0.002</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Source: Authors’ computation.
Part Two: Monetary policy transmission on the term structure of interest rates in China
Chapter 3
What moves the yield curve in China? Effects of PBC actions and macro news
China is undergoing fast transition in both its financial system and its overall policy framework and is making efforts toward putting in place a more market-based oriented system. With the third plenum of the 18th Party Congress in November 2013, Chinese authorities declared, among reform priorities, intentions “to accelerate the improvement of a Modern Market System by establishing a unified, open, competitive and orderly market system”. This achievement would require at least a fully developed banking sector and a liquid government bond market.

The creation of a modern banking system is essential for improving the efficiency of capital allocation as well as macroeconomic stability and capital account convertibility. This involves the continuation of interest rate liberalization to reflect the real cost of borrowing of banks. Indeed, while interbank interest rates and bond yields are market determined, bank deposit and lending rates remain partly\(^3\) regulated and have been progressively liberalized since 2003. Then, the bond market typically plays two important roles. First, it can provide information about the macroeconomic situation and help policy makers to gauge market expectations. Second, it would reflect liquidity conditions and represent a benchmark for the pricing of financial assets, playing thus an important role in the allocation of resources and risk diversification.

The development of the Chinese bond market took place over the last two decades, since the establishment of the interbank bond market in 1997. The bond market has particularly emerged very rapidly from the early 2000s becoming the third largest in the world in absolute terms, at about RMB 35.89bn at end-2014 (or about USD 4.24 trillion). This rapid development has been notably motivated by financing need issues with the aim to (1) reduce the economy’ over-reliance on the banking system for credit, mitigate financial risk and enhance market efficiency and (2) find the additional financing the central government needs to fund infrastructure construction and priority investment projects.

\(^3\) The PBC has been progressively liberalizing benchmark rates since June 2012, starting first with the relaxation of bank deposit rate caps (banks are allowed to offer deposit rates over benchmark deposit rates by no more than 10%. On July 2013, the PBC removed the restriction of 30% downward floating to benchmark lending rates, lifting the restrictions on lending rates.
However, despite its rapid growth, China’s bond market remains underdeveloped compared to the size of the economy, witnesses liquidity issue and a heavy reliance on commercial banks, by far the main market players. Thus, this research attempts to examine the evolving bond market development in China. More specifically, we question the ability of market determined rates to reflect liquidity conditions and act as benchmark for use in asset pricing and monetary policy. To answer to it, this study consists in examining whether changes in bond yields can be explained by fundamental factors.

First, we evaluate the mechanisms of monetary policy transmission in China, via the management of expectations reflected in the term structure of interest rates. This one, involving a set of bond yields of different maturities, describes the relationship among short-term, medium-term and long-term rates at a given point in time. The majority of the existing literature on China monetary policy transmission finds the link between monetary policy and real economic performance to be historically weak in China. However, motivated by the evolving financial system, recent empirical researches have re-examined the monetary policy transmission in China over the past decade only, and tends to conclude on its increasing effectiveness on the real economy. Among others, Liu (2010), using a VAR framework from 1997 to 2005, find that China’s output and price decrease significantly following a contractionary policy shock, suggesting the presence of an interest rate channel. Cassola and Porter (2011) also find that bond yields contain considerable information about the state of the economy as well as evidence of an emerging transmission channel with changes in PBC rates influencing the bond yield curve, which are then associated with changes in growth and inflation. Pang and Siklos (2015) finds that the monetary transmission mechanism in China resembles that of the US even if the channels through which monetary policy affects their respective economies differ. In a similar way, Fernald, Spiegel and Swanson (2014) also conclude that the monetary policy transmission channels in China have moved close to those of Western market economies and find that monetary policy instruments, including interest rates, had a significant impact on economic activity and inflation over the 2000-2013 period.

This improvement in monetary policy transmission from the early 2000s can be attributed to the rapid institutional and structural changes in China toward a more market-oriented system. The conduct of monetary policy has particularly evolved since 2002 with a policy now seemingly similar to an informal inflation targeting policy, a result argued in the second chapter and also supported by
He et al. (2013). It is generally argued that the achievement of an inflation-targeting framework requires clear communication, the rationale for its future monetary policy decisions and central bank credibility with the goal of managing public expectations (about future inflation) and enhancing the predictability of the central bank’s actions (Williams, 2015). Therefore, this chapter aims also at analyzing the role played by central bank communication on the term structure of interest rates.

This topic has been widely analyzed in developed countries. An excellent survey of Blinder et al. (2009) emphasizes communication as a powerful tool for central bank to conduct a more predictable monetary policy, thereby decreasing financial market volatility and contributing to a more stable economy. Moreover, central bank communication would likely capture some of the complexity of monetary policy in China, particularly when it is statistically unobservable. Indeed, the PBC has historically used some administrative window guidance to influence growth in bank credit and was particularly the means found by the Chinese authorities to side-step the transmission mechanism (in driving bank credit growth). However, such practice is not statistically observable but can be captured only when analyzing central bank communications.

Third, the term structure of interest rates and macroeconomic activity are closely related (Wu, 2005). Thus, we examine the market reaction to macroeconomic situation by analyzing the effects of the domestic macroeconomic news on the yield curve in China. To measure such macroeconomic news, we build two composite indicators from 12 macroeconomic variables to reflect (1) the releases of macroeconomic variables and (2) a “surprise” indicator derived from the difference between data releases of macroeconomic variables and market consensus forecasts of such variables.

Finally, a debate that has received much attention after the GFC focuses on the capacity of emerging markets to moderate the impact of global financial and monetary forces through their own monetary policy (among others see Rey, 2015, Obstfeld, 2014). Among few works on China case, Pang and Siklos (2015) find that spillovers from the US to China are significant and originate from both through the real and financial sectors of the US economy. Therefore, our study contributes to the literature by extending our model to evaluate the cointegration relationship among the bond yield curve of the United States and China as well as the domestic bond yield curve response to US policy decisions (such as US quantitative easing implementation) and the US term structure of interest rates.
This research follows a methodology initially used in the paper of Porter and Xu (2009), modified by Garcia-Herrero and Girardin (2013) and recently used by He and Wang (2011), by estimating a EGARCH model to look at the effects of exogenous monetary policy measures and macroeconomic factors on the bond market over the 2007-2013 period. Moreover, we add to the literature on the transmission of information across the China bond market through two main contributions. First, the model focuses on the entire yield curve rather than money markets or selected bond yield maturities. Indeed, monetary policy actions, including talks, aim at altering not just current short-term interest rates, but the “anticipated” path of short-term rates reflected in the long-term interest rates. Therefore, we estimate empirically the yield curve in China through the well-known Nelson Siegel model, powerful for summarizing the term structure into three easily interpretable latent factors at each date, related to the level, the slope and the curvature of the yield curve. Second, the model encompasses additional key factors that potentially affect the bond yield curve including central bank communication, macroeconomic news and US monetary policy.

The results provide further evidence for an impact of regulated lending and deposit rates on the structure of China bond yields more substantial than other traditional instruments. Moreover, we find that the bond yield curve moves consistently with the macroeconomic news and surprise, highlighting adjusted market expectations of the future macroeconomic situation contained in the movements of the yield curve. Then, our central bank speech-based indicator appears significant after the burst of the GFC crisis. Therefore, the enhancing effort made by the PBC to communicate about its conduct of monetary policy seems to play an emerging role in managing market expectation. In addition, we argue that this indicator is particularly useful to capture administrative window guidance effects during the GFC on the bond yield curve.

Finally, we find significant spillover effects from the US on the Chinese bond yield curve. Indeed, our results show a transmission of US monetary policy changes, including during the exceptional monetary easing period after the GFC crisis and the existence of a long-term relationship between the US and China level parameters of the bond yield curves.

The rest of the chapter is organized as follow. The first section attempts to provide a comprehensive overview of the bond market in China through a presentation of key historical development and the current functioning of the bond market. The second section presents the literature review on the
transmission mechanisms of monetary policy to the yield curve. The third section discusses the methodology and data while section 4 presents the estimation results. The final section concludes.

3.2. Development of the Chinese bond market

A broad consensus of economists recognized the development of a well-functioning bond market as a prerequisite in its economic transition to a more market-oriented system, in order to achieve key challenges such as managing and diversifying risks in the banking sector, stimulating sustainable growth and also the increasing need for alternative financing in China. Therefore, this section aims at reviewing the historical development of the Chinese bond market and the current structure of the market.

3.2.1. Historical lessons

While major development of the Chinese bond market took place over the last two decades, its history dates back to more than one century ago, at the end of the Qing dynasty. However, the Chinese bond market featured a different development historically than over the last decade through a heavy reliance to the foreign bond market. Indeed, Huang and Zhu (2007) explain that reliance of local governments upon foreign merchants during the Qing Dynasty helped financing different rebellions and wars (against France in 1880s, 1894 war with Japan etc) while the central government was under fiscal pressure of paying indemnities resulting from a series of previous wars with the West. Most of such provincial loans were secured on provincial shares of Maritime Customs, which started the tradition of using maritim customs as collateral for many subsequent foreign bonds issued by various levels of the Qing government. However, by gaining access to the foreign capital market, the imperial government gradually put various sources of its fiscal income into foreigners’ hands. Conversely, Goetzmann et al. (2005) show that there were a very limited number of domestic bond issuances during the Qing Dynasty. Then, foreign investors contributed to finance a series of large infrastructure projects (such as railway project) and defense projects during the Qing Dynasty.

34 The Qing dynasty ruled from 1644 to 1911.
Chapter 3 - What moves the yield curve in China? Effects of PBC actions and macro news

and Republic of China regime (1911-1949). However, because of a series of defaults and restructuring in the 1920-1930s, which hurt the government’s credit in repaying its obligations, foreign bond issuance stopped during this period. Overall, Huang and Zhu (2007) explained that the weak government credibility and the lack of contract enforcement were directly responsible for the faltering growth of Chinese domestic bond market.

After the foundation of the People’s Republic in 1949, few bonds were issued domestically to assist the economic development and the bond market remained flat under the central planning economy until early 1980s. Appendix 3.A summarizes key events of its development (extracted from Huang and Zhu, 2007). Simply put, the Chinese domestic bond market has grown since the 1990s from being almost nonexistent to becoming one of the largest in the world. Moreover, the development process has considerably moved from relying heavily on foreign markets to a domestic development. The market has developed progressively, initially opening access to a limited number of healthy companies, while companies in greater need of bond financing remained left out of the market. The state attached also a particular caution to keep control over companies to avoid that state-owned assets being possessed by foreign creditors, like what happened to Chinese railway loans a century ago. During the early 1990s, state-owned and local government-owned enterprises obtained permission to issues bonds and took the opportunity to raise capital in an excessive way as they were not financially constrained by bankruptcy prospects. Indeed, most of them were strictly subsidiaries of various levels of government agencies. As a consequence, many of the issuers defaulted and caused financial instability with a significant increase in the balance sheet of the state-owned banks and the State Economic Planning Commission decided to close down the corporate bond market.

As pointed out by Huang and Zhu (2007), the legal background played an important role in the development of the bond market over the past two decades. At first, China only had a primary market and issuance was done through administrative allotment and government bonds could not be traded or transferred after issuance (Bai, Fleming and Horan, 2013). Secondary market trading was introduced in selected cities in 1988 and then allowed nationwide in 1990 when stock exchanges were opened in both Shanghai and Shenzhen. Until the creation of a primary dealer system in 1993, Treasury bonds were issued exclusively as physically printed bonds. After 1993, treasury bonds started being issued as book-entry bonds and certificate bonds which facilitate trading.
3.2.2. Breadth, depth and liquidity of the bond market

The Chinese bond market has emerged very rapidly from early 2000s becoming the third largest bond markets in the world at about RMB 32.2 trillion at end-2014 (or USD 5.2 trillion after the US and the Japanese government bond markets). Indeed, the Chinese bond market has been growing very fast from early 2000 (at around 10% and 45% outstanding bond growth per year). It has helped promoting the development of direct financing, which can reduce the economy’s over-reliance on the banking system for credit, mitigate financial risk and enhance market efficiency.

The bond market has developed into a multi-layered market comprised of the national interbank market and the exchange-traded market (Shanghai Stock Exchange and Shenzhen Stock Exchange). The interbank bond market, established in 1997 by the State Council is an over-the-counter (OTC) wholesale market, where market positioning of institutional investors and one-to-one quote-drive trading take place. It has become the most active bond market (absorbing almost all trading in the second half of the 2000s). The exchange bond market is a retail market, in which individual and small- and medium-size institutional investors carry out trading. With the rapid development of the bond market, China has gradually promoted a healthier bond market.

Indeed, the types of bonds in China's bond market have become increasingly diversified, almost equivalently traded between treasury bonds (34% of total at end-2013) issued by the Ministry of Finance (MoF), financial bonds issued by government-backed policy banks and financial institutions
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(33% of total), corporate bonds issued by domestic corporations (31% of total) and central bank bonds (2% of total). The latter are short-term debt certificates issued to commercial banks, used frequently to regulate the monetary base in the background of persistent increase in China's foreign exchange reserves (around 20% at end-2010). This research focuses only on the treasury bond market; indeed, the corporate bond market has developed only very recently meaning empirical analysis on a short period would not be robust.

Figure 30: Bond outstanding by type, December 2013 (% of total)

![Figure 30: Bond outstanding by type, December 2013 (% of total)](image)

However, despite this rapid bond market development, many questions remain about the efficiency of the Chinese bond market, related to three noticeable issues. First, the Chinese bond market is considered underdeveloped yet compared to the size of the economy. Indeed, the total amount of bonds outstanding reached in 2014 about 50% of GDP (from around 15% in 2000), relatively low compared to other Asian countries such as South Korea, Malaysia, Singapore and Thailand (respectively at 125%, 100%, 82% and 70% of GDP) and accounts for less than one fourth of the bond market share in Japan (225% of GDP). Among our sample, a less-developed bond market is only present in Indonesia, the Philippines and Vietnam.
Second, market access has progressively allowed an increasing number of investors on the interbank market, enhancing greater competition and market efficiency. Those participating in the market include banks, insurance companies, agricultural credit institutions, fund management companies, securities firms, non-bank financial institutions and corporations. In addition, China has progressively relaxed regulation on foreign investors from late 2002 with the launch of the Qualified Foreign Institutional Investor (QFII) scheme offering foreign capital an opportunity to invest in the Chinese bond market. More recently, China has started allowing local governments to issue bonds to finance urban infrastructure construction projects. The State Council approved early 2007 a new policy allowing Chinese policy and commercial banks with high credit rating, upon obtaining approval from relevant authorities, to issue CNY denominated bonds in Hong Kong. Notwithstanding such increasing participants on the bond market, commercial banks make up by far the majority of market investors, holding 75% of the total end-2014, followed by special members (9% of total) and fund institutions (6% of total). Therefore, the understanding of the monetary policy transmission to the government bond rates structure has to be examined through the strategy or the incentives of banks to invest on this market rather than lending to firms.

35 Until recently, Chinese local and municipal government were not allowed to issue their own bonds, despite financing need and deficit issues. Local governments were used to rely exclusively on fiscal appropriation from the central government, and thus budgeting and financing used to be an important tool that central government used to keep local government.

36 Special members comprise the PBOC, Ministry of Finance, policy banks, China Government Securities Depository Trust and Clearing Co., and China Securities Depository and Clearing Corporation.
Finally, liquidity issue is an important aspect in the well-functioning of financial markets, and is believed to improve resource allocation and information efficiency. The bond turnover ratio, a measure of bond market liquidity, is computed as the extent of trading in the secondary market relative to the amount of bonds outstanding. The higher the turnover ratio, the more active the secondary market. Figure 32 emphasises the increasing liquidity on the market over the 2006-2013 period on the government and corporate bond markets. As a consequence, China has progressively undertaken reforms to enhance the functioning of the domestic bond market through increasing number of participants, including foreign investors. Such incentives to develop the bond market and more market-oriented system would allow increasing the monetary policy transmission efficiency and the ability of the bond market to act as benchmarks for use in asset pricing.

3.3. Transmission mechanisms of monetary policy to the yield curve in China

This section provides a literature review on the role played by monetary policy action in movements of the yield curve. It starts with the theoretical aspects of the expectation hypothesis and the experience of major OECD countries. The second part focuses on the theoretical and empirical research applied to China.
3.3.1. OECD experiences

The monetary policy transmission mechanism can operate through the impact of monetary policy instruments across the yield curve to the extent that a long-maturity interest rate reflects the opportunity cost of investment and consumption. The standard view of the monetary policy transmission mechanism relies on the expectation theory (EH) of the term structure of interest rates, introduced by Lutz (1940). This theory suggests that long-term rates are a weighted average of current and expected future short-term rates. In other words, it suggests that monetary policy affects long-term rates by directly influencing short-term rates and by altering market expectations of future short-term rates. The nominal yield on a n-period zero-coupon bond is described as:

$$R_{n,t} = \frac{1}{n} \sum_{j=0}^{n-1} f_{t,j} = \frac{1}{n} \sum_{j=0}^{n-1} (r_{t,j} + \gamma_{t,j})$$  \hspace{1cm} (1)$$

with $f_{t,j}$ the average of forward rates, $r_{t,j}$ the expected policy rate in the $j$th period and $\gamma_{t,j}$ the time-varying forward rate term premium. The nominal bond rate is the average of the expected policy rate over the lifetime of the bond plus the time-varying forward rate term premium.

Academic observers have argued that monetary policy is a major factor in the movements of the yield curve. However, a long standing empirical literature has shown that the expectation hypothesis is rejected across a number of countries and that the relationship between policy actions and long-term rates appears variable. Among other works, Cook and Hahn (1989) examine the response of short-term and long-term rates to changes in the Fed Funds rate and conclude that such changes were followed by large movements in short-term interest rates, moderate movements in intermediate-term rates and small but significant movements in long-term rates. Rudebusch (1995) finds similar results, providing evidence that US monetary policy affects short-term interest rates while the long-end of the yield curve is much less affected. Evans and Marshall (1998) explored how exogenous impulses to monetary policy affect the yield curve for nominally risk-free bonds. They show that a contractionary policy shock induces a pronounced positive but transitory response in short-term interest rates (with a term premium increase), with a smaller effect on medium-term and almost no effect on long-term rates. This finding stands in contrast to the popular opinion that changes in monetary policy systematically affect long-term bond prices through the Expectation Hypothesis.
Campbell and Shiller (1991) suggest that the empirical failure may be due to an over-reaction of long rates to the expected change in short rates. Hardouvelis (1991) believes that large measurement errors can account for the forecast in the wrong direction. Fama (1986), as well as Cook and Hahn (1989), among others, argue that a time-varying term premium correlated with the spread can explain the empirical failure of the Expectation Hypothesis. Mankiw and Miron (1986) believe that time-varying risk premia, change in risk perception, adjustments in relative asset supplies, measurement errors and near-rational, rather than rational, wrong expectations, can play a role in explaining the empirical rejection of EH. To summarize, a common result of the standard modelling is that the yield curve is significantly influenced by monetary policy and market expectations about future policy but their effect varies across time and maturities.

Firstly, the magnitude of the response of long-term rates to policy actions clearly depends on the expected persistence of such actions and may vary over the business cycle (Labadie, 2002). Roley and Sellon (1995) argue that the relationship between policy actions and long-term rates is likely to vary over the business cycle as financial market participants alter their views on the persistence of policy actions. Therefore, the reaction of long-term rates is likely to be much more variable than the response of short-term rates as uncertainties about future policy actions increase as maturity lengthens. For example, in the early stages of policy tightening, investors may foresee that the PBC would renew its policy to moderate economic activity and lower future inflation. Their perceptions would imply that the change in long-term rates may fully reflect or even exceed the current monetary policy change. At the opposite end of the cycle phase, if investors believe that inflation and economic activity have reached their target levels and that additional policy tightening is not likely to occur, while short-term rates may fully react to policy changes, long-term rates may respond very little or even decline. These examples highlight that the response of long-term rates to monetary policy depends on market perceptions of future policy actions.

Second, inflation expectations are generally considered as an important factor affecting long-term interest rates. More importantly, if the central bank usually does not allow inflation to move away from its target, this would keep long-term interest rates down since investors would demand only a small interest rate premium above the inflation rate. Conversely, if market participants expect inflation to increase, they would demand a higher interest rate to compensate the risk they bear. Kozicki and Tinsley (2007) show that, during periods of passive policy, bond rates may exhibit stable
response to inflation if time-varying term premia incorporate inflation-dependent risk pricing or if future policy is anticipated to be active. The key role of time-varying term premia for capturing time variation in yields has also been pointed out in several empirical works including Shiller, Campbell and Schoenholtz (1983), Duffee (2002) and Dai and Singleton (2002).

Third, increasing attention has been paid to the qualitative impact of monetary policy changes on stock returns and bond yields. Among other works, Durhan (2005), Bernanke and Kuttner (2005), Ehrmann and Fratzscher (2007) argue that only monetary policy surprises (by the timing of the magnitude) affect the stock market. This would result on a larger response of long-term rates due to the revision of investors' expectations of future policy actions. Moreover, Andersson, Dillen and Sellin (2006) find that central bank speeches are a more important determinant for the longer end of the term structure. The monetary policy effectiveness is strongly related to monetary policy signaling, i.e. the way policy makers indicate their intentions through policy reports, speeches and other communication channels. This is in line with those previously found for the US, the UK and some other OECD countries (Kohn and Sack, 2004; Connolly and Kohler, 2007; Reeves and Savicki, 2007).

3.3.2. Applications to China

Theoretical analysis

The focus of this paper is empirical but a significant part of the literature have analyzed theoretically monetary policy transmission mechanisms in China. Porter and Xu (2009) developed a theoretical model to analyze the link between regulated policy instruments and interbank rates. Since commercial banks remain the main market player, they consider a competitive model of commercial banks, where there are N independent price taking banks and whereby the bank’s profit maximization problem can be written as follow:

$$
\pi_i = \max \{r_1 L_i + r_e E_i + r_r \alpha D_i + r B - r_d D_i - C(D_i, L_i, E_i)\}
$$

Each bank absorbs deposits ($D_i$) from households and makes loans ($L_i$) to firms in the loan market. The assets on the bank’s balance sheet also include required reserves submitted to the central bank, according to the RRR ($\alpha$) set by the PBC, and excess reserves ($E_i$) deposited in the central bank. Aside from loans and reserves, each bank can buy central bank bills, and invest in bonds or other financial
products in the money and bond markets $B$. $r_l$ is the lending rate of loans, $r_d$ the deposit rate, $r_e$ the rate paid on excess reserves set by the PBoC, $r_f$ the interest rate paid on required reserves, and $r$ the bond yield. $C(D_i, L_i, E_i)$ is the managing cost of the bank, which is a function of deposits, loans and excess reserves. Based on this theoretical model, they find that the regulation of key retail interest rates diminishes the ability of the market-determined rates to act as independent price signals, or as benchmarks for use in asset pricing and monetary policy.

Porter and Xu (2009) concluded in favour of promoting further interest rate liberalization arguing that the regulation of interest rates diminishes the ability of the market determined rates to act as independent price signals. Chen, Chen and Gerlach (2011) also studied the monetary policy transmission suggesting an extension of Porter and Xu (2009). They also highlight that the presence of regulated rates have a large impact on the transmission mechanism of monetary policy. In particular, they find that the effect of monetary policy and retail bank lending depends on how the regulated interest rates deviate from their equilibrium levels. Finally, He and Wang (2012) develop and calibrate a similar theoretical model to illustrate how monetary policy transmission works under the dual-track interest-rate system in China. They argue that the role of the deposit-rate ceiling is like that of an anchor that keeps interest rates generally low in China's formal financial sector, as the banking sector still dominates the Chinese credit market. Therefore, as long as the regulated deposit rate is lower than the equilibrium interest rate, a quantitative credit target is necessary to curb excess loan demand from firms.

**Empirical analysis**

The recent empirical literature tends to conclude on the increasing effectiveness in monetary policy transmission in China over the past decade. First, He and Wang (2012) have also examined empirically the monetary policy transmissions to money and bond market through a GARCH model over the 2004-2010 period. They find that market interest rates are most sensitive to changes in benchmark deposit interest rates, significantly responsive to changes in reserve requirements, but not particularly reactive to open market operations. Sun (2013) find that monetary policy over the 2000-2011 period has large and persistent impact on output in China. Among other works, Cassola and Porter (2011) find that bond yields contain considerable information about the state of the
Transmission mechanisms of monetary policy to the yield curve in China

economy as well as evidence of an emerging transmission channel. Indeed, their results show that changes in PBC rates influence the term structure of interest rates (treasury, financial and corporate bond yields) which are then associated with changes in growth and inflation. More recently, Fernald, Spiegel and Swanson (2014) conclude that the monetary policy transmission channels in China have moved close to those of Western market economies and find that monetary policy instruments, including interest rates, have significant impact on economic activity and inflation over the period from 2000 to September 2013.

However, the major part of the literature on China has focused on the transmission mechanism to the money market rate and to a lesser extent to bond yields. Considering the entire structure of the yield curve, including the short-, medium- and long-maturity yields is even more relevant since they are the fundamental conduits for the transmission of monetary policy. As rightly portrayed by Svensson (2004), monetary policy is to a large extent the management of expectations. Indeed, bond yields contain expectations of future policy rates, not recent monetary policy changes. Therefore, monetary policy effectiveness depends on the deformation of the yield curve which reflects perceptions of future monetary policy.

As pointed out by Schmidt and Nautz (2011), effective communication should ensure that financial markets understand the central bank’s interest rate policy. Indeed, the objective of communication is to guide and to influence market expectations concerning the future monetary policy decisions and thereby affect long-term interest rates. In other words, monetary policy action, including talks, aims at altering not just current short-term interest rates, but the “anticipated” path of short-term rates reflected in the long-term interest rates. Garcia-Herrero and Remolona (2008) also argue that “the expectation channel” operates most effectively when the financial markets are forward looking, when they understand how policymakers expect economic conditions and monetary policy to evolve over time and how the central bank would respond to any changes in the outlook.

However, central bank communication is not always effective. For instance, forecasters may indeed “understand” monetary policy but misperceive future interest rate decisions simply because they do not have good projections about future inflation and output. The PBC has become much more active in delivering speeches by its governing body, focusing on monetary policy issues and economic outlook, and publishing statements after each monetary policy committee (MPC) meetings. Garcia-Herrero and Girardin (2013) have shown evidence that the money market not only listens to the
PBC’s words but understands the tone of the monetary policy. They find that the conditional volatility of money market rates changes right after a speech from the PBC’s governing body. Second, they find a statistically significant rise in interbank rates the more hawkish the speeches are.

### 3.4. Data and methodology

This section details the data used starting with the description of the China bond yield curve followed by the exogenous variables related to monetary policy and macroeconomic factors. Then, we introduce the methodology selected to examine the information transmission of exogenous factors to China’s bond yield curve on a high frequency basis.

#### 3.4.1. China bond yield curve data

Weekly data on the “yield curve of interbank fixed rate treasury bond” are used, considered as the bond yield benchmark in China, extracted from Wind Information\(^{37}\) over the period from January 2007 to December 2013 with maturities ranging from 1 to 10 years (365 observations per maturity). Longer-maturity bond yields are excluded from the analysis due to liquidity issue over longer segments. Indeed, the treasury bond interbank market is most active over the short- and medium-term segments, as shown on the following figure 33.

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Then, the pre-2000s period is not examined because this period is not arguably very informative to capture monetary policy transmission effectiveness since a number of structural reforms point towards an evolving monetary policy transmission over the new millenium. Such changes include the rapid and healthier development of the bond market since the establishment of the interbank market in 1997 through more progressive interest rate liberalization, better liquidity on the bond market and an increasing number of participants. Therefore, the development of the bond market suggests that monetary policy transmission mechanisms would perform better over the 2007-2013 period. Moreover, the change in monetary policy behavior in the early 2000s supports the focus on the very recent period.

Figure 34 introduces the evolution of interbank fixed rate treasury bond rates on a weekly basis over the period from January 2007 to December 2013 with maturities ranging from 1 to 10 years (365 observations per maturity). It shows the strong correlation between maturities (more than 80%). Moreover, Table 19 summarizes statistical properties highlight non-stationarity according to the Augmented Dickey-Fuller unit root test and the more volatile short-end segment. Finally, the average Chinese interbank yield curve over our sample, representing the relation between average bond yields by maturities, is on average upward sloping.
Chapter 3 - What moves the yield curve in China? Effects of PBC actions and macro news

Figure 34: Evolution of China treasury bond yields (%)

![Figure 34: Evolution of China treasury bond yields](image)

Table 19: Descriptive statistics on bond yields

<table>
<thead>
<tr>
<th>Maturity (years)</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>ADF Unit Root Test (t-stat) (^{(1)})</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.24</td>
<td>0.79</td>
<td>0.87</td>
</tr>
<tr>
<td>2</td>
<td>2.50</td>
<td>0.79</td>
<td>0.89</td>
</tr>
<tr>
<td>3</td>
<td>2.74</td>
<td>0.71</td>
<td>0.82</td>
</tr>
<tr>
<td>5</td>
<td>3.08</td>
<td>0.62</td>
<td>0.75</td>
</tr>
<tr>
<td>7</td>
<td>3.32</td>
<td>0.57</td>
<td>0.87</td>
</tr>
<tr>
<td>10</td>
<td>3.58</td>
<td>0.52</td>
<td>0.79</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Augmented-Dickey-Fuller Unit Root test. Figures indicate t-statistic.

Source: authors’ calculation

3.4.2. Monetary policy instruments and macroeconomic news

Monetary policy instruments

The explanatory variables introduced in the model are the main monetary policy instruments used frequently by the PBC, a central bank communication indicator related to monetary policy, two indicators on macroeconomic announcements and foreign variables related to US monetary policy and US bond yield curve. The data series used span the period from January 2007 to December 2013. The main monetary policy instruments include the benchmark one-year deposit (DEPOSIT) and lending (LENDING) rates, the Reserve Requirement Ratio (RRR), the central bank bill issuance (OMO),
all extracted from CEIC. The benchmark interest rates and RRR are introduced in the model in first difference. Moreover, the announcement of RRR changes, around 10 days before it becomes effective, is introduced in addition to the effective changes.

**Figure 36: Weekly monetary policy instruments over the period 2007-2013**

*Source: CEIC*

**Central bank communication indicator**

Our central bank communication indicator (SPEECH) is built on our proper media-based approach developed in chapter 1. The data series used span from January 2007 to December 2013 on a weekly basis, more reliable than on a daily basis due to our approximation of speech date announcements.
Figure 37: Central bank communication indicator over 2007-2013

Macroeconomic announcement indicators

Two macroeconomic composite indicators are build, one related to releases of announcement (NEWS) and the second encompasses macroeconomic surprises (SURPRISE), the difference between news and consensus forecasts. Both macroeconomic composite index aggregate 10 indicators, extracted from Forex Factory, related to real GDP, industrial production, consumer price index, producer price index, trade balance, fixed assets investment, M2 and manufacturing purchasing manager index (national and HSBC sources). The main interest in aggregating in two composite indicators is related to the common release dates for most of macroeconomic variables. Details about the construction of indicators are presented in Appendix 3.C.

Figure 38: Macroeconomic news indicator

Figure 39: Macroeconomic surprise indicator

Source: Authors’ calculation
Foreign variables related to US monetary policy and US bond yield curve

Finally, the likely effect of the global monetary policy environment, and specifically US monetary policy, on the China bond market can be questioned with the growing position of China at the international level and its growing dependence to the world economy particularly since its WTO accession in December 2001. Therefore, we introduce foreign variables in the model to reflect the potential effect of US monetary policy as well as US bond yields. For the US monetary policy stance, we use the shadow Fed Funds rate (USSHADOW), as developed by Wu and Xia (2015) which well capture the implemented Quantitative Easing in the US. This indicator is extracted on a daily basis from the Federal Reserve Bank of Saint Louis’ web site and converted into a weekly basis using the end-week value. For the US bond yields, we apply also the Nelson Siegel model as for Chinese data to capture the slope (USSLOPE) and the level of the US term structure of interest rates (USLEVEL)\(^\text{38}\). Since US Fed funds rate has been low from end-2008, the evolution of the level and the slope are ultimately quasi-equivalent. The more negative is the curvature the more convex is the US bond yield curve.

Figure 40: US estimated latent yield curve factors

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\(^{38}\) For technical aspects, about the Nelson Siegel model for the US, see the methodology applied to the China case in the following section and use 0.0609 for the lambda parameter as found by Diebold and Li (2006)
3.4.3. Methodology

Estimation of the Nelson Siegel parameters

There are plenty of methods to analyze the yield curve accurately in the literature but commonly approaches used by central banks to estimate term structure of interest rates are parametric models (developed by Nelson Siegel (1987) or an extended version developed by Svensson (1994)) or smoothing spline-based (Vasicek and Fong (1982) or an extended version developed by Fisher, Nychka and Zervos (1995)).\(^{39}\) The different approaches are characterized by a different trade-off between the flexibility to represent shapes generally associated with the yield curve and the smoothness. Moreover, the interpretation of estimated parameters is also important and represent one advantage of the Nelson Siegel model (1987) which summarizes information contained in the entire yield curve at each date into three easily interpretable latent variables called the level \((\beta_1)\), the slope \((\beta_2)\) and the curvature \((\beta_3)\). The function is described as follow:

\[
y_t(\tau) = \beta_{1t} + \beta_{2t} \left( \frac{1 - e^{-\lambda_{t}\tau}}{\lambda_{t}\tau} \right) + \beta_{3t} \left( \frac{1 - e^{-\lambda_{t}\tau}}{\lambda_{t}\tau} - e^{-\lambda_{t}\tau} \right)
\]

\(^{39}\) For a technical documentation, we refer to the BIS paper 25 (2005): “Zero-coupon yield curves: technical documentation”
where \( y_t(\tau) \) represents the rate at maturity \( \tau \) at time \( t \). \( \beta_1 \) denotes the long-run level of interest rates, \( \beta_2 \) represents the slope factor and the \( \beta_3 \) factor is for the curvature of the yield curve. The lambda parameter is the exponential decay rate along maturities for each factor, with a larger lambda producing a faster decay (Diebold and Li, 2006). Diebold and Li (2006) fixed in the case of the US that lambda parameter at 0.0609. In the case of China, iterative OLS estimations are required to optimize the lambda parameter which minimizes the root mean square error over the period from January 2007 to December 2013. Therefore, we calculate the Root Mean Square Error (RMSE) at each date fixing alternatively different lambda parameter ranging from 0.03 to 0.07, based on OLS estimation.

Our lambda optimization procedure in Figure 41 (through minimizing the sum of RMSE over the entire sample) suggests setting the parameter at 0.0454 which maximizes the impact of the medium-term factor at a maturity of 40 months (against 30 months according to Diebold and Li’s results in the US case). Finally, the Nelson Siegel model is estimated at each date using this fix lambda parameter through OLS regression. Our estimated statistical models of the yield curve clearly capture well the shape of the observed yields, as shown in example in Figure 42. Finally, the appendix 3.A illustrates the relatively low estimation errors at each maturity and confirms the accuracy of the Nelson Siegel model. This procedure is also used to estimate the US bond yield parameters.

**Cointegration relationship between China and US bond yield parameters**
Cointegration is defined as a situation where linear combinations of non-stationary time series are stationary. This implies the existence of a long-run equilibrium between the variables. In this chapter, the cointegration relationship between estimated China and US bond yield parameters are tested using the Johansen procedure (1988).

In this basic model, one regresses the bond yield parameters of China against US as follow:

\[ Y_{it} = \alpha + \beta Y_US_{it} + \epsilon_{it} \]  

Where \( Y \) and \( Y_US \) are respectively the Chinese and US estimated bond yield parameters and \( i=\{\text{level, slope or curvature parameters}\} \). \( \epsilon_{it} \) represents the white noise process. The Johansen procedure consists in applying an augmented Dickey-Fuller test on the residuals to check if they are stationary. If the residuals obtained from the regression are stationary, then a long-run relationship exists between the two countries, or in other words, the bond yield curve of China and the US are cointegrated. The null hypothesis is that there is one or greater than one cointegrating relationship.

**Estimation of the Nelson-Siegel parameters through an ECM-EGARCH model**

One appropriate and frequently used model to estimate the impact of policy shocks on China’s interbank bond rates is the Exponential GARCH (EGARCH) model. The EGARCH model specifies the mean equation as follows:

\[ \Delta Y_t = \mu_t + \epsilon_t \text{ with } \epsilon_t = \sigma_t Z_t \]  

Where \( \Delta Y_t \) is the changes in one of the \( \beta_1, \beta_2 \) or \( \beta_3 \) factors (which removes non-stationarity issues as stressed by Garcia-Herrero and Girardin, 2013) and \( \mu_t = E\Delta Y_t|F_{t-1} \) is the conditional mean of \( \Delta Y_t \) given the information set \( F_{t-1} \). \( \epsilon_t \) is the error term.

Then, the conditional volatility equation can be written as follows:

\[ \ln(\sigma_t^2) = \omega^* + \beta \ln(\sigma_{t-1}^2) + \alpha |\epsilon_{t-1}| + \delta \epsilon_{t-1} + a X_{it} \]  

where \( \omega^* = \omega - \alpha E|\epsilon_t| \), the \( \alpha \) terms is for the ARCH effect, the \( \beta \) for GARCH term (and measures the persistence in conditional volatility), \( \delta \) parameter measures the asymmetry effect and \( X \) includes some exogenous variables such as the macroeconomic surprises (SURPRISE) or the monetary policy communication indicator (SPEECH). Indeed, we aim at examining if both parameters tend to reduce market uncertainty or not. This model allows for rich specifications for both the time varying mean.
and volatility of the bond rates. Moreover, volatility can react asymmetrically to good or bad news. The specification of the volatility in terms of its logarithmic transformation implies that there are not restrictions on the parameters to guarantee the positivity of the variance. Nelson (1991) establishes the conditions for covariance stationarity of the EGARCH model under particular specifications of the error distribution. Furthermore, a sufficient condition for the stationarity of the EGARCH model is \( |\beta| < 1 \) when \( \varepsilon_t \) has a distribution such that \( E[\log^+(\omega + \alpha |\varepsilon_{t-1}| + \delta_t |\varepsilon_{t-1}|)] < \infty \); see Straumann and Mikosch (2006). Then, Nelson (1991) establishes the conditions for covariance stationarity of the EGARCH model under particular specifications of the error distribution. In particular, assuming that \( |\beta| < 1 \), the EGARCH model is always stationary if \( \varepsilon_t \) has a Generalized Error Distribution (GED) with parameter \( \zeta > 1 \).

We follow the methodology initially used by Porter and Xu (2009) for interest rates in level and modified by Garcia-Herrero and Girardin (2013) for the first difference of the three latent parameters of the yield curve. For instance, the Chinese yield curve exhibiting “fat-tails”, we assume innovations in the GARCH model with a generalized-error distribution (GED) suggested by Nelson (1991). \( \mu_t \) is a function, as described in equation (6), of the changes in interest rate margin (\( \Delta\text{MARGIN} \)), the difference between lending and deposit rates changes, changes in the deposit rate (\( \Delta\text{Deposit} \)), the announcement and effective changes in the RRR (\( \Delta\text{RRR} \)) and the amount of net bill issuance by the PBC (OMO). We omit in this estimation other instruments which are either rarely used by the PBC (such as interest rate on excess reserves) or not observable (such as credit quotas). We add to monetary policy instruments our indicator of monetary policy communication (\( \text{SPEECH} \)), our macroeconomic indicators related to data releases (\( \text{NEWS} \)) and macroeconomic surprise (\( \text{SURPRISE} \)) defined as the difference between the expected from Consensus and the observed variables.

US factors are also introduced, such as a US shadow interest rate changes (\( \Delta\text{USSHADOW} \)) and the three latent factors of the US bond yield curve (\( \Delta\text{USCURVE}=(\Delta\text{USLEVEL}, \Delta\text{USL} \text{SLOPE}, \text{CURVATURE} \) ). Additional variables (Dummies) are included to take seasonalities into account: the Lunar-New-Year, the National-Day (on October 1, followed by around 5-days holidays) and May-Day vacations. Finally, incase of existing cointegrating relationship between China and US bond yields, we add an error correction term \( \text{EC} \) in the equation, equal to the residuals of the equation (3) (with one-week delay).
\[ \mu_t = \beta_0 + \beta_1 \Delta \text{MARGIN}_t + \beta_2 \Delta \text{Deposit}_t + \beta_3 \Delta \text{RRR}_t + \beta_4 \Delta \text{OMO}_t + \beta_5 \text{NEWS}_t + \beta_6 \text{SPEECH}_t + \beta_7 \text{SURPRISE}_t + \beta_8 \Delta \text{USSHADOW}_t + \beta_9 \Delta \text{USCURVE}_t + \beta_{10} \text{Holiday}_t + \beta_{11} \text{Day}_t + \beta_{12} \text{Month}_t + \beta_{13} \text{EC}_{t-1} + \epsilon_t \] (6)

The coefficient of the error correction term should be negative (a positive value would mean an explosive process). Moreover, as described in the previous section, we would expect that yield curve parameters would increase when the PBC increases the benchmark deposit rate, the RRR, issues central bank bills (particularly when the deposit-rate ceiling is binding), macro news and central speech about monetary policy. Moreover, yield curve parameters would also move in line with US interest rates.

However, both the conduct of monetary policy and the functioning of the bond market have evolved considerably over the last decade, suggesting varying transmission effects of monetary policy and macroeconomic determinants. For instance, Ho, Zhang and Zhou (2014), argue that responses of Chinese variables to US shocks at the zero lower bound are different from that in normal times, which suggest structural changes in both the Chinese economy and the US monetary policy transmission mechanism, that can be explain notably by the influence of substantial inflows of hot money into China. Moreover, we can question the stability in monetary policy transmission mechanism in China in the context of the Global Financial Crisis and with the progressive interest rate liberalization in China. Consequently, we suggest estimating the model over the whole period from 2007 to 2013 and also over three distinct periods: (1) the pre-crisis period from January 2007 to August 2008, (2) the crisis period from August 2008 to November 2009 and (3) the post crisis period from November 2009 to December 2013.

### 3.5. Empirical analysis

This section presents our estimation results into four steps. The first part presents the results of the Nelson Siegel model to estimate the parameters of the China yield curve. The second part examines the likely cointegrating relationship between China and US yield curve parameters. Then, the third part presents the results of the ECM-EGARCH model over the period 2007-2013 through examining the effects of domestic factors, monetary policy instruments, PBC monetary policy communication,
Empirical results

macroeconomic releases and surprise, as well as foreign factors related to US monetary policy and US bond yield curve on the term structure of interest rates. The final step analyzes the deformation of the bond yield curve according to the different pre-GFC, crisis and post-GFC sub-periods. The last section concludes.

3.5.1. Estimation of the Nelson Siegel parameters for China bond yield curve

The Nelson Siegel model is very useful to summarize information contained in the entire yield curve into three easily-interpretable latent variables as the level ($\beta_1$), the slope ($\beta_2$) and the curvature ($\beta_3$) of the yield curve. Figure 43 represents the results of the three estimated latent factors (in level on the left-hand side and in first difference on the right-hand side) and Table 20 provides some descriptive statistics of the yield curve latent factors over the period 2007-2013.

Firstly, the latter particularly highlights, through the Augmented Dickey-Fuller tests, the non-stationarity of the different latent factors considered in levels while are stationary in first difference. Moreover, major negative movements in the yield curve have been observed in the aftermath of the GFC with a sharp decline in long-term interest rates (-0.40 in 2008W38 of the level factor) and a flattening of the yield curve (-0.58 decline in slope parameter observed in 2008W50), a configuration in general typical of a large deterioration of macroeconomic conditions.

| Table 20: Descriptive statistics of yield curve latent factors over the period 2007-2013 |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
|                                 | Level factor $\beta_0$ | Slope factor $\beta_1$ | Curvature factor $\beta_2$ |
| (in level)                      | Mean             | 4.2             | 1.8             | -1.0            |
|                                 | St. Dev.         | 0.4             | 1.0             | 1.0             |
|                                 | Maximum          | 5.1             | 4.0             | 1.3             |
|                                 | Minimum          | 3.5             | -0.1            | -4.5            |
|                                 | Kurtosis         | 2.64            | 2.40            | 3.40            |
|                                 | Skewness         | 0.29            | -0.65           | -0.40           |
|                                 | ADF Unit Root Test | 0.28            | -1.05           | -2.84           |
| (one-week basis point change)  | St. Dev.         | 0.09            | 0.14            | 0.33            |
|                                 | Maximum          | 0.34 (2013W47)  | 0.49 (2011W25)  | 1.27 (2009W06)  |
|                                 | Minimum          | -0.40 (2008W38) | -0.58 (2008W50) | -1.16 (2013W26) |
|                                 | Kurtosis         | 5.05            | 5.68            | 4.94            |
|                                 | Skewness         | 0.00            | -0.07           | 0.11            |
|                                 | ADF Unit Root Test(*) | -15.28          | -12.64          | -15.34          |

(*) Augmented-Dickey-Fuller Unit Root test. Figures indicate t-statistic. Test critical values: 1% level=-2.57, 5% level=-1.94, 10%level=-1.62

Source: Author’s calculation
Chapter 3 - What moves the yield curve in China? Effects of PBC actions and macro news

Then, Figure 43 shows that the whole sample can be broken into sub-periods according to the economic situation. The pre-GFC period is characterized by continuing robust economic growth under a tightening monetary policy environment, particularly from mid-2007 to mid-2008. Over this period, the term structure of interest rates is upward sloping, concave and on average at a high level. In the background of the GFC and the economic slowdown in China which began before the crisis, from July 2008 to March 2009, the central bank adopted a substantial monetary easing policy to fight against the decline in real GDP growth and inflation. This accommodative policy stance led to a flattening of the yield curve and a strong decline in the level of yields followed by an increase in the slope explained by very low short-term interest rates. The post-crisis period, from early-2010 to mid-2011, denotes a progressive shift in monetary policy objectives, allowing weaker economic growth and a more important concern on inflationary pressure. This is revealed by the shape of the yield curve with expectations of higher future short-term interest rates (an increase in interbank bond rates, particularly over the short-end of the yield curve which results in a flatter yield curve).

**Figure 43: Estimated parameters with Nelson Siegel model on the Chinese yield curve**

![Image of graphs showing estimated parameters with Nelson Siegel model on the Chinese yield curve](image-url)
3.5.2. Are China and US bond yield curves cointegrated?

The important question in this section concerns the existence (or not) of a long-term relationship between China and US bond yield parameters. Thus, we provide cointegration tests using the Johansen procedure between each of the Chinese estimated yield curve parameters (given separately) with the US ones over the 2007-2013 sample. Table 21 shows the result of the unrestricted cointegration rank test (maximum eigenvalue).

**Table 21: Cointegration test results (Johansen procedure)**

<table>
<thead>
<tr>
<th>Hypothesized</th>
<th>Eigenvalue</th>
<th>Max-Eigen Stat.</th>
<th>0.05 Critical</th>
<th>Prob.**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(China and US level parameters)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0.07</td>
<td>25.80</td>
<td>14.26</td>
<td>0.00</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.01</td>
<td>3.22</td>
<td>3.84</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>(China and US slope parameters)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0.02</td>
<td>8.15</td>
<td>14.26</td>
<td>0.36</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.01</td>
<td>3.49</td>
<td>3.84</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>(China and US curvature parameters)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0.03</td>
<td>11.60</td>
<td>14.26</td>
<td>0.13</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.02</td>
<td>5.71</td>
<td>3.84</td>
<td>0.02</td>
</tr>
</tbody>
</table>

**MackKinnon-Haug-Michelis (1999) p-values**
Source: Author’s calculation

It highlights one cointegrating relation for the level parameters but reject the null hypothesis that there is one cointegrating relationship between the China and US slopes parameters and curvature parameters. Consequently, results of the estimates the long-run relationship between the China level
parameter and the US one through OLS estimation are presented in Table 22. The coefficient of the US level factor is significant and the residuals of the estimation are stationary according to the Augmented Dickey-Fuller test. Finally, a test for structural stability based on recursive residuals is done in Figure 45 and conclude to an overall stability of coefficients.

### Table 22: Long-run relationship between China and US Nelson-Siegel level parameters (OLS estimates)

<table>
<thead>
<tr>
<th>China Level factor $\beta_0$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3.48***</td>
</tr>
<tr>
<td>[0.07]</td>
<td></td>
</tr>
<tr>
<td>US level factor</td>
<td>0.19***</td>
</tr>
<tr>
<td>[0.02]</td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>25.2%</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-82.4</td>
</tr>
<tr>
<td>Observations</td>
<td>366</td>
</tr>
<tr>
<td>ADF Unit root test on residuals $^{(1)}$</td>
<td>-3.93</td>
</tr>
</tbody>
</table>

Standard error of estimated coefficients are in brackets. ***, ** and * denote significance at 1%, 5% and 10% respectively. $^{(1)}$Augmented-Dickey-Fuller Unit Root test. Figures indicate t-statistic. Test critical values: 1% level = -3.45, 5% level = -2.87, 10% level = -2.57

Source: Authors' calculation

---

![Figure 44: China level parameter OLS](image)

![Figure 45: Stability test (recursive residuals)](image)
To conclude, this section emphasizes a long-run relationship between only the China and US level parameters. This means that the PBC seems to follow the evolution of the US long-term interest rates but not the entire yield curve deformation over the 2007-2013 period.

### 3.5.3. ECM-EGARCH model over the whole sample (2007-2013)

Table 23 reports the effects of Chinese monetary policy (through actions and communication), the domestic macroeconomic situation and US interest rates (the shadow policy rate and estimated bond yield curve parameters) on the level, slope and curvature factors (in first difference) of the Chinese bond yield curve, through an EGARCH model estimation, over the period from January 2007 to December 2013. An error-correction term is also added for the estimation of the level factor only. Appendix 3.D presents fitted latent factors details and residuals graphs.

First of all, the exogenous determinants allows us to explain more accurately the slope factor of the bond yields and to a lesser extent the level factor while the curvature factor model is less satisfying. Then, the volatility equations show significant GARCH as well as ARCH effects and respect stationarity conditions with $|\beta| < 1$ and GED coefficient is significantly higher than 1. However and more surprisingly, asymmetric factor in the volatility equation has been tested but excluded in the results appearing not significant. Then, standardized residuals or squared standardized residuals (presented in Appendix 3.D) suggest that there is no residual autocorrelation or ARCH effects.

Then, the results presented provide further evidence for an impact of regulated interest rates on the structure of China bond yields more substantial than other traditional instruments. First, interest rate regulation, measured through the net interest spread (difference between lending and deposit rates changes), affects significantly the level and slope factors of the Chinese bond yield curve. More precisely, a narrowing of regulated margins tends to push the slope up (negative coefficient on the slope) while long-term rates decrease (positive coefficient on the level). Therefore, the narrowing of regulated margins is associated with a steeper yield curve and lower levels of long-term rates that can be attributed to a loosening of monetary policy. The PBC reduced this lending-deposit rate spread several times in 2007-2008 and also in 2012.
Table 23: EGARCH model on Chinese yield curve latent factors over the period 2007-2013

<table>
<thead>
<tr>
<th>Variables</th>
<th>Level factor $\beta_0$</th>
<th>Slope factor $\beta_1$</th>
<th>Curvature factor $\beta_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean equation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag($\beta_{t-1}$)</td>
<td>0.23***</td>
<td>0.38***</td>
<td>0.21***</td>
</tr>
<tr>
<td></td>
<td>[0.05]</td>
<td>[0.04]</td>
<td>[0.05]</td>
</tr>
<tr>
<td>EC factor (t-1)</td>
<td>-0.06***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.01]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta$ Margin(t)</td>
<td>1.27***</td>
<td>-0.99***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.24]</td>
<td>[0.31]</td>
<td></td>
</tr>
<tr>
<td>$\Delta$ Deposit rate(t)</td>
<td>0.08*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.05]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta$ Deposit rate(t-1)</td>
<td></td>
<td>0.37***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.07]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta$ RRR (t+1)</td>
<td></td>
<td>0.001*</td>
<td>0.13*</td>
</tr>
<tr>
<td></td>
<td>[0.00]</td>
<td>[0.07]</td>
<td></td>
</tr>
<tr>
<td>OMO (t)</td>
<td>-0.07*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.04]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macro news (t)</td>
<td></td>
<td>-0.04***</td>
<td>0.12***</td>
</tr>
<tr>
<td></td>
<td>[0.01]</td>
<td>[0.04]</td>
<td></td>
</tr>
<tr>
<td>Macro surprise (t)</td>
<td>0.09**</td>
<td></td>
<td>-0.38*</td>
</tr>
<tr>
<td></td>
<td>[0.04]</td>
<td></td>
<td>[0.21]</td>
</tr>
<tr>
<td>$\Delta$ Shadow FF (t)</td>
<td>0.07**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.03]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta$ Shadow FF (t-1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta$ USlevel (t)</td>
<td>0.07***</td>
<td>-0.18***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.02]</td>
<td>[0.04]</td>
<td></td>
</tr>
<tr>
<td>$\Delta$ USslope (t)</td>
<td></td>
<td></td>
<td>0.12***</td>
</tr>
<tr>
<td></td>
<td>[0.03]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta$ US curvature(t-1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.04]</td>
<td></td>
<td>[0.03]</td>
</tr>
<tr>
<td>DUM Day (t)</td>
<td></td>
<td></td>
<td>-0.003***</td>
</tr>
<tr>
<td></td>
<td>[0.00]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variance equation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>-1.08**</td>
<td>-1.10**</td>
<td>-1.00***</td>
</tr>
<tr>
<td></td>
<td>[0.49]</td>
<td>[0.43]</td>
<td>[0.01]</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.36***</td>
<td>0.41***</td>
<td>0.43***</td>
</tr>
<tr>
<td></td>
<td>[0.11]</td>
<td>[0.13]</td>
<td>[0.13]</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.84***</td>
<td>0.81***</td>
<td>0.72***</td>
</tr>
<tr>
<td></td>
<td>[0.09]</td>
<td>[0.08]</td>
<td>[0.13]</td>
</tr>
<tr>
<td>GED</td>
<td>1.32***</td>
<td>1.07***</td>
<td>1.25***</td>
</tr>
<tr>
<td></td>
<td>[0.13]</td>
<td>[0.10]</td>
<td>[0.18]</td>
</tr>
<tr>
<td>Observation</td>
<td>363</td>
<td>363</td>
<td>362</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>431.0</td>
<td>290.9</td>
<td>-66.2</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.14</td>
<td>0.21</td>
<td>0.08</td>
</tr>
<tr>
<td>ARCH test (1 lag)</td>
<td>0.22</td>
<td>0.66</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Standard error of estimated coefficients are in brackets. ***, ** and * denote significance at 1%, 5% and 10% respectively. The ARCH test regresses the squared residuals on lagged squared residuals and a constant. Results of the test are p-value.

Source: Authors’ calculation
Empirical results

This had the consequence to lower directly banks’ profitability through reducing interest rate margins and provided incentives for banks to diversify assets to compensate profit loss such as expanding trading activities in the interbank bond market. This would in turn increase liquidity on the bond market (as shown on Figure 32) and enhance the functioning of the domestic bond market, favorable for increasing monetary policy transmission effectiveness.

Second, we find that the slope of the Chinese bond yield curve rises significantly with the increase of regulated deposit rates. This tightening effect can be interpreted amid a lack of demand among financial institutions which see their funding costs rise with the interest rate increase. Other tightening measures from RRR rise to liquidity withdrawal through open market operations respectively affect the curvature and the slope factor. Therefore, our results support two interpretations: (1) monetary policy instruments transmit well across the structure of bond yields in China but (2) prevent the potential ability of bond yield curve to serve for asset pricing from potential mismatch between bond yields and real macroeconomic or financial conditions since interest rates remain regulated.

However, the latter has to be mitigating because our results show strong evidence that the Chinese bond yield curve moves consistently with the macroeconomic situation. A positive macroeconomic surprise drives long-term interest rate up, reflecting adjusted expectations of the future macroeconomic situation, but the slope factor tends to decline with the positive macroeconomic releases suggesting a flattening of the yield curve. Then, the effect of macroeconomic determinants is more ambiguous on the medium-term segment of the yield curve with the curvature factor negatively affected by good macroeconomic surprise while positively affected by positive economic releases. Moreover, central bank communication does not appear to have a significant effect on the Chinese bond yield over the sample period (and for this reason excluded in presented results).

Conversely, while China’s bond market was largely closed to foreign investors over our sample, our results provide evidence of a parallel between China yield curve deformation and the one of the US bond yield curve with the China bond yield level, slope and curvature factors moving positively respectively with the US level, slope and curvature positive variations. Moreover, the evolution of the shadow Fed Funds rate tend to impact positively the China bond yield curve with a major effect on the long-term segment. Therefore, our results provide empirical evidence of a transmission of US monetary policy changes, including during the exceptional monetary easing after the GFC crisis on
the China economy. This can be explained with the increasing degree of trade openness of China especially since its WTO accession in 2001.

Our results are also consistent with other empirical studies analyzing the loss of control on capital movements by China. Among other works, Gunter (2006) have found that capital flight from China have been sharply accelerated since mid-2000s taking the form of mis-invoicing of exports and imports. Consequently, our results emphasize the role of domestic monetary policy and the macroeconomic situation in the evolving bond market but also the high importance for China to manage the impact of global monetary and financial forces. However, the conduct of monetary policy and the functioning of the bond market in China have evolved considerably over the last decade. Moreover, the global environment has been marked by the GFC crisis. Such components may suggest varying transmission effects of monetary policy and macroeconomic determinants.

3.5.4. ECM-EGARCH model over various sub-periods

The analysis of the transmission effects of domestic and foreign determinants on the term structure of interest rates over different sub periods will help highlight the evolving development of China’s bond market. Moreover, the GFC crisis may have impacted the transmission effects on the China bond market. Therefore, we estimate the slope and level factors changes over three sub-periods: (1) the pre-crisis period from January 2007 to August 2008 (2) the crisis period from August 2008 to November 2009 and (3) the post-crisis period from November 2009 to December 2013. Table 19 and 20 contain empirical results over the different sub-periods respectively for the level and slope factors. The results highlight significant varying effects of each determinant on China’s bond yield curve. Indeed, we find differentiated effects of the monetary policy instruments on the level and slope factors according to the sub-periods. Indeed, changes in interest rates, RRR or OMO have played a significant role on the movements of the China bond yield curve over the sample but their effects are varied across time. We find particularly that changes in interest rates significantly affect the level parameter, consistently with the expectation hypothesis, except during the global crisis. This is not

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40 We do not estimate the curvature factor model over the different sub-periods as results over the whole period was not as accurate than the slope and level models.
Empirical results

really a surprise as the PBC mainly operated administrative window guidance and helped China fighting against the global crisis.

More interestingly, the changes are more noticeable over the other determinants. First, the response of the yield curve movements to domestic macroeconomic surprises was stronger during the crisis period than the pre- or post-crisis periods. Indeed, during the crisis, macroeconomic surprises strongly impacted positively (negatively) the level (slope) of the yield curve. This shows the strong sensitivity of market reaction to macroeconomic news during “abnormal” periods.

Second, the effects of our central bank communication index appear particularly significant, more importantly during the GFC crisis on the level parameter, and changing sign on the level and slopes parameters after the crisis. Two reasons can explain this finding. First, the indicator may capture window guidance aspects during the crisis period. Indeed, central bank speeches have the advantage not only to explain traditional monetary policy actions on interest rates, RRR and OMO but can also take window guidance into account which is of high benefit particularly during the crisis since directing a record growth in bank credit was the means found by the Chinese authorities to side-step the transmission mechanism in driving bank credit growth. However, such practice is not statistically observable. Therefore, central bank communication about monetary policy appears in this sense as a genuine monetary policy instrument. Moreover, while central banks in advanced economies have used “forward guidance” to amplify the impact of monetary policy and to manage market expectations, the PBC may increase communication to reinforce monetary policy actions and attempting to manage market expectations. Therefore, the central bank may communicate to enhance more transparency and a rationale in its conduct of monetary. The central bank can even issue confusing “backward guidance” cautioning the market not to interpret its interest rate cut as monetary easing (Ma, 2015). Therefore, central bank speeches seems to play since the crisis two important roles, one of transparency by guiding the market about monetary policy decisions and second as a genuine monetary policy indicator.

Third, results highlight strong and constant positive effect of US level changes on China level changes before and during the crisis while decreases over the post-crisis period. Along similar lines, the US slope coefficient was strongly positive before and during the crisis, and turned negatively since the crisis. Therefore, the China yield curve response to US shocks at the zero lower bound
appear different from that in normal times, which suggests the presence of structural changes in US monetary policy transmission to China yield curve.

**Table 24: EGARCH model on the level factor $\beta_0$ over sub-periods**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean equation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag($\beta_0$,t-1)</td>
<td>0.32*** (0.06)</td>
<td>0.39*** (0.07)</td>
<td>0.23*** (0.05)</td>
</tr>
<tr>
<td>EC factor (t-1)</td>
<td>-0.03*** (0.01)</td>
<td>-0.11*** (0.03)</td>
<td>-0.07*** (0.02)</td>
</tr>
<tr>
<td>ΔDeposit rate(t)</td>
<td>0.28*** (0.06)</td>
<td>0.23** (0.09)</td>
<td>-0.06* (0.03)</td>
</tr>
<tr>
<td>ΔRRR (t-1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔRRR (t)</td>
<td>0.04** (0.02)</td>
<td>-0.30*** (0.00)</td>
<td></td>
</tr>
<tr>
<td>ΔRRR (t+2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macro news (t-1)</td>
<td>-0.07*** (0.00)</td>
<td>-0.02** (0.01)</td>
<td></td>
</tr>
<tr>
<td>Macro surprise (t)</td>
<td>0.53*** (0.012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speech (t)</td>
<td>0.01*** (0.00)</td>
<td>-0.02** (0.01)</td>
<td>-0.01* (0.00)</td>
</tr>
<tr>
<td>ΔShadow FF(t-1)</td>
<td>0.09*** (0.03)</td>
<td>-0.02*** (0.00)</td>
<td></td>
</tr>
<tr>
<td>ΔUSLevel (t-1)</td>
<td></td>
<td></td>
<td>0.06** (0.03)</td>
</tr>
<tr>
<td>ΔUSLevel (t)</td>
<td>0.21*** (0.03)</td>
<td>0.35*** (0.04)</td>
<td>-0.32*** (0.04)</td>
</tr>
<tr>
<td>ΔUSslope (t)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Variance equation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>-1.95*** (0.00)</td>
<td>-9.93*** (0.09)</td>
<td>-8.30*** (1.24)</td>
</tr>
<tr>
<td>Resid (t-1)^2</td>
<td>-1.37*** (0.00)</td>
<td>0.77*** (0.21)</td>
<td>0.51** (0.25)</td>
</tr>
<tr>
<td>Garch (t-1)</td>
<td>0.44*** (0.00)</td>
<td>-0.73*** (0.08)</td>
<td>-0.49** (0.34)</td>
</tr>
<tr>
<td>GED</td>
<td>4.9* (2.8)</td>
<td>4.9 (3.26)</td>
<td>1.24*** (0.15)</td>
</tr>
<tr>
<td>Observation</td>
<td>82</td>
<td>65</td>
<td>222</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>113.9</td>
<td>77.9</td>
<td>283.3</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.21</td>
<td>0.46</td>
<td>0.09</td>
</tr>
<tr>
<td>ARCH test (1-lag)</td>
<td>0.57</td>
<td>0.66</td>
<td>0.90</td>
</tr>
</tbody>
</table>

Standard error of estimated coefficients are in brackets. ***, ** and * denote significance at 1%, 5% and 10% respectively. The ARCH test regresses the squared residuals on lagged squared residuals and a constant. Results of the test are p-value.
Table 25: EGARCH model on the slope factor $\beta_1$ over sub-periods

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean equation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag($\beta_1$,t-1)</td>
<td>0.21*</td>
<td>0.38***</td>
<td>0.41***</td>
</tr>
<tr>
<td></td>
<td>[0.11]</td>
<td>[0.03]</td>
<td>[0.04]</td>
</tr>
<tr>
<td>$\Delta$Deposit rate(t-1)</td>
<td>0.47***</td>
<td>0.39***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.17]</td>
<td>[0.03]</td>
<td></td>
</tr>
<tr>
<td>$\Delta$RRR (t)</td>
<td></td>
<td>0.15***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.04]</td>
<td></td>
</tr>
<tr>
<td>$\Delta$RRR (t+1)</td>
<td>0.08**</td>
<td>0.15***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.04]</td>
<td>[0.04]</td>
<td></td>
</tr>
<tr>
<td>$\Delta$RRR (t+2)</td>
<td></td>
<td>0.36***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.05]</td>
<td></td>
</tr>
<tr>
<td>OMO(t)</td>
<td></td>
<td>-0.08**</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.03]</td>
<td></td>
</tr>
<tr>
<td>Macro news (t-1)</td>
<td>0.03*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.02]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macro news (t)</td>
<td>-0.05**</td>
<td>-0.04***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.02]</td>
<td>[0.01]</td>
<td></td>
</tr>
<tr>
<td>Macro surprise (t-1)</td>
<td>-0.88***</td>
<td>0.32***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.13]</td>
<td>[0.07]</td>
<td></td>
</tr>
<tr>
<td>Speech (t-1)</td>
<td>-0.01*</td>
<td>0.01*</td>
<td>0.01*</td>
</tr>
<tr>
<td></td>
<td>[0.00]</td>
<td>[0.00]</td>
<td>[0.01]</td>
</tr>
<tr>
<td>$\Delta$Fed Funds (t-1)</td>
<td>-0.18**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.07]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta$Shadow FF (t-1)</td>
<td>-0.15***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.04]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta$USlevel (t)</td>
<td>-0.15*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.09]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta$USslope (t)</td>
<td>0.12*</td>
<td>0.08***</td>
<td>-0.11***</td>
</tr>
<tr>
<td></td>
<td>[0.07]</td>
<td>[0.03]</td>
<td>[0.03]</td>
</tr>
<tr>
<td>Dum Month (t)</td>
<td></td>
<td>0.00***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.00]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Variance equation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>-2.94*</td>
<td>-8.35***</td>
<td>-1.28*</td>
</tr>
<tr>
<td></td>
<td>[1.65]</td>
<td>[0.68]</td>
<td>[0.74]</td>
</tr>
<tr>
<td>Resid (t-1)^2</td>
<td>0.91**</td>
<td>1.10***</td>
<td>0.46*</td>
</tr>
<tr>
<td></td>
<td>[0.39]</td>
<td>[0.43]</td>
<td>[0.23]</td>
</tr>
<tr>
<td>Garch (t-1)</td>
<td>0.55*</td>
<td>-0.72***</td>
<td>0.77***</td>
</tr>
<tr>
<td></td>
<td>[0.30]</td>
<td>[0.10]</td>
<td>[0.15]</td>
</tr>
<tr>
<td>GED</td>
<td>1.94***</td>
<td>0.90***</td>
<td>0.90***</td>
</tr>
<tr>
<td></td>
<td>[0.66]</td>
<td>[0.23]</td>
<td>[0.12]</td>
</tr>
<tr>
<td>Observation</td>
<td>82</td>
<td>65</td>
<td>215</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>85.9</td>
<td>63.0</td>
<td>179.1</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.27</td>
<td>0.48</td>
<td>0.24</td>
</tr>
<tr>
<td>ARCH test (1-lag)</td>
<td>0.69</td>
<td>0.64</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Standard error of estimated coefficients are in brackets. ***, ** and * denote significance at 1%, 5% and 10% respectively. The ARCH test regresses the squared residuals on lagged squared residuals and a constant. Results of the test are $p$-value.
3.6. Conclusion

With the gradual liberalization of the Chinese financial system, the interbank bond market is playing an increasing role in macro management, fund allocation and risk management. The object of this paper is to examine factors that explain major moves in the interbank bond yield curve in China over the period 2007-2013 on a weekly basis. More specifically, we question the ability of market determined rates to reflect liquidity conditions and act as benchmark for use in asset pricing and monetary policy. To answer, we quantify through a EGARCH model the transmission effects of price- and quantity-based based monetary policy instruments, as well as central bank speeches about monetary policy and macroeconomic composite indicators. Finally, we examine the potential spillover of the US monetary policy on the China bond yield curve examining the existence of a cointegration relationship between US and China yield curve parameters as well as short-term effects in the EGARCH model.

Results provide further evidence for an impact of regulated interest rates on the structure of China bond yields more substantial than RRR changes and open market operations. Moreover, the net interest spread, a measure of the interest rate regulation, seems also to affect significantly the level and slope factors of the Chinese bond yield curve. Therefore, our results emphasize that monetary policy instruments transmit well across the structure of bond yields in China but can prevent at least partially the ability of bond yield curve to serve for asset pricing since interest rates remain regulated.

However, the latter result has to be mitigating because our results show strong evidence that the Chinese bond yield curve moves consistently with the macroeconomic situation with more pronounced effects of macroeconomic surprises during the crisis period. Indeed, our results show stronger sensitivity of market reaction to macroeconomic news during “abnormal” periods. Moreover, the volatility of the bond yield curve appears also negatively affected by macroeconomic surprises.

Moreover, we find significant US spillover effects on the Chinese bond yield curve. Indeed, we identify a long-term relationship between the US and China level parameters of the yield curve. Moreover, our results provide empirical evidence of a transmission of US monetary policy changes, including the exceptional monetary easing after the GFC crisis on the China economy which can be
explained by the increasing degree of trade and financial openness of China. However, our results suggest the presence of structural changes in US monetary policy transmission to China yield curve with the responses to US shocks at the zero lower bound different from that in normal times.

Finally, with the transition to a more-market oriented system, we find that commercial banks, the main player on the bond market in China, seem to be increasingly responsive to central bank speeches about monetary policy, particularly after the burst of the GFC crisis. Indeed, we find a significant effect of our speech-based monetary policy index on the bond yield curve from the crisis, either to reinforce or caution the market about monetary policy instruments moves. This seems to highlight the increasing effort made by the central bank to enhance transparency by guiding the market about actual and future monetary policy decisions. Moreover, our analysis confirms the role of communication as a genuine monetary policy indicator, providing useful information about window guidance aspects, unobservable by nature. Therefore, our empirical analysis highlights that transmission mechanisms are already in place, at least over the last decade. We support the idea that further interest rate liberalization would enhance the ability of the bond yield curve to be used as a benchmark for pricing of risk and capital.
**Appendix 3.A: Key events on China bond market development**

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>Ministry of Finance started to issue treasury bonds in 61 cities in China as an experiment</td>
</tr>
<tr>
<td>Dec 1990</td>
<td>Establishment of the Shanghai Stock Exchange, which permitted trading of bonds</td>
</tr>
<tr>
<td>1994</td>
<td>Short sell of treasury bonds were permitted, and raised market risk substantially. T-Bond futures contracts were permitted to trade.</td>
</tr>
<tr>
<td>1995</td>
<td>Speculations and irregularities in T-bond trading led to the closure of regional T-bond trading centers, e.g., the Wuhan Trading Center, and T-bond features contracts were banned.</td>
</tr>
<tr>
<td>1995</td>
<td>OTC trading of T-bonds was stopped, and the Shanghai and Shenzhen Stock Exchanges became the only legal trading platforms. Book-entry bonds were issued in the Shanghai and Shenzhen Stock Exchanges, and the bond trading system was established with the increasing volume in re-purchase transactions.</td>
</tr>
<tr>
<td>May 1998</td>
<td>PBC started OMOs, which stimulated the development of interbank bond market of bond/notes trading.</td>
</tr>
<tr>
<td>Sept 1998</td>
<td>China Development Bank started to issue financial bonds in the interbank bond market.</td>
</tr>
<tr>
<td>Oct 1998</td>
<td>PBC approved insurance companies to become members of the interbank bond market.</td>
</tr>
<tr>
<td>Oct 1999</td>
<td>A portion of securities firms and all asset management firms became member of the interbank bond market.</td>
</tr>
<tr>
<td>Sept 2000</td>
<td>Financial firms were allowed by PBC to become members of the interbank bond market.</td>
</tr>
<tr>
<td>Oct 2002</td>
<td>Non-financial institutions were allowed by PBC to become members of the interbank bond market.</td>
</tr>
<tr>
<td>2005</td>
<td>Short-term corporate notes were allowed to be issued in the interbank bond market.</td>
</tr>
<tr>
<td>Jan 2007</td>
<td>The State Council allowed financial institutions to issue CNY denominated bonds in Hong Kong</td>
</tr>
<tr>
<td>Mar 2007</td>
<td>Corporate pension funds were allowed to trade in the interbank bond market.</td>
</tr>
<tr>
<td>Mar 2013</td>
<td>Qualified QFII investors are allowed to investment in the interbank bond market (previously, they were only allowed to invest in the A-share market and bonds listed in the Shanghai and Shenzhen exchanges)</td>
</tr>
</tbody>
</table>

Source: extracted from H Huang and N Zhu (2007)
Appendix 3.B: Accuracy of the Nelson-Siegel model applied in China case

Moreover, Figure 46 shows the estimation error at each maturity. It shows that the estimation errors are relatively low, particularly for the 1-year, 3-year, 7-year and 10-year maturities and confirms the accuracy of the Nelson-Siegel model.

Figure 46: Estimated error of the Nelson-Siegel model on China yield curve at each maturity

Source: Authors’ calculation
Appendix 3.C - Construction of a macroeconomic composite index of news and surprises

Our macroeconomic composite indicators are based on the following 10 indicators, extracted from Forex Factory website.

Table 27: Economic calendar for Chinese macroeconomic announcements

<table>
<thead>
<tr>
<th>Announcement</th>
<th>Frequency</th>
<th>Release date</th>
<th>Units</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real GDP (YoY)</td>
<td>Quarterly</td>
<td>15-20th</td>
<td>%</td>
<td>NBS</td>
</tr>
<tr>
<td>Industrial Production (YoY)</td>
<td>Monthly</td>
<td>9-10th</td>
<td>%</td>
<td>NBS</td>
</tr>
<tr>
<td>Manufacturing purchasing manager index</td>
<td>Monthly</td>
<td>1st</td>
<td>Index</td>
<td>NBS</td>
</tr>
<tr>
<td>HSBC Manufacturing purchasing manager index</td>
<td>Monthly</td>
<td>1st-2nd</td>
<td>Index</td>
<td>HSBC</td>
</tr>
<tr>
<td>Consumer price index (YoY)</td>
<td>Monthly</td>
<td>9-10th</td>
<td>%</td>
<td>NBS</td>
</tr>
<tr>
<td>Producer price index (YoY)</td>
<td>Monthly</td>
<td>9-10th</td>
<td>%</td>
<td>NBS</td>
</tr>
<tr>
<td>Retail sales (YoY)</td>
<td>Monthly</td>
<td>9-10th</td>
<td>%</td>
<td>NBS</td>
</tr>
<tr>
<td>Trade balance</td>
<td>Monthly</td>
<td>8th</td>
<td>USD bn</td>
<td>GAC</td>
</tr>
<tr>
<td>Fixed assets investment (YoY)</td>
<td>Monthly</td>
<td>9-10th</td>
<td>%</td>
<td>NBS</td>
</tr>
<tr>
<td>M2 growth (YoY)</td>
<td>Monthly</td>
<td>9th-11th</td>
<td>%</td>
<td>PBOC</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations based on data from Forex Factory

To allow a comparison of the different macroeconomic news, the indicators are scaled with the min-max process. Then, the macroeconomic news composite indicator computes the average of the 10 “harmonized” macroeconomic news. The macroeconomic surprise composite index aggregates the difference between the 10 macroeconomic news indicators and expected data from the Consensus (extracted from Forex Factory).

\[41 \text{In January, April, July and October, industrial production, retail sales and fixed asset investments are published between the 15th and 20th with the release of real GDP growth.}\]
Appendix 3.D – Details on EGARCH estimation over 2007-2013

Figure 47: Fitted latent factors and residuals

Fitted slope factor  
Residual on slope factor

Fitted level factor  
Residual on level factor

Fitted curvature factor  
Residual on curvature factor
Appendix 3.E – Details on EGARCH estimation over sub-periods

Figure 48: Fitted slope and level factors over sub-periods

<table>
<thead>
<tr>
<th>Level factor</th>
<th>Slope factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 2008/November 2009</td>
<td>August 2008/November 2009</td>
</tr>
</tbody>
</table>
Figure 49: Residuals on estimated slope and level factors over sub-periods

**Level factor**
- January 2007/August 2008
- August 2008/November 2009
- November 2009/December 2013

**Slope factor**
- January 2007/August 2008
- August 2008/November 2009
- November 2009/December 2013
This thesis has provided a comprehensive analysis of two crucial aspects of the economic transition of China towards a more-market oriented system. Chapter 1 and 2 examined the monetary policy formation and its macroeconomic determinants while Chapter 3 focused on the transmission of monetary policy through the interest rate channel.

Chapter 1 focuses on the monetary policy setting in China, conducted by the People's Bank of China. This chapter emphasizes the important interrelation between partial economic reforms, the state-controlled nature of the financial system and the conduct of monetary policy in China. This review is of particular interest to avoid any misunderstanding of the complex conduct of monetary policy and allows us to explain why the central bank has employed a large range of instruments in the implementation of its monetary policy. Accordingly, many questions remain about how properly measuring the monetary policy in China since no single instrument can constitute an adequate representation of the monetary policy stance.

Therefore, the first chapter presents two alternative approaches to measure accurately the monetary policy, one based on price- and quantity-instruments (including window guidance aspects) and the second based on central bank speeches extracted from press information. Both are substitutes and prove to be essential to take into account the complex and adaptive behaviour of the People's Bank of China. Moreover, our instrument-based indicator, named the monetary policy index (MPI), emphasizes a change in style towards smoother but more hawkish policy moves from 2002 onwards, consistent with a number of institutional, economic and financial reforms, including the start of the mandate of Governor Zhou Xiaochuan, greater financial and trade openings following the WTO accession of China in December 2001 and the new step towards gradual interest rate liberalization.

The second chapter enhances the understanding of China’s monetary policy rule since the mid-1990s, focusing on the role of inflation. It aims at evaluating the rule followed by the People’s Bank of China (PBC), by considering both the structural economic transformation of the country and its evolving monetary policy framework. The estimation of a dynamic discrete-choice model à la Monokroussos (2011) implies from 2002 onwards a conduct of monetary policy characterized by implicit inflation targeting. The PBC’s behaviour pre-2002 resembles that of the pre-1979 inflation-
accommodating G3 countries, and is characterized after 2002 by a policy rule similar to the post-
1979 anti-inflation (forward-looking) policy of the G3. An accurate estimation of the monetary policy
rule after 2002 needs to consider China as an open-economy with its rapid trade and financial
opening after its WTO accession in 2001 and the significant influence of US interest rate policy.\textsuperscript{42}

The third chapter has focused on the monetary policy transmission mechanism across the bond yield
curve in China. It examines the evolving bond market development and questions the ability of
market determined rates to reflect liquidity conditions and act as a benchmark for use in asset
pricing and monetary policy, which represents a crucial step towards the liberalization of the financial
system in China. This study consists in examining whether changes in the three latent factors (i.e. the
level, the slope and the curvature) of the Chinese bond yield curve can be explained by fundamental
factors.

The results provide further evidence for an impact of regulated lending and deposit rates on the
structure of China bond yields more substantial than that of other traditional instruments. Moreover,
we find that the bond yield curve moves consistently with the macroeconomic news and surprises,
highlighting adjusted market expectations of the future macroeconomic situation contained in the
movements of the yield curve. Then, our central bank speech-based indicator appears as a significant
driver of the yield curve after the burst of the GFC. Therefore, the enhanced effort made by the PBC
to communicate about its conduct of monetary policy seems successful in the management of
market expectations. In addition, we argue that this indicator is particularly useful to capture
administrative window guidance effects on the bond yield curve during the GFC. Finally, we find
significant US spillover effects on the Chinese bond yield curve. Indeed, our results show a
transmission of US monetary policy changes, including the exceptional monetary easing after the
GFC (measured through the deformation of the US bond yield curve’s latent factors and a shadow
Fed Funds interest rate).

Therefore, this chapter concludes on a mixed interpretation about the ability of the bond yield curve
to represent a good benchmark for asset pricing. Indeed, the monetary policy transmission
effectiveness seems to have emerged over the last decade with monetary policy actions (either

\textsuperscript{42} Preliminary results of the research conducted in this chapter have been published in BIS papers n°77 (2014)
following the BIS-PBC research conference on “Globalisation, inflation and monetary policy in Asia and the Pacific” in
Beijing in September 2013.
changes in instruments or speeches), macroeconomic factors and the US monetary policy transmitting well across the bond yield curve in China. However, the specific impact of the remaining regulated interest rates on the bond yield curve alters the potency of the latter to reflect real macroeconomic or financial conditions in China.

Overall, this thesis conveys some insights about the evolving economic transition to a more market-oriented system. First, we have highlighted the change in the conduct of monetary policy in China, particularly from 2002, involving on the one hand the adoption of a framework similar to informal inflation-targeting, taking into account forward-looking aspects, and on the other the influence of the US monetary policy environment in the context of trade and financial openness of the Chinese economy. Such results are also in line with the gradual domestic financial liberalization process. Moreover, we emphasize the emergence of monetary policy transmission effectiveness over the last decade with significant effects of traditional monetary policy instruments and macroeconomic factors on Chinese bond yield curve.

Both results prove that China is putting in place the required mechanisms to achieve successfully and smoothly its economic transition to a more market-oriented system by (1) adapting the monetary policy setting to macroeconomic determinants and (2) allowing progressively a more efficient allocation of capital through a lower reliance on bank loans, more trading activity, an increasing number of market participants and greater competition in the bond market. At the same time, the interrelation between economic reforms, the evolving financial system and the monetary policy framework would evolve accordingly. More specifically, the progressive interest rate liberalisation would reduce the dominance of the central bank and also the state control on the financial system reducing their rooms for managing economic reforms and likely generating a higher vulnerability of the Chinese economy.

Going forward, the central bank will continue to adapt its monetary policy to the economic and financial environment in China. For instance, the PBC already introduced early 2013 new tools, the short-term liquidity operations (SLO), and the standing lending facility (SLF), to reduce interest rate volatility and ensure adequate liquidity. Such tools could be included in our Monetary Policy Index (MPI) over this more recent sample, since this Index is able to account for the continuous adaptive monetary policy, and is thus an appropriate flexible tool to measure monetary policy in China. Besides, it would be strongly relevant to extend our research by building an adjusted MPI with time-
varying weights on each monetary policy instrument as the gradual interest rate liberalisation is likely to reduce the effectiveness of quantitative instruments, such as window guidance, while increasing the role of price instruments.
Conclusion générale

Cette thèse a fourni une analyse de deux aspects importants dans la transition économique de la Chine vers un système plus orienté vers les mécanismes de marché. Les chapitres 1 et 2 ont examiné la formation de la politique monétaire et de ses déterminants macroéconomiques. Le chapitre 3 a analysé la transmission de la politique monétaire par le canal des taux d’intérêt.

Le chapitre 1 se concentre sur la formation de la politique monétaire en Chine, menée par la Banque Populaire de Chine. Ce chapitre met l’accent sur l’importance du lien entre certaines réformes économiques, la nature étatique du système financier et la conduite de la politique monétaire en Chine. Cette analyse est particulièrement utile pour éviter toute mauvaise compréhension de la conduite complexe de la politique monétaire et nous permet d’expliquer pourquoi la banque centrale a employé un large éventail d’instruments dans la mise en œuvre de sa politique monétaire. En conséquence, de nombreuses questions demeurent sur la manière de mesurer correctement la politique monétaire en Chine car aucun instrument unique ne peut représenter de manière adéquate l’orientation de la politique monétaire.

Par conséquent, le premier chapitre introduit deux approches alternatives pour mesurer avec précision la politique monétaire, la première basée sur les instruments (prix, quantité ainsi que les mesures administratives) et la seconde basée sur les discours de la banque centrale extraits des articles des médias. Les deux sont des substituts et se révèlent essentiels pour prendre en compte la conduite complexe et adaptative de la Banque Populaire de Chine. De plus, notre indicateur basé sur les instruments, appelé Indice de Politique Monétaire, met en évidence un changement de style dans la politique après 2002, à la fois plus graduelle et plus agressive envers l’inflation, en accord avec un certain nombre de réformes institutionnelles, économiques et financières, y compris le début du mandat du gouverneur Zhou Xiaochuan, l’ouverture commerciale et financière de la Chine depuis son adhésion à l’OMC en décembre 2001 et le processus de libéralisation progressive des taux d’intérêt.

Le deuxième chapitre accroît la compréhension de la règle de politique monétaire suivie par la Chine depuis le milieu des années 1990s, en se concentrant sur le rôle de l’inflation. Il vise à évaluer la règle suivie par la Banque Populaire de Chine, en tenant compte à la fois de la transformation économique

Le troisième chapitre a mis l’accent sur les mécanismes de transmission de la politique monétaire à travers la courbe des rendements obligataires en Chine. Il examine le développement du marché obligataire et s’interroge sur la capacité des taux obligataires, déterminés par le marché, de refléter les conditions de liquidité et d’être utilisés comme référence pour évaluer les prix des actifs et la politique monétaire, ce qui représente une étape importante vers la libéralisation du système financier en Chine. Cette étude consiste à examiner si les variations des trois facteurs latents de la courbe de taux (soit le niveau, la pente et la courbure) peuvent être expliquées par des facteurs fondamentaux.

Les résultats mettent en évidence un impact significatif des taux des dépôts et des prêts sur la structure par terme des taux d’intérêt en Chine, plus important que ceux des autres instruments traditionnels. De plus, nous constatons que les paramètres de la courbe de taux varient de manière significative avec les annonces et surprises macroéconomiques, suggérant un ajustement des anticipations du marché sur la situation macroéconomique future. Ensuite, notre indicateur basé sur les discours de la banque centrale apparaît comme un facteur faisant également varier la courbe de taux, particulièrement depuis la crise financière globale. Par conséquent, l’effort accru de la BPC de communiquer davantage sur sa conduite de la politique monétaire semble fonctionner pour influencer les anticipations du marché. De plus, nous pensons que cet indicateur est particulièrement utile pour capturer les effets des directives administratives sur la courbe de taux pendant la crise financière. Enfin, nous trouvons des effets significatifs de la politique monétaire américaine, y compris l’assouplissement monétaire exceptionnelle post-crise (mesuré par la déformation des facteurs latents de la courbe des taux américains et un taux d’intérêt « shadow »), sur la courbe de taux chinoise.
General conclusion

Par conséquent, ce chapitre se termine sur une interprétation mixte sur la capacité de la courbe des rendements obligataires à représenter un bon point de référence pour l’évaluation des actifs. En effet, l’efficacité de la transmission de la politique monétaire semble avoir émergé au cours de la dernière décennie avec une bonne transmission des actions de la politique monétaire (à la fois les instruments et les communications), des facteurs macroéconomiques et de la politique monétaire américaine sur la courbe des taux en Chine. Cependant, l’impact spécifique des taux d’intérêt réglementés sur la structure par terme des taux altère la capacité de ce dernier à refléter les conditions macroéconomiques et financières réelles en Chine.


Ces résultats montrent bien que la Chine met en place les mécanismes nécessaires pour réussir sa transition économique vers un système plus axé sur les mécanismes de marché par (1) l’adaptation de la conduite de la politique monétaire en fonction des déterminants macroéconomiques et (2) permettant progressivement une allocation plus efficiente du capital par un moindre recours aux prêts bancaires, un marché obligataire plus actif, plus liquide et plus compétitif grâce à un nombre croissant de participants sur le marché. Par ailleurs, les réformes économiques, l’évolution du système financier et le cadre de la politique monétaire devraient évoluer conjointement. Plus précisément, la libéralisation progressive des taux d’intérêt devrait réduire la domination de la banque centrale et aussi le contrôle de l’État sur le système financier mais en réduisant leurs marges de manœuvre dans les réformes économiques et susceptibles également de générer une plus grande vulnérabilité de l’économie chinoise.
A l’avenir, la banque centrale continuera à adapter sa politique monétaire à l’environnement économique et financier de la Chine. Par exemple, la BPC a déjà introduit mi-2013 de nouveaux instruments (tels que « Short-term Liquidity Operations » et « Standing Lending Facility ») afin de réduire la volatilité des taux d’intérêt et d’assurer une liquidité adéquate. Ces outils pourraient être inclus dans notre indicateur de politique monétaire depuis 2013 puisque notre méthodologie permet justement de prendre en compte la politique monétaire adaptative de manière continue, et est donc un outil flexible et approprié pour mesurer la politique monétaire en Chine dans son ensemble. En outre, il serait utile d’étendre notre recherche en construisant un indicateur ajusté avec des poids variant dans le temps pour chaque instrument de politique monétaire puisque la libéralisation des taux d’intérêt devrait réduire l’efficacité des instruments quantitatifs, tels que les mesures administratives, tout en augmentant le rôle des taux d’intérêt.
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