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Régulation des cycles financiers dans la zone euro : quel rôle pour la politique macroprudentielle ?

Regulating financial cycles in the euro area: what role for macroprudential policy?

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RÉGULATION DES CYCLES FINANCIERS DANS LA ZONE EURO : QUEL RÔLE POUR LA POLITIQUE MACROPRUDENTIELLE ?

Sous la direction de

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L'Université Grenoble Alpes n'entend donner aucune approbation ou improbation aux opinions émises dans cette thèse. Ces opinions doivent être considérées comme propre à leur auteur.

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Résumé de la thèse en français

Régulation des cycles financiers dans la zone euro : Quel rôle pour la politique macroprudentielle ?

1. Introduction

La crise financière de 2008-2009, d'une ampleur et d'une durée sans précédent, s'est propagée rapidement des États-Unis à l'ensemble des économies mondiales, qu'elles soient développées ou émergentes. Comparée par certains à la crise de 1929, elle est jugée encore plus grave en raison de l'intégration financière internationale croissante, de la déréglementation et des innovations financières. Dans la zone euro, la crise financière de 2008-2009 a révélé les limites de la politique monétaire unique en tant que principal outil d'ajustement macroéconomique, qui non seulement n'a pas réussi à réguler le cycle financier, mais a également contribué aux divergences intra-zone. Bien qu'une complémentarité avec des instruments budgétaires nationaux aurait été utile pour réagir à la crise durant la phase descendante du cycle, c'est surtout durant la phase ascendante que se forment les déséquilibres, souvent financiers avant d'être économiques, ce qui rend la politique budgétaire insuffisante (Couppey-Soubeyran et Dehmej, 2017).

La crise de la dette souveraine européenne, survenue à la suite de la crise financière, a exacerbé les divergences économiques et financières entre les États membres. Cette crise a montré comment les problèmes budgétaires dans un petit nombre de pays de la zone euro pouvaient déclencher des turbulences sur les marchés financiers mondiaux, affectant la confiance des investisseurs et les conditions de financement international (Demiris et Kypraios, 2014). Ces facteurs ont mis en évidence les insuffisances des politiques de régulation traditionnelles (telles que la régulation et la supervision microprudentielle – la supervision des banques – la régulation et la supervision des marchés financiers, la politique budgétaire, la politique monétaire) dans le cadre de la stabilité financière, et la nécessité de renouveler et/ou de compléter les approches de la régulation du système financier notamment en y adjoignant une approche macroprudentielle.

La politique macroprudentielle (MaP), bien qu'elle n'ait pas de définition unique (Maes, 2009 ; Clement, 2010), peut être définie selon le CGFS (2012)[1] comme visant à limiter le risque systémique à la fois dans sa dimension transversale (risque entre les établissements financiers à un moment

[1] CGFS pour Committee on the Global Financial System.

donné – effet de contagion) et dans sa dimension temporelle (évolution du risque systémique dans le temps – accumulation de déséquilibres financiers et atténuation du cycle financier). L'objectif est de prévenir les dysfonctionnements du système financier dans son ensemble qui pourraient avoir des conséquences macroéconomiques sur l'économie réelle. Il s'agit donc de prévenir les crises financières en évitant la formation de déséquilibres financiers, de phénomènes procycliques et de bulles spéculatives, plutôt que de gérer les crises une fois qu'elles éclatent.

Cette approche n'est pas entièrement nouvelle mais a regagné en importance après la crise de 2008-2009 avec l'apparition de nombreux instruments macroéconomiques et microéconomiques destinés à répondre à l'instabilité financière mondiale causée par cette crise (Galati et Moessner, 2013 ; Claessens, 2014). Son efficacité repose sur trois piliers essentiels : (i) la gouvernance de cette politique, (ii) l'identification des défaillances de marché et la sélection des instruments appropriés pour y remédier, et (iii) la compréhension des mécanismes de transmission et l'interaction avec les autres politiques économiques, telles que les politiques budgétaire, monétaire et microprudentielle. Les instruments macroprudentiels sont variés et incluent, entre autres, les coussins de capital contracycliques, les plafonds de ratio prêt-valeur (loan-to-value ratio), les limites sur les expositions interbancaires et les restrictions sur les activités à haut risque. Ces outils visent à renforcer la résilience des institutions financières, à limiter l'accumulation excessive de risques et à atténuer les comportements procycliques.

L'adoption de l'approche macroprudentielle après la crise de 2008-2009 a suscité de nombreux débats au sein de la communauté scientifique en raison des défis inhérents à cette approche. Premièrement, la MaP n'est pas neutre vis-à-vis des autres politiques économiques, ce qui peut entraîner des interférences ou des blocages entre différentes autorités, en particulier dans la zone euro. Dans cette région, la dynamique spécifique repose sur la cohabitation d'une politique monétaire unique, dirigée par la Banque centrale européenne (BCE), avec des politiques budgétaires et des réglementations nationales. Cette dualité de politiques engendre des défis particuliers pour la régulation des cycles financiers. La coopération entre les autorités nationales et la BCE est cruciale pour la mise en œuvre efficace des politiques macroprudentielles, mais est souvent entravée par des intérêts nationaux divergents et des disparités dans les structures et pratiques réglementaires. Deuxièmement, la mise en place d'une MaP efficace est intrinsèquement difficile. D'une part, la nature politiquement sensible de ces mesures peut conduire à l'inaction. D'autre part, après une série de crises graves, le régulateur macroprudentiel peut être enclin à un interventionnisme excessif. Cette thèse vise à contribuer à ces débats en explorant ces défis et en proposant des solutions.

En se basant sur les limites des cadres d'analyse précédents, mises en évidence dans les débats concernant les impacts des instruments macroprudentiels sur la stabilité financière depuis la crise de 2008, cette thèse vise à étudier l'effet de la MaP sur la stabilité financière de la zone euro. D'une part, nous montrons que l'indice de stabilité financière agrégée (ISFA) est préférable aux autres indicateurs de surveillance du risque financier, car il estime mieux la réponse intuitive du cycle financier après un choc. D'autre part, le cadre d'analyse QPM (new Keynesian quarterly projection model) offre des indications précieuses sur l'impact des chocs financiers et l'efficacité des politiques pour promouvoir la stabilité financière. Par ailleurs, nous montrons également que l'effet des politiques budgétaires sur la stabilité financière dépend du niveau de la dette publique.

2. Contribution de la thèse à la littérature : débat sur la mesure de la stabilité financière, les cadres d'analyse de la MaP et les effets de la politique fiscale sur la stabilité financière

La contribution de la thèse à la littérature est large et diversifiée. La thèse est constituée de trois chapitres dont chacun analyse la revue de littérature existante. Le chapitre 1 étudie les récents débats sur la stabilité financière et sa mesure, analyse les inconvénients des mesures existantes dans la littérature tout en proposant une mesure alternative robuste de la stabilité financière. Le chapitre 2 étudie une très large littérature sur les différents cadres d'analyse empirique des politiques macroprudentielles, notamment les modèles économétriques traditionnels (les modèles VAR et GMM), les modèles DSGE[2] ainsi que les modèles cœur-périphérique, tout en intégrant un nouveau cadre d'analyse celui des modèles de projections trimestrielles. Le chapitre 3 présente une revue de littérature riche et contrastée des effets des multiplicateurs budgétaires sur la position budgétaire en tant que facteur essentiel de la stabilité financière, le lien entre la dynamique des marchés du crédit et la transition vers un choc fiscal, et la politique fiscale et les marchés financiers.

2.1 Résumé du débat empirique sur la définition de la stabilité financière et les différentes méthodes utilisées pour sa mesure

A la différence de la stabilité des prix qui a une définition précise et transparente, la stabilité financière, quant à elle, ne repose pas sur une définition unique. Il s'agit d'un concept complexe que plusieurs auteurs ont essayé de définir. Parmi ceux-là, certains la définissent par son contraire, c'est-à-dire par l'absence d'instabilité financière (Mishkin, 1999 ; Ferguson, 2002 ; Davis, 2023),

[2] Dynamic stochastic general equilibrium.

tandis que d'autres la définissent directement (Schwartz, 1986 ; Crockett,1997 ; Foot, 2003 ; Hesse et Čihák, 2007 ; Chant, 2010 ; Agoraki et al., 2011), c'est-à-dire par l'instabilité.

Fondamentalement, un système financier peut être caractérisé comme stable en l'absence de volatilité excessive, de stress ou de crises (Gadanecz et Jayaram, 2008). Bien que cette définition étroite soit relativement simple à formuler, elle ne tient pas compte de la contribution positive d'un système financier qui fonctionne bien à la performance économique globale. Une définition plus large est donc nécessaire, incluant la dimension macroéconomique de la stabilité financière et l'interaction entre le secteur financier et le secteur réel. Bennani et al. (2017) définissent la stabilité financière comme un état du système financier par lequel celui-ci fait preuve de résilience face à des épisodes stressants et des chocs financiers ou réels. Bien que cette définition fasse explicitement référence à la capacité à résister aux chocs, celle-ci est toujours appréciée, ce qui donne un caractère statique à la définition adoptée.

Ainsi, ne reposant pas sur une définition précise, la stabilité financière reste difficile à mesurer. Cependant, au cours des dernières années, plusieurs recherches académiques se sont concentrées sur divers indicateurs statistiques qui illustraient et décrivaient la vulnérabilité du système financier pour évaluer la stabilité financière (FMI, 2006 ; Law et Ibrahim, 2017 ; Brave et Butters, 2011 ; Dent et al., 2016 ; Akosah et al., 2018). Les différentes méthodes quantitatives utilisées pour évaluer la stabilité financière sont, notamment, les systèmes d'alerte précoces, les stress tests, et les indices de stabilité financière agrégés. Chaque méthode à ces avantages et ces inconvénients. Les systèmes d'alerte précoces, par exemple, bien qu'ils permettent d'identifier les vulnérabilités sous-jacentes, ont l'incapacité à prédire le moment exact des crises. Les stress tests, quant à eux, permettent de détecter les sources de risque et les vulnérabilités mais ne parviennent que très rarement à capturer le risque systémique. Enfin, concernant les indicateurs financiers agrégés, ils permettent de faire des comparaisons de différents systèmes financiers et de suivre l'évolution de la stabilité. Cependant, leur mise en place repose sur plusieurs étapes, notamment la sélection des différentes variables (financières et macroéconomiques) et la technique de pondération.

Pour résumer, il ressort de toutes ces recherches que la définition de la stabilité financière et sa mesure n'ont abouti à aucun consensus. Les rapports de stabilité financière, publiés par les banques centrales, sont ainsi des éléments indispensables pour analyser les risques. Ils augmentent la transparence, contribuent à la stabilité financière et renforcent la coopération entre les acteurs du secteur financier.

2.2 Résumé du débat sur les différents cadres d'analyse empirique des politiques macroprudentielles

Depuis l'apparition des politiques macroprudentielles, le cadre d'analyse standard a été les modèles DSGE (Jeanne, 2014 ; Korinek et Sandri, 2016). Par exemple, Jeanne (2014) utilise un modèle DSGE pour comparer les effets des politiques prudentielles nationales et des contrôles des capitaux et montre que les politiques nationales sont préférables mais peuvent nécessiter des contrôles des capitaux en cas de contraintes réalistes. D'autre part, de nombreuses études ont analysé les défis spécifiques liés à la zone euro à travers des modèles cœur-périphérie (Gerali et al., 2010 ; Quint et Rabanal, 2014). Gerali et al. (2010), par exemple, intègrent un secteur bancaire imparfaitement concurrentiel dans un modèle DSGE avec des frictions financières, et dénotent que le secteur bancaire atténue les chocs de demande mais propage les chocs d'offre. Certaines études telles que celle de Bielecki et al. (2019) et Darracq Pariès et al. (2019) mettent en évidence les synergies et les compromis entre les politiques monétaires et macroprudentielles au sein de l'Union économique et monétaire (UEM). Badarau et al. (2020) ont réexaminé le postulat selon lequel une mise en œuvre nationale de la MaP est toujours préférable et trouvent que, sous certaines conditions, une internalisation est préférable.

Par ailleurs, d'autre études empiriques utilisant notamment les modèles VAR ont examiné l'impact des politiques macroprudentielles sur les variables macroéconomiques et leur lien avec la politique monétaire (Claessens et al., 2013 ; Kuttner et Shim, 2016 ; Cerutti et al., 2017). Il en résulte que les mesures comme les plafonds de ratio prêt-valeur (loan-to-value – LTV – ratio) réduisent la croissance des actifs et du crédit immobilier, et peuvent influencer la croissance des prix des logements. Akinci et Olmstead-Rumsey (2018) soulignent que les politiques macroprudentielles ont été plus actives depuis la crise financière mondiale et qu'elles ont principalement ciblé le secteur du logement. Alam et al. (2019) mettent en lumière des effets forts et non linéaires des changements de LTV sur le crédit des ménages. Fernandez-Gallardo et Paya (2020) en utilisant un modèle VAR structurel analysent les effets des chocs de MaP, et montrent qu'ils contribuent à la stabilité financière.

Même si elles comportent certaines limites, ces études offrent des perspectives importantes. Elles se distinguent par l'intégration des variables financières, cruciales pour examiner l'effet des chocs financiers. Cela renforce considérablement leur contribution à la pertinence de la MaP. Ces modèles proposent une analyse spécifique au contexte de la zone euro, mais sont souvent basées sur des hypothèses simplificatrices qui ne reflètent pas la complexité de la sphère réelle de l'économie. Certains modèles, en particulier les modèles DSGE, sont complexes et nécessitent une expertise technique avancée pour leur interprétation.

2.3 Résumé du débat sur les effets de la politique fiscale sur la stabilité financière

La recherche empirique sur les impacts des chocs de politiques fiscales sur la stabilité financière est limitée par rapport à l'abondance des travaux concernant les impacts sur l'activité économique réelle, donnant lieu à de nombreux débats. Cependant, d'innombrables études ont examiné les effets des multiplicateurs fiscaux sur différents éléments qui influencent la stabilité financière, notamment la position fiscale. Parmi ces études nous pouvons citer Corsetti et al. (2012), Blot et al. (2014b), Bi et al. (2016), Aussilloux et al. (2018). Par exemple, Blot et al. (2014b) analysent les effets des multiplicateurs budgétaires sur la dynamique de la dette publique et sur la production dans les pays européens. En outre, Poghosyan (2017) analyse les facteurs qui influencent les cycles de la dette souveraine à l'échelle mondiale, et montre une relation asymétrique entre les cycles financiers et les cycles de la dette.

Un autre aspect intéressant de ce débat est le marché du crédit. En effet, le marché du crédit joue un rôle important dans la transmission des chocs budgétaires à l'économie globale. Favara et Imbs (2015) et Justiniano et al. (2015) étudient l'impact de l'offre de crédit sur les marchés immobiliers. Ces recherches utilisent des modèles d'équilibre général et montrent comment il est important de comprendre que la politique budgétaire peut avoir des effets négatifs sur les conditions de crédit, le prix des actifs et, par conséquent, la stabilité financière. Par ailleurs, d'autre études, notamment Jappelli et Pistaferri (2007), mettent en évidence comment les mesures fiscales, telles que les subventions et les politiques fiscales, peuvent impacter les dynamiques des marchés immobiliers. Par exemple, les taxes sur les gains en capital des logements, la TVA réduite sur les achats de maisons, la déductibilité fiscale des paiements d'intérêts, ou la taxation de la valeur locative imputée du logement sont des exemples de l'impact de la politique budgétaire.

D'autre part, certaines études se sont axées sur les réactions des marchés financiers suite aux changement significatifs des politiques fiscales. Darrat (1988) montre que le marché financier canadien réagit positivement à la suite d'un accroissement des déficits publics. Cependant, l'auteur soutient également que en tenant compte des valeurs retardées des déficits publics, cette réaction devient négative. Ce résultat a été contesté par des études comme van Aarle et al. (2003), Ardagna (2009) et Agnello et Sousa (2011). Certaines études plus récentes soulignent également l'influence significative des politiques fiscales sur les marchés financiers (Foresti et Napolitano, 2016 ; Taguchi et Enkhbaatar, 2019 ; André et al., 2023).

3. Contribution empirique de la thèse

Compte tenu de la structure de la zone euro et de la question de la stabilité financière, nous nous sommes concentrés sur l'étude d'un échantillon de 11 pays de la zone euro, à savoir l'Autriche, la Belgique, la Finlande, la France, l'Allemagne, la Grèce, l'Irlande, l'Italie, les Pays-Bas, l'Espagne et le Portugal[3].

3.1 Contribution empirique du chapitre 1 : ISFA, mesure robuste de la stabilité financière et outils de surveillance du risque

Le chapitre 1 propose un indicateur robuste de mesure de stabilité financière appelé indice de stabilité financière agrégée (ISFA)[4] pour les pays de la zone euro. La méthodologie utilisée s'inspire des travaux de Cheang et Choy (2009) et d'Akosah et al. (2018), et emploie 23 variables de différents marchés (actions, crédit, monétaire, change) et d'autres indicateurs macroéconomiques clés sur la période 2007-2020 (à partir de données trimestrielles). Les variables sont ensuite classées en sous-catégorie et normalisées empiriquement. Chaque sous-catégorie donne lieu à un sous-indice. Les ISFA s'obtiennent en pondérant les sous-indices composites (développement financier, solidité financière, vulnérabilité financière, conditions monétaires, climat économique mondial) à l'aide de la moyenne arithmétique uniformisée des poids obtenus à partir de l'analyse en composantes principales utilisant l'algorithme de maximisation de l'espérance. Les périodes de récession dans la zone euro et à l'international, identifiées par le NBER, le CEPR et l'ECRI[5], servent de référentiel d'évaluation de nos indicateurs. Les ISFA suivent de près la stabilité financière, chutent en période de récession et atteignent des valeurs élevées en période de prospérité, particulièrement pour l'indice agrégé des 11 pays de la zone euro.

Le chapitre 1 établit également une comparaison des ISFA avec les autres indicateurs de surveillance du risque financier, notamment le risque macroéconomique et le risque financier. En effet, à travers les réponses impulsionnelles des modèles VAR, nous évaluons la dynamique du cycle suite à un choc mesuré par ces différents indicateurs de surveillance. Les résultats obtenus sont robustes en considération de la divergence des cycles financiers dans la zone euro. Toutefois, lorsque notre ISFA mesure le risque financier, la réponse du cycle financier aux chocs est similaire dans tous les pays (les cycles financiers diminuent d'abord puis augmentent) malgré les différences dans l'ampleur des chocs. Pour la zone euro dans son ensemble, l'impact de l'instabilité sur le cycle

[3] Le Luxembourg n'a pas été intégré à notre échantillon du fait du poids du pays dans le PIB de la zone euro (0,2%).
[4] AFSI en anglais pour *Aggregate Financial Stability Index*.
[5] NBER: National Bureau of Economic Research; CEPR: Centre for Economic Policy Research; ECRI: Economic Cycle Research Institute.

financier, tel que mesuré par l'ISFA, sera probablement moins grave que celui mesuré par d'autres indicateurs de risque. Ce chapitre contribue au débat sur la mesure de la stabilité financière en mettant en évidence une autre propriété des indices financiers agrégés à travers cette analyse comparative.

Les résultats de cette étude suggèrent que l'ISFA peut être un outil complémentaire et utile pour les décideurs macroprudentiels dans leur surveillance de la stabilité financière. Il permet en effet de mieux estimer la réponse intuitive du cycle financier après un choc comparé à d'autres indicateurs de surveillance de la stabilité financière, tels que les indices de risque macroéconomique, de risque de marché et de risque de liquidité. Ainsi, les autorités en charge de la stabilité financière pourraient compléter leurs indicateurs en utilisant les indices agrégés basés sur notre méthodologie pour évaluer la stabilité du système financier, et comme base pour élaborer les politiques de stabilisation. La flexibilité de notre méthode ISFA permet d'incorporer facilement des risques spécifiques à certains secteurs, tels que les risques liés aux crypto-monnaies ou aux catastrophes naturelles.

3.2 Contribution empirique du chapitre 2 : Le modèle QPM, un cadre d'analyse intéressant pour l'analyse macroprudentielle

Le chapitre 2 s'est adonné au développement d'un cadre d'analyse (new Keynesian quarterly projection model – QPM) permettant d'améliorer l'évaluation des risques systémiques ainsi que la mise en œuvre des accords de Bâle III. En effet, conçus initialement pour l'analyse de la politique monétaire, les QPM sous leur forme traditionnelle comportent deux grandes parties : domestique et étrangère. Le modèle met l'accent sur la partie domestique, qui est composée de quatre blocs clés à savoir : la demande globale, la courbe de Phillips, la condition de parité non couverte des taux d'intérêt, et la règle de politique monétaire. Partant de cette version simple et d'un bloc de crédit établit par Karam et al. (2021), nous ajoutons deux blocs (politique macroprudentiel et stabilité financière) afin d'analyser comment les décideurs macroprudentiels peuvent définir des politiques monétaires et macroprudentielles afin de promouvoir la stabilité économique et financière dans la zone euro.

La méthode utilisée pour paramétrer le modèle repose sur une combinaison de calibration et d'estimation bayésienne, notamment la méthode de « *systerm prior* » développée par Andrle (2018). Puis, nous concentrons notre analyse sur l'examen des propriétés du modèle en effectuant une évaluation approfondie pour identifier les forces et les faiblesses du modèle. Les fonctions de réponse impulsionnelle résultantes sont satisfaisantes et permettent de mieux comprendre les dynamiques du modèle tout en démontrant efficacement l'impact des politiques macroprudentielles

dans la promotion de la stabilité financière. En outre, la décomposition des chocs historiques permet de quantifier la contribution de divers chocs exogènes à la dynamique de variables macroéconomiques et financières importantes telles que le taux d'inflation, l'écart de production (*output gap*), l'écart de crédit et la stabilité financière globale.

Les résultats montrent que, d'une part, les chocs de demande agrégée impactent l'écart de production, l'inflation et les taux d'intérêt. En d'autres termes, ces chocs causent des changements dans l'activité économique et des pressions inflationnistes, nécessitant ainsi l'ajustement des taux d'intérêt pour équilibrer l'offre et la demande. D'autre part, les chocs de demande de crédit affectent la croissance du crédit, les ratios de solvabilité des banques et les taux de prêt. Un accroissement de la demande de crédit peut entraîner des taux de prêt plus élevés, affectant les coûts d'emprunt et mettant en évidence la nécessité de maintenir des tampons de capital adéquats pour la stabilité bancaire. Par ailleurs, les chocs liés à la stabilité financière mettent en évidence l'interconnexion entre les conditions financières et les résultats macroéconomiques. Ces chocs peuvent avoir des impacts à la fois positifs et négatifs sur l'inflation, l'écart de production, les taux d'intérêt et la performance bancaire, témoignant de l'importance de surveiller et de traiter les risques pour la stabilité financière.

Au regard de ces résultats, les autorités macroprudentielles peuvent donc utiliser ce cadre d'analyse, car il permet d'avoir des perceptions précieuses sur l'impact des chocs financiers et l'efficacité des politiques en matière de stabilité financière et de croissance économique. Les QPM offrent une évaluation complète des effets des chocs financiers sur plusieurs variables macroéconomiques, facilitant une meilleure compréhension des dynamiques économiques et la prise de décision.

3.3 Contribution empirique du chapitre 3 : L'effet des chocs budgétaire sur la stabilité financière en fonction du ratio de dette publique

Bien que le chapitre 2 ait mis en évidence comment les politiques monétaire et macroprudentielle doivent interagir afin d'assurer la stabilité financière dans la zone euro, il est toutefois important de mentionner que cette interaction à elle seule est insuffisante pour promouvoir une stabilité pérenne dans la zone. D'autres éléments sont à prendre en considération, notamment la coordination entre MaP et les politiques budgétaires. Ainsi, le chapitre 3 cherche à appréhender la manière dont les chocs de politiques fiscales impactent la stabilité financière et le cycle financier de la zone euro, tout en tenant compte du niveau de la dette publique.

A ces fins, et dans un premier temps, nous testons et estimons la valeur seuil du ratio dette publique/PIB à l'aide de l'approche proposée par Hansen (2000). Puis dans un second temps, en

suivant Auerbach et Gorodnichenko (2013b), Owyang et al. (2013), Jordà et al. (2015) et Ramey et Zubairy (2018), nous estimons un modèle de projection locale non linéaire en donnée de panel pour évaluer l'effet des chocs de politique fiscal sur le cycle financier et la stabilité financière à travers différent régime de dette publique (régime élevé et régime bas).

Les résultats de cette analyse se résume comme suit. D'une part, le seuil de la dette publique par rapport au PIB estimé à partir de notre échantillon est de 71%, dépassant le critère de Maastricht de 60%. Cela indique que ces pays ont la capacité de gérer des niveaux d'endettement plus élevés sans être confrontés à une instabilité financière immédiate. D'autre part, dans un régime de dette élevée, un choc positif de dépenses publiques a des effets négatifs sur le cycle financier (augmentation de la volatilité des prix, ralentissement de la croissance du crédit, hausse des taux d'intérêt) et des effets positifs sur la stabilité financière via des investissements prudents. En régime de faible dette, un choc de dépenses publiques a des effets positifs à court terme sur le cycle financier et la stabilité, mais ces effets peuvent devenir négatifs après trois trimestres en raison de surchauffe ou de bulles d'actifs. Concernant les chocs de recettes publiques, dans un régime de dette élevée, l'effet est mitigé : il stimule modérément le cycle financier mais affecte négativement la stabilité financière. En régime de faible dette, les chocs de recettes publiques ont un impact négatif sur les deux cycles, en raison de la réduction des revenus disponibles et des incitations à l'investissement. Ces résultats soulignent l'importance de coordonner les politiques fiscales et macroprudentielles pour maintenir la stabilité financière, notamment dans la zone euro. Une union budgétaire et fiscale au niveau de la zone euro pourrait faciliter cette coordination, bien qu'elle nécessite une volonté politique et une coopération significative entre les États membres.

Regulating financial cycles in the euro area: What role for macroprudential policy?

General introduction

1. Background information

The 2008–9 financial crisis was unprecedented, in both scale and duration. Although it began in the United States, with the collapse of the American housing market, it quickly spread and affected all economies globally, both developed and emerging (see Reinhart and Rogoff, 2008, 2009, 2014). Some compare it to the 1929 crisis and consider it even more serious, particularly because of increasing international financial integration (Agénor, 2012), deregulation, and financial innovations (Haddad, 2023), which forced the implementation of countercyclical regulation. The European sovereign debt crisis, which began in 2010, is another prominent example. This crisis showed how fiscal problems in a small number of eurozone countries could trigger turbulence in global financial markets, affecting investor confidence and international financing conditions (Demiris and Kypraios, 2014).

These financial crises have had devastating effects on the global real economy in general (see, for example, Bernanke, 2018; Alcidi et al., 2010) and the euro area in particular (Tuori and Tuori, 2014; Cole et al., 2024). First, they have disrupted the functioning of financial markets, leading to a contraction in credit and investment and causing economic recessions (Demiris and Kypraios, 2014). Second, these crises have exposed the inadequacies of traditional regulatory policies (such as microprudential regulation and supervision – banking supervision – financial market regulation, and supervision) in the context of financial stability, and the need to renew and/or complement approaches to financial system regulation, notably by adding a macroprudential approach.

In the euro area, for example during the 2008–9 crisis, the single monetary policy, considered the main tool for macroeconomic adjustment, was unable to regulate the financial cycle. Instead, it accentuated intra-zone divergences (see Bank of Spain, 2009; Schnabl, 2013; Georgiadis, 2015). Complementing monetary policy with national budgetary instruments would have been desirable, really helping to deal with the financial crisis in the downward phase of the cycle. However, imbalances mainly form in the upward phase and are often financial before being economic because of the importance of the banking and financial sector. Fiscal policy is therefore insufficient (Kindleberger, 1978; Allen and Gale, 1999; Bennani et al., 2017a; Couppey-Soubeyran and Dehmej,

2017). On the other hand, a regulatory approach aimed at controlling the financial cycle, integrating countercyclical macroprudential policy measures, could have better prevented the formation of these financial imbalances.

Macroprudential policy does not have a single definition (Maes, 2009; Clement, 2010). However, based on the publication of the CGFS (2012),[6] we can define macroprudential policy as having the objective of limiting systemic risk in its transversal dimension (measuring systemic risk between systemic financial institutions at a given time – contagion effect) and its temporal dimension (evolution of systemic risk over time – accumulation of financial imbalances and attenuation of the financial cycle). The aim is thus to limit a dysfunction of the financial system as a whole that would have macroeconomic consequences for the real sphere of the economy (Borio, 2003). It is therefore a question of avoiding – rather than managing them when they burst – financial crises by preventing financial imbalances, procyclical phenomena, and speculative bubbles, among other things. This is not a completely new approach but one that re-emerged on the front line following the 2008–9 crisis, through the emergence of numerous instruments, at the macroeconomic and microeconomic levels, in response to the global financial instability caused by the crisis (Galati and Moessner, 2013; Claessens, 2014).

Historically, financial regulation has focused on the microprudential dimension, that is on the health and stability of individual financial institutions (BCBS, 2011). Regulators have implemented capital requirements, liquidity standards, and other measures to ensure the soundness of banks and other financial institutions. On the one hand, capital requirements were introduced by the Basel I, II, and III accords – these accords are designed to ensure that financial institutions hold sufficient capital to absorb losses and protect depositors and the financial system (see VanHoose, 2007). These requirements are often based on capital ratios, such as the solvency ratio. Basel III, for example, introduces stricter capital requirements and new liquidity ratios to strengthen the resilience of banks. On the other hand, the aim of liquidity standards is to ensure that financial institutions have sufficient liquid assets to cope with sudden outflows of funds (see, for example, Allen et al., 2009). The liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR) are examples of measures introduced by Basel III to improve banks' liquidity management. Regulators conduct ongoing supervision of financial institutions to ensure that they comply with these capital and liquidity standards. This includes on-site inspections, off-site analyses, and stress tests to assess banks' resilience to stress scenarios (BCBS, 2014).

[6] Committee on the Global Financial System.

However, this microprudential approach has limitations (see, for instance, Pollin, 2011). It cannot prevent systemic crises, since it focuses on the stability of individual institutions without always considering the interconnections and externalities between them. The financial crisis of 2008–9 is a perfect example, revealing these limits and showing that even financially sound institutions can be vulnerable to systemic shocks (see Acharya et al., 2017). In response to the limitations of the microprudential approach, financial regulation has evolved toward a more macroprudential dimension (Borio, 2010), the aim of which is to strengthen the stability of the financial system as a whole. The idea is that the macroprudential approach identifies, monitors, and mitigates systemic risks – risks that can cause widespread financial instability. These risks can vary in nature: they can result from the excessive accumulation of debts, speculative bubbles on assets, complex interconnections between financial institutions, or even procyclical behaviors that amplify economic and financial cycles.

The effectiveness of macroprudential policy rests on three pillars: (i) governing this policy, (ii) identifying market failures and selecting instruments to address them, and (iii) understanding transmission mechanisms and the interaction with other economic policies, notably fiscal, monetary, and microprudential. Each of these pillars plays a key role in ensuring effective and robust regulation of the financial system. The first pillar concerns the organization and decision-making processes essential to the implementation and supervision of macroprudential policies. The effectiveness of this governance requires clear coordination between different stakeholder authorities, such as central banks, financial regulators, and finance ministries (CGFS, 2010). Structured and well-defined governance helps to reduce conflicts of interest and ensure the implementation of coherent and effective policies. Transparency of actions and decisions, as well as the accountability of the institutions involved, are crucial aspects of this governance. This ensures that policies are based on sound information and that responsible authorities can be held accountable for their actions (IMF, 2013). The second pillar, which involves identifying market failures, is crucial to anticipating and preventing systemic risks, which requires continuous and thorough monitoring of financial markets to detect signs of imbalances, such as speculative bubbles or procyclical behavior (Borio, 2003). Once these failures have been identified, it is important to choose the appropriate instruments, such as countercyclical capital buffers, loan-to-value ceilings, and limits on interbank exposure, to address them (Claessens, 2014). Finally, the third pillar, which corresponds to understanding the transmission mechanisms and the relationship with other economic policies, is essential to avoiding unproductive effects. Fiscal, monetary, and microprudential policies can have overlapping or contradictory effects (Galati and Moessner, 2013). For example, expansionary monetary policy can stimulate credit demand, which can increase

financial risks if adequate macroprudential measures are not in place to contain this growth. Similarly, expansionary fiscal policies can aggravate financial imbalances if they are not coordinated with macroprudential efforts. Developing a thorough understanding of the interactions between these policies is therefore crucial to designing coherent and effective strategies (Borio and Shim, 2007).

Macroprudential instruments are varied and include countercyclical capital buffers, loan-to-value (LTV) caps, limits on interbank exposure, and restrictions on high-risk activities. First, countercyclical capital buffers require banks to accumulate additional capital reserves during periods of economic growth (Drehmann and Borio, 2012). This allows them to better absorb losses during recessions. The aim of this instrument is to smooth the credit cycle and prevent excessive risk accumulation during economic booms. Second, LTV caps limit the amount a borrower can borrow relative to the value of the asset purchased. Typically, they apply to mortgages (Crowe et al., 2011). By restricting borrowers' debt levels, these caps help to prevent housing bubbles and reduce potential losses for banks in the event of default. Third, limits on interbank exposure reduce the risk of contagion between banks by restricting the amount of loans that one bank can extend to another. These limits are designed to prevent problems at one financial institution spreading throughout the banking system (Upper, 2007). Finally, restrictions on high-risk activities, such as proprietary trading and investments in complex and opaque assets, should limit banks' exposure to large losses. These measures seek to limit speculative activities that could destabilize the financial system (Acharya, 2009), and the aim is to strengthen the resilience of financial institutions, limit excessive risk accumulation, and mitigate procyclical behavior. Implementing these instruments requires close coordination between national and supranational regulators, particularly in a monetary union such as the euro area.

The emergence of this approach in the aftermath of the crisis has sparked several debates given the difficulties that such a macroprudential approach can raise. First, macroprudential policy is not neutral for other economic policies, which can create interferences or blockages between different authorities. Second, implementing an effective macroprudential policy is difficult by nature. On the one hand, implementing macroprudential policy measures is politically sensitive, which can lead to inaction. On the other hand, after a series of serious crises, the macroprudential regulator can be biased toward excessive interventionism. The aim of this thesis is to contribute to these debates.

The core aims of this thesis are as follows: **on the one hand, to understand an effective and robust measure of financial stability in the eurozone by considering the strong disparity of financial cycles between member countries of the zone; and, on the other hand, to study the impact of macroprudential policies in the eurozone.**

2. Purpose and plan of the thesis

The aim of this thesis is to study the impact of macroprudential policy on the financial stability of the euro area. Specifically, it will address the following questions: (i) How do we measure financial stability, and what is the reaction of the financial cycle following a shock to the various systemic risk monitoring indicators in the euro area? (ii) What is the overall impact of financial shocks on the banking system and the macroeconomic environment of the euro area? (iii) What is the macroeconomic effect of a bank capital and/or equity instrument? (iv) What is the response of financial stability to a fiscal shock depending on the level of public debt?

In the first chapter we focus on measuring financial stability and comparing systemic risk monitoring indicators in the eurozone. The objective will be, on the one hand, to present and debate the different measures dedicated to financial stability, and, on the other hand, to propose an econometric methodology for comparing monitoring indicators. In the second chapter we focus on analyzing the overall impact of financial shocks on the banking system and the macroeconomic environment through a quarterly forecast model, as well as measuring the feedback of a macroprudential instrument on the eurozone economy. Finally, the third chapter will examine the effect of fiscal shocks on stability and the financial cycle depending on the level of debt.

3. Presentation of the chapters

In the first chapter of this thesis, entitled "Financial stability measure and comparison of financial risk monitoring indicators," we address a dual concern, namely the issue of measuring financial stability, on the one hand, and comparing systemic risk monitoring indicators on the other. In the first part of this chapter, we revisit the issue of financial stability and its measurement, analyze the drawbacks of existing measures in the literature, and propose a robust measure of financial stability in the euro area. Unlike price stability, which is based on a precise and transparent definition, there is no consensus comparable to financial stability. This makes measuring it difficult given the interdependence and complexity of interactions between the different elements of the financial system and the real economy. Basically, a financial system can be described as stable when it lacks excessive volatility, stress, and crisis (Gadanecz and Jayaram, 2008). Although this narrow definition is relatively simple to formulate, it does not consider the positive contributions of a well-functioning financial system to overall economic performance. Thus, in the first part of our analysis we use a methodology initiated by Cheang and Choy (2009) and taken up by Akosah et al. (2018), which is based on the standardized arithmetic mean of the weights obtained from the principal

component analysis using the expectation maximization algorithm, to construct an aggregate financial stability indicator (AFSI) for the euro area and the 11 member states.

In the second part of the chapter, considering the indicator obtained to be a financial risk monitoring tool, and using a VAR model, we compare the response of the financial cycle following a shock to this indicator with other financial risk monitoring indicators such as macroeconomic risk (GDP) and financial risk (stock market indices). Our objective is to identify among these monitoring indicators which one allows us to better estimate the intuitive response of the financial cycle after a shock. In this first chapter we recommend to macroprudential authorities the AFSI as a "complement" and tool in their financial stability monitoring exercise, since it offers a clear picture of financial stability by potentially identifying areas of stability, instability, and crisis. In addition, it seems to offer a better estimate of the intuitive response of the financial cycle after a shock than other financial stability monitoring indicators, such as macroeconomic risk, market risk, and liquidity risk indices.

Although the subject of the thesis is a relatively modern issue, some studies have addressed it – but always from different angles. First, we distinguish the studies that have addressed the issue of financial stability and its measurement, as well as crisis signaling indicators. Similarly, other studies have focused on the activation and calibration of macroprudential instruments (macroprudential stress tests) to verify the resilience of the entire financial system to shocks, considering the transmission of shocks to the real economy. The first chapter shows that financial stability indicators (FSIs) are preferable to other indicators for monitoring financial stability.

The second chapter, entitled "Quarterly projection model for macroprudential policy analysis and financial stability in the euro area," proposes a quarterly projection model (QPM) to investigate how macroprudential instruments should interact with monetary policy instruments, considering cross-country heterogeneity, in order to ensure financial stability in the euro area. This model integrates AFSIs and analyzes the interaction between monetary policy, macroeconomic variables, and financial stability.

The model parameterization is based on Bayesian calibration and estimation, particularly the system priorities method of Andrle (2018). A thorough evaluation of the model properties has been performed, revealing that the impulse response functions provide satisfactory results. These functions help us to understand the dynamics of the model and demonstrate the impact of macroprudential policies on financial stability. The main objective of this chapter is to demonstrate the practical value of the QPM as a tool to quantify the impact of financial shocks on the banking system and the euro area economy. Furthermore, the study assesses the macroeconomic impact of

banking capital instruments, analyzing how their introduction affects economic conditions. The results show that financial shocks reveal important information about the dynamics of euro area economies and the interaction between different economic variables.

The analysis indicates that an increase in credit demand can lead to an increase in lending rates, affecting borrowing costs for individuals and businesses. The effects on bank solvency ratios highlight the importance of maintaining adequate capital buffers to ensure the stability and resilience of the banking system. The results confirm the findings of previous studies, showing that shocks to financial stability indicators can have varied effects on inflation, the output gap, interest rates, and bank performance. These results underscore the importance of monitoring and addressing financial stability risks to preserve the overall health of the economy. Macroprudential authorities and analysts are encouraged to use the QPM in their analyses, as it provides valuable insights into the impact of financial shocks and the effectiveness of policies to promote financial stability and economic growth. The QPM provides a deep understanding of the complex dynamics of the economy and helps us to make more informed decisions. It assesses the impact of financial shocks on various macroeconomic variables and analyzes policy measures, providing insights into their effectiveness in mitigating risks and promoting sustainable growth.

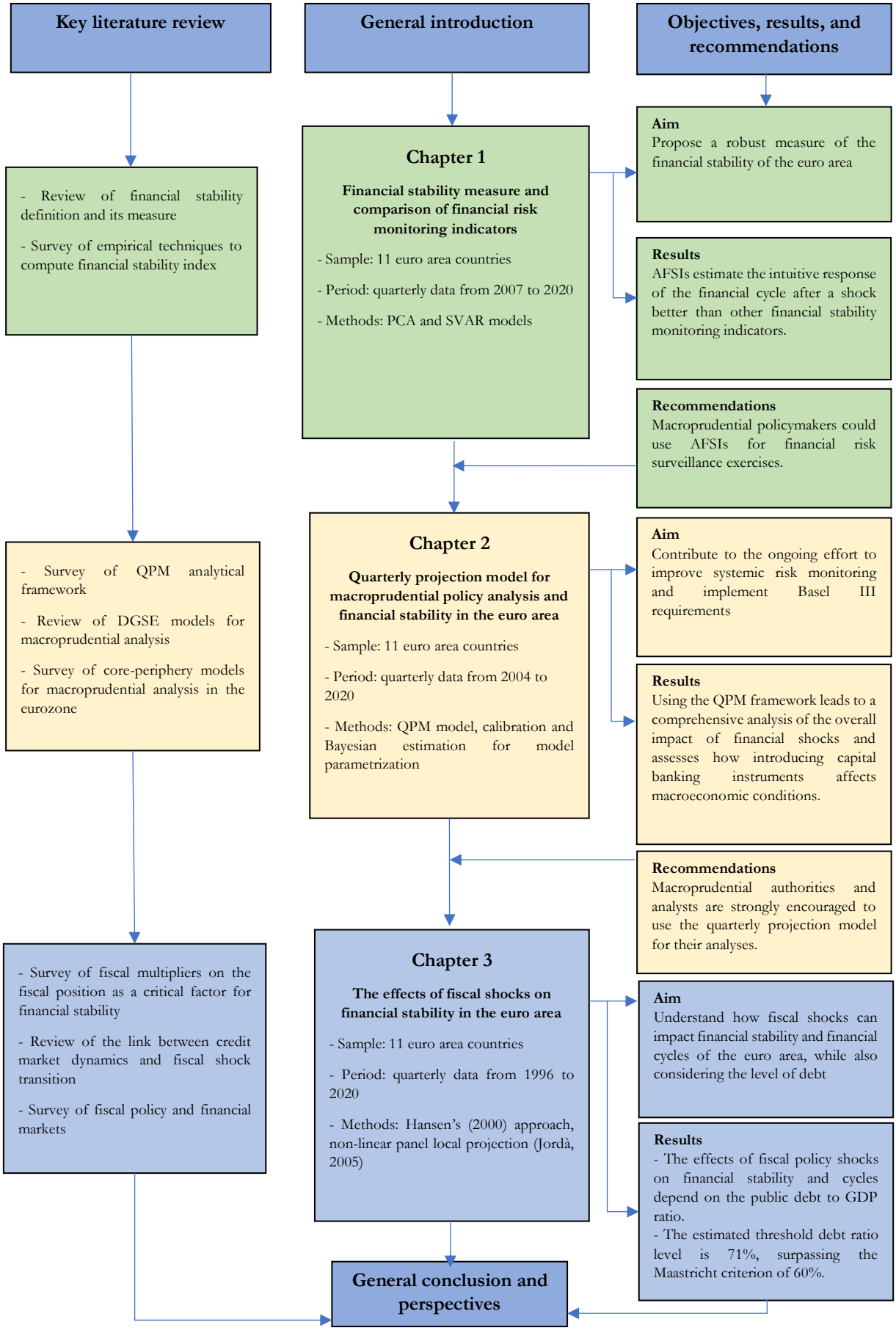
In Chapter 2 we highlight how macroprudential instruments should interact with monetary instruments to ensure financial stability in the euro area. However, we should remember that this interaction between macroprudential policy and monetary policy alone cannot achieve financial stability in this area. Other elements must be considered, particularly coordination between macroprudential policy and fiscal policy. Therefore, the third chapter, entitled "The effects of fiscal shocks on financial stability in the euro area," looks at how fiscal policy shocks can impact financial stability and the financial cycle in the euro area, depending on the level of public debt. To do this, we use the Hansen (2000) approach to test and estimate the value of the threshold of the ratio of public debt to GDP. Then, following Auerbach and Gorodnichenko (2013b), Owyang et al. (2013), Jordà et al. (2015), and Ramey and Zubairy (2018), we estimate a non-linear local projection model in panel data and evaluate the effect of a fiscal shock on the financial cycle and stability, considering different public debt regimes. From this analysis, we find that the impulse response functions of the model yield significant results that can be summarized as follows.

First, we find that the threshold for government debt to GDP in our sample is 71%, exceeding the Maastricht criterion of 60%. This indicates that these countries can manage higher debt levels without facing immediate financial instability. In a high debt regime, a positive government spending shock has negative effects on the financial cycle (increased price volatility, slower credit growth, higher interest rates) and positive effects on financial stability via prudent investment. In

a low debt regime, a government spending shock has positive short-term effects on the financial cycle and stability, but these effects can turn negative after three quarters because of overheating or asset bubbles. Regarding government revenue shocks, in a high debt regime the effect is mixed: it moderately stimulates the financial cycle but negatively affects financial stability. Under low debt, government revenue shocks negatively impact both, because of reduced disposable income and investment incentives. These results highlight the importance of coordinating fiscal and macroprudential policies to maintain financial stability, particularly in the euro area. A fiscal union could facilitate such coordination, although it requires political will and significant cooperation among member states.

Figure 1 depicts the structure of the thesis, illustrating its main parts and describing its steps, as well as important findings and consequent recommendations.

Figure 1: Thesis structure



Chapter 1

Financial stability measure and comparison of financial risk monitoring indicators

Chapter 1

Financial stability measure and comparison of financial risk monitoring indicators

Abstract: Financial stability is indispensable for government, demanding important devotion of resources while regularly searching for ways to enhance the capacity to anticipate and restrain future spells of instability. Policymakers need to control and assess financial stability to be capable of finding potential threats in the financial system and taking suitable macroprudential measures early on. The goal of this chapter is to respond to the following questions: (1) How can we measure the financial stability in the euro area? (2) How does a financial cycle react to a subsequent shock on the different risk monitoring indicators, and to what extent does the effect vary across indicators? To respond to these questions, we first use the arithmetic mean of the uniform and principal component analysis using the expectation-maximization algorithm weighting method to construct an aggregate financial stability index (AFSI) for both the euro area and 11 member states. Second, we use the bivariate vector autoregression (VAR) model to compare the impact of risk monitoring indicators on the financial cycle. We find that AFSIs can be a "complement" and a useful tool for macroprudential policymakers in their exercise of financial stability surveillance, allowing policymakers to have a clear picture of financial stability by offering them the possibility to identify stability, instability, and crisis areas. Furthermore, they seem to offer a better estimation of the intuitive response of the financial cycle after a shock compared to other financial stability monitoring indicators, such as macro risk, market risk, and liquidity risk indexes.

Keywords: Financial Stability, Aggregate Financial Stability Index, Risk Monitoring, EM-PCA, VAR Model, Euro Area.

JEL Classification: B22, B23, C43, C51, E58, G01.

1. Introduction

The purpose of macroprudential policymaking is to ensure and preserve financial stability by preserving and limiting systemic risk, namely, the risk of large-scale disruption in the provision of essential financial services, with serious consequences for the real sector[7] (hampering economic activity and reducing economic welfare).

Indeed, when something goes wrong in the financial markets, or when the condition of their key institutions becomes severely strained, the related pressures on households and businesses might have undesirable effects on the real economy because capital can be impeded from flowing to worthy investments, potentially causing a credit crunch (Nelson and Perli, 2005). Therefore, financial stability is indispensable for government, demanding important devotion of resources while regularly searching for ways to enhance the capacity to anticipate and restrain future spells of instability.

Given the increasing complexity of the underlying factors contributing to instability, and the severity of the potential effects of instability on the real economy, it is important for policymakers to have financial stability monitoring tools (see Haldane et al., 2007; IMF, 2008). These tools must seek to create a more systematic approach to monitoring the global financial infrastructure to improve the understanding of risks and conditions that affect financial institutions and other intermediaries, and ultimately to warn policymakers and market participants about potential risks[8]. With this goal in mind, Haldane et al. (2007), based on a model of probability, assessed for the Bank of England the impact of possible key threats to financial stability. Their assessment included global parameters and relied on qualitative analysis, and it sought to evaluate a set of risks in the form of a map, including credit risk, market risk, funding risk, income generation risk, and operational risk. Specifically, the map offers the related risks and conditions, and how much better or worse they are, but it does not determine whether or not they are a specific threat to global financial stability.

The Global Financial Stability Map, used by policymakers for financial stability surveillance, was therefore introduced, from a large number of economic, market, and survey-based indicators, by Dattels et al. (2010). The authors characterize financial stability in their analysis as a function of six aggregate indicators of risks and conditions, which are related to a variety of sub-indicators. Hence, the map seeks to appraise broad risks to financial stability arising from, and feeding back to, credit markets, the economy, market and funding liquidity, and leverage. However, the map does not

[7] See Bennani et al. (2017).
[8] See, for example, Dattels et al. (2010).

consider certain key sources of stability risks, such as operational risks or the microstructure of asset markets.[9]

Another kind of tool used by policymakers for the macroprudential supervision of financial risks are a set of indicators called "financial risk surveillance indicators," grouped into classes of risks. For instance, the European Systemic Risk Board (ESRB) uses in its risk dashboards a breakdown into eight major risk families,[10] which are the interlinkages and composite measures of systemic risk, macro risk, credit risk, funding and liquidity risk, market risk, profitability and solvency risk, structural risk, and risk related to central counterparties.[11] The aim of these indicators is to warn policymakers about the risk of inaction. For example, Alfaro and Drehmann (2009) show the utility to monitor GDP as a macro risk, by studying the stylized facts of GDP before a crisis in order to see the extent to which they can warn about a crisis.

Nevertheless, it seems that these indicators, as their name shows, only serve to prevent the risk of financial instability and the occurrence of a potential crisis. What happens when these indicators fail to prevent risk and a crisis happens? Do they still help? Can they help to predict the impact, magnitude or extent of a crisis in the financial system? Is there another kind of indicator that can help with this goal? The purpose of this chapter is to answer these different questions.

Using the expectation-maximization principal component analysis (EM-PCA), and the methodology used in the literature by Cheang and Choy (2009) and taken up by Akosah et al. (2018), on the data of 11 euro area countries, we summarize information contained in 23 individual country variables[12] into a single aggregate financial stability index (AFSI). Then, we turn the 11 AFSI countries' data into a single aggregate index for the euro area. Lastly, we compare the impact of a financial shock, as measured by the AFSIs, on the financial cycle with the impact of a financial shock, as measured by some of the financial minoring risk indicators for both the 11 countries and the euro area, using a bivariate vector autoregression (VAR) model with impulse response function.

We find that AFSIs can be a "complement" and a useful tool for macroprudential policymakers in their exercise of financial stability surveillance, allowing policymakers to have a clear picture of financial stability by offering them the possibility to identify stability, instability and crisis areas. Furthermore, it seems to estimate better the intuitive response of a financial cycle after a shock

[9] See Dattels et al. (2010).
[10] The US Office of Financial Research in charge of risk analysis for the Financial Stability Oversight Council (FSOC) a more summary classification: macro risk, market risk, credit risk, funding and liquidity risk, and contagion and interconnexion risk (see Bennani et al., 2017).
[11] https://sdw.ecb.europa.eu/reports.do?node=1000005783.
[12] The variables regrouped into five sub-indexes (Financial Development Index, Financial Soundness Index, Financial Vulnerability Index, Monetary Condition Index and World Economic Climate Index).

compared to other financial stability monitoring indicators, such as macro risk, market risk, and liquidity risk indexes.

The remainder of this chapter is structured as follows. Section 2 reviews previous relevant literature. Section 3 presents our empirical methodology, Section 4 describes the data and its statistical properties, and the estimation. Section 5 presents our results and their implications, and Section 6 concludes.

2. Literature review: financial stability and its measure

2.1. Financial stability definition

Before defining financial stability, it is important to mention the key principles that define it. Schinasi (2004) identifies five key principles for developing a working definition of financial stability.[13] First, financial stability is a broad concept, encompassing the different aspects of finance (and the financial system) – infrastructure, institutions, and markets. Second, financial stability not only implies that finance adequately fulfills its role in allocating resources and risks, mobilizing savings, and facilitating wealth accumulation, development, and growth; it should also imply that the systems of payment throughout the economy function smoothly (across official and private, retail and wholesale, and formal and informal payment mechanisms). Third, financial stability relates not only to the absence of actual financial crises but also to the ability of the financial system to limit, contain, and deal with the emergence of imbalances before they constitute a threat to themself or economic processes.[14] Fourth, financial stability must be formulated in terms of the potential consequences for the real economy. Disturbances in financial markets or in individual financial institutions need not be considered threats to financial stability if they are not expected to damage economic activity at large. The fifth and last principle in financial stability is thought of as occurring along continuum; an example that is more transparent is the health of an organism, which also occurs along a continuum.[15]

Starting from these key principles, we can see that the financial system is complex and its stability is built on expectations and dynamics and depends on many parts of the system working rationally

[13] There are also many prerequisites for establishing a sound and stable financial system, such as: macroeconomic stability and a policy framework for maintaining it; an adequate – if not effective – framework for financial regulation, supervision and surveillance (implicitly mentioned in the text as infrastructure; well-established codes, standards and business practices), and more generally private incentive structures; and an enforceable legal system that supports productive private financial contracts.

[14] See Schinasi (2004) for more detail.

[15] A healthy organism can usually attain a greater level of health and well-being, and the range of what is normal is broad and multi-dimensional.

well. This complexity of the financial system makes its modeling[16] sufficiently complicated, just as it does the definition of its stability. Indeed, unlike price stability, which is based on a precise and transparent definition, there is no consensus comparable to financial stability. Many definitions of financial stability have been given by different economists (academics and central bankers) during the last few years (see Duisenberg, 2001; Large, 2003; Norwegian Central Bank, 2003). These studies on the definition of financial stability can be grouped into two classes. On the one hand, we have those who have tried to define financial stability by its opposite, namely, financial instability; and, on the other hand, there are the authors who have tried to directly define the concept of financial stability.

Studies of the first class include Mishkin (1999) and Ferguson (2002), who consider that there is financial stability in the absence of instability. Instability here occurs when shocks to the financial system interfere with the information flow so the financial system can no longer do its job of channeling funds to those with productive investment opportunities (Mishkin, 1999). According to Mishkin, this is justified by the fact that a decline in the ability of financial intermediaries, particularly banks, to engage in financial intermediation, and to make loans, leads directly to a decline in investment and aggregate economic activity. And this is because of the important role of these institutions in financial markets, which is to engage in information-producing activities that facilitate productive investment for the economy. For Davis (2002), financial instability is a forerunner of a financial crisis that leads to the collapse of the financial system and its incapacity to redistribute financial resources in the country.

The second class includes Schwartz (1986), Wellink (2002), Foot (2003), the Norwegian Central Bank (2003), Large (2003), Padoa-Schioppa (2003) and Schinasi (2004), whose studies have tried to define financial stability directly. Crockett (1997) had already defined financial stability as an absence of instability;[17] this author believes that financial stability is stability in financial markets and that instability comes from price movements, causing economic fundamentals. The Deutsche Bank (2003) asserts that the concept of financial stability widely represents a steady state in which the financial system efficiently performs its key economic functions, such as allocating resources and spreading risk, as well as settling payments, and it is able to do so even in the event of shocks, stress situations, and periods of profound structural change.[18] Schinasi (2004), based on the key

[16] Existing models only attempt a stylized view, trying to elucidate the underlying mechanisms driving financial stability. See, for example, Aymanns et al. (2018) for more details.

[17] For Crockett (1997), instability is a situation in which economic performance is potentially deteriorated by fluctuations in the price of financial assets or by an inability of financial institutions to meet their contractual obligations.

[18] It identifies two types of analysis that authorities need to identify potential risks as early as possible and to recognize the emergence of any undesirable developments. The first consists of taking into account the relevant developments

principles described above, defines financial stability as a condition in which an economy's mechanisms for pricing, allocating, and managing financial risks (credit, liquidity, counterparty, market, etc.) are functioning sufficiently well to contribute to the performance of the economy. Hesse and Čihák (2007) suggest that financial stability at the symmetrical level has a rapport with the absence of system-wide episodes in which the financial system fails to function and the resilience of financial systems to stress. Chant (2010) shows that financial stability must be seen through its absence (namely, through the polar category of financial instability). However, Agoraki et al. (2011) argue that the financial stability of banks depends on the different country-specific institutional characteristics.

Fundamentally, a financial system can be characterized as stable in the absence of excessive volatility, stress, or crises (Gadanecz and Jayaram, 2008). Although this narrow definition is relatively simple to formulate, it does not consider the positive contribution of a well-functioning financial system to the overall economic performance. Therefore, a broader definition is required, including the macroeconomic dimension to financial stability and the interaction between the financial sector and the real sector. In this context, the ECB (2007) defined financial stability as a condition in which the financial system, which includes intermediaries' financial institutions, markets and infrastructure, is able to cope with shocks and counterbalance the prospects for disruption of the financial intermediation process.

Borio and Drehmann (2009) assert that financial stability is the converse of financial instability. Finacial instability, here, is characterized by a situation in which normal-sized shocks to the financial system are sufficient to produce financial distress. Specifically, it is a situation in which the financial system is fragile. Strassberger and Sysoyeva (2016) point out that it is important to understand financial stability as a permanent capacity of the banking sector in relation to the continuous performance of its functions without adverse negative effects on the real sector. The ECB (2017) rethinks the question of financial stability by defining it as the state in which the banking sector can avert the build-up of systemic risk, but key risks continue to emanate from imbalances and vulnerabilities in the fiscal, macroeconomic, and financial sector domains. Bennani et al. (2017) define financial stability as a condition of the financial system whereby it shows resilience in the face of stressful episodes and financial or real shocks. Although this definition explicitly refers to

in the real economy, on the international financial markets and at the systemically relevant intermediaries or groups of intermediaries. And the second type implies a critical assessment of the quality of the regulatory framework governing markets and intermediaries, as well as the soundness of the technical systems, with payment transactions and securities settlement, in particular, being necessary.

the ability to withstand shocks, this is still appreciated, giving a static character to the definition adopted.

2.2. Financial stability measure

As we have seen above, financial stability, unlike price stability, is difficult to define. This characteristic makes its measurement difficult given the interdependence and complexity of the interactions between the different elements of the financial system and the real economy. However, during the past year, different researchers (academics and policymakers)[19] have fixed on various statistical indicators that embodied and illustrated the vulnerability of the financial system to gauge financial stability. The early warning system, macro-stress testing and financial stability indices are the quantitative methods used to evaluate financial stability. Yet, it is vital to note that while, on the one hand, each of these techniques has its advantages, weaknesses, and limits, on the other hand, approaches to the development of these measures have evolved over time as concerns have shifted from the microprudential dimension to the macroprudential dimension of financial stability.

2.2.1. Early warning Indicators

Initially developed in the literature for currency and balance of payment crises to banking crises,[20] the early warning system was established from potential leading indicators to forecast the probability of a financial crisis. In other words, the authors of this literature examine empirical regularities in the run-up to financial crises to allow officials and/or private market participants to identify vulnerabilities in advance and to take remedial action (Aikman et al., 2018). Honohan's work (1997) was one of the first essays to specify and evaluate a set of early warning indicators. Considering the antecedents of three types of crisis (macroeconomic crises driven by endogenous boom–bust financial cycles; microeconomic crises associated with weak management and fraud in individual banks; and crises in government-permeated banking systems), the author found that crises with macroeconomic origins tended to be associated with high rates of credit growth, elevated loan-to-deposit ratios, and high levels of foreign borrowing in advance.[21]

Subsequently, Kaminsky et al. (1998) and Kaminsky and Reinhart (1999) introduced the signal-extraction approach by predicting thresholds that minimize each indicator's noise-to-signal ratio (i.e., the ratio of the probability of false alarms to one, minus the probability of missing a crisis).

[19] See, for example, IMF (2006), Hawkins and Klau (2000), Nelson and Perli (2005), Gray et al. (2007).
[20] See, for example, Calvo et al. (1993), Eichengreen et al. (1996).
[21] A finding that aligns remarkably closely with current perspectives on the drivers of financial stability risks.

The key advantage of this technique is its scalability: a large number of potential early warning indicators can be assessed. The authors point out that the real exchange rate, equity valuations, real interest rates and the money multiplier were the indicators with the lowest noise-to-signal ratios. Based on this approach, and counting the number of indicators that have crossed their thresholds at any given time, Kaminsky (1999) developed a set of composite early warning indices. Out-of-sample crisis probabilities calculated from this framework increased substantially before the 1997 Asian crisis in Thailand, the Philippines and Malaysia, but not in Indonesia.

Borio and Lowe (2002a, 2002b) applied the Kaminsky et al. (1998) approach to banking crises. They focused on signals provided by cumulative increases in credit and equity prices, and they analyzed whether composite measures outperformed individual indicators viewed in isolation. They found that the best-performing indicator, on an individual basis, was a "credit gap," as given by a rolling Hodrick-Prescott filter. This indicator later received significant attention in the literature, encompassing as an anchor variable the countercyclical capital buffer (CCyB).[22] Moreover, it was shown that this indicator is particularly useful in forecasting crises on a 3-year horizon rather than near-term risks. The prime composite measure in their analysis, in terms of performance, was to weight together credit and asset price gaps, leading to a noise-to-signal ratio that was almost 50% lower than that obtained for the credit gap alone – a benefit achieved by reducing the number of false positive signals issued.

More traditional regression-based techniques were also employed in other papers to examine the covariance of financial crises. Papers that use this approach are Demirgüç-Kunt and Detragiache (1998), Eichengreen et al. (1996) and Frankel and Rose (1996) – see also Berg and Patillo (1999) for an application to currency crises. Using this approach, Demirgüç-Kunt and Detragiache (2000) developed tools for monitoring bank crisis risk. The first tool was an early warning system that issued a signal when the projected crisis probability exceeded a certain threshold, chosen to reflect policymakers' preferences over avoiding false alarms versus missing crises. The second was a rating system for bank fragility, which mapped crisis probability forecasts onto different fragility classes. And, in an out-sample forecasting exercise, Demirgüç-Kunt and Detragiache (1998) showed that, while these tools identified signs of fragility in Thailand and the Philippines in the run-up to the Asian crisis, they provided a more confident picture of risks in other Asian economies.

The downside of these models is, first, their inability to predict the *timing* of crises. Second, they do not give information about the shock's response ability (Vintu and Negotei, 2018). This is why, from the mid-2000s, interest in this approach began to fade. However, the advantages of these

[22] See, for example, Drehmann et al. (2011).

models lie in their ability to identify underlying vulnerabilities, which may persist for a substantial period of time before a crisis occurs (Chamon and Crowe, 2012). This insight also explains why there has been renewed interest in searching for indicators of financial stability risk over the past decade since the global financial crisis. Another group of papers in the recent literature adopt a multivariate approach to identifying build-ups in vulnerabilities for macroprudential policy purposes. These papers include Aikman et al. (2016), which gives a set of indicators of financial stability in the US financial system. Dattels et al. (2010) use a closely related approach for the purposes of constructing the IMF's risk monitoring system. Aikman et al. (2018) adopted a similar methodology[23] for assessing each indicator relative to its historical distribution, aggregating them into composite measures.

2.2.2. Stress test

Generally speaking, stress testing involves analysing how an object or system copes under pressure. Bank stress testing, also called microprudential stress testing, is designed to test the resilience of banks to severe but plausible shocks (Dent et al., 2016). In practice, this typically means modeling the impact of hypothetical adverse macroeconomic and financial market scenarios on bank profitability and balance sheets. The process of microprudential stress is conducted in three steps.[24] First, the regulator plans an initial stress, which designates a crisis narrative and associated set of exogenous shocks. This scenario is designed in such a way that it is adverse, plausible, and coherent (Siddique and Hasan, 2012). Second, when the scenario has been determined, its effect on the balance sheet of banks is determined to compute the post-stress regulatory capital ratio and profits. And, third, once the post-stress capital ratio has been determined, it is compared to a hurdle rate set by the regulator. If it does not meet this hurdle, the bank is said to have failed the stress test. In this context, the regulator commonly has the authority to require the bank to raise extra capital. Microprudential stress tests are thus used as a tool to recapitalize undercapitalized banks, thereby reducing their leverage and increasing their resilience.

Microprudential stress tests have three main advantages. First, they allow market participants to obtain clear insights into the opaque balance sheet of the evaluated financial institutions (Bookstaber et al*.,* 2014). Second, they help financial institutions to ameliorate their own risk management. Stress tests require banks to have a global view of their own risk management practices by forcing them to appraise their resilience to a variety of novel scenarios. Thus, more

[23] The methodology involves identifying indicators in distinct risk categories.
[24] See, for example, Aymanns et al. (2018).

banks are now engaged in serious internal stress tests. And, finally, it is shown that microprudential stress tests are an effective mechanism to recapitalize banks (Armour et al., 2016). For example, the stress test forced European banks to increase their capital by 260 billion euros between 2011 and 2016 (Arnold and Jenkins, 2016).

In spite of their strengths, microprudential stress tests also have their weaknesses. The first and most important them is that microprudential stress tests ignore the fact that economies are complex systems and thus they fail to capture systemic risk (Aymanns et al., 2018). By considering institutions individually, they ignore the interconnections and interactions between financial institutions that serve to propagate and amplify distress, and the losses that result from adverse scenarios are substantially underestimated (Bookstaber et al., 2014). As argued by Bernanke (2015), the majority of losses in the last financial crisis can be traced back to such interactions, as opposed to the initial shock emerging from credit losses in subprime mortgage loans. Second, it was shown that the value of the information that microprudential stress tests provide is increasingly being questioned. As argued by Glasserman and Gowtham (2015), their outcomes have converged. This makes it possible to wonder, on the one hand, what the information produced by the stress tests is actually worth (Hirtle et al., 2016); and, on the other hand, to realize that the value of such information is decreasing over time (Candelon and Sy, 2015).

These weaknesses of microprudential stress tests, and their inability to appropriately account for systemic risk, have led to the development of a specific type of stress test focused on this goal, called the macroprudential stress test, which seeks to appraise the resilience of the whole financial system rather than one specific institution.[25] Macroprudential stress tests expand microprudential stress tests by incorporating contagion effects between interconnected financial institutions that can arise following the initial scenario. That implies that, on the one hand, the regulators must not only appraise the effect of the initial shocks on the individual balance sheets but also apprehend how the balance sheets are interlinked; on the other hand, they should analyze the consequences of these interlinkages and the ability of financial distress to propagate throughout the system (Aymanns et al., 2018).

To sum up, unlike the early warning system, which allows prediction of the likelihood of a financial crisis (especially a currency crisis) but doesn't give information about the ability of the shock response, stress testing proposes more faithful analysis, which can estimate the financial system's resistance to adverse macroeconomic scenarios. As shown in several studies, stress tests can find out the source of risk and vulnerabilities of the investigated banking sector or the overall financial

[25] See, for example, Alessandri et al. (2009) and Henry and Kok (2013).

sector. Studies based on stress tests include Schmieder et al. (2011), Buncic and Melecký (2012), Jakubík and Sutton (2013), Bennani et al. (2017), and Aymanns et al. (2018). Čihák (2007), using an Excel-based exercise with institution-by-institution data, illustrates that stress tests are complementary to other tools for financial stability analysis, in particular, the financial soundness indexes developed by the IMF (2006). Recently, Kohn and Liang (2019) assessed the impact of stress tests based on features of the stress test program that differentiate stress tests from regulatory capital requirements. They found that the stress tests appear to offset some procyclicality in capital ratios, driven by not only the macroeconomic scenarios but also the requirement to pre-fund shareholder payouts, which rise as the economy expands. Their review also proposes that there are many other questions that could be pursued on stress tests even if they conclude that these remain an effective risk management tool.

2.2.3. Aggregate financial indexes

Aggregate financial indicators, which cover a large part of the definition of financial stability, are another quantitative method used for measuring the stability of the financial system, besides the aforementioned early warning systems and stress testing. An example of such indicators is the IMF's (2006) set of financial soundness indicators. This quantitative method is used by Hawkins and Klau (2000), Nelson and Perli (2005) and Gray et al. (2007) to inspect market pressure, external and banking system vulnerabilities. For instance, Nelson and Perli (2005) used this method to compute a "financial fragility index" for the US financial system. They showed that the fragility composite index may allow an estimation of the probability that the financial system is, or is not, in a state of shock. The construction of their index includes two steps. First, the authors group information contained in 12 individual variables into 3 indicators that refer to *t* volatility and correlation. Second, a logit model is used to predict the statistical likelihood that financial markets behave in a similar way at any time to that recorded during the previous financial crisis. The Swiss National Bank (2006), by combining market data with balance sheet data, also adopted this method to build a similar pressure indicator for banking.

Likewise, country-specific financial stability indexes have been constructed, including: Illing and Lui (2003) for Canada; Morales and Estrada (2010) for Colombia; Albulescu (2010) for Romania; Sales et al. (2012) for Brazil; Sere-Ejembi et al. (2014) for Nigeria; and Arzamasov and Penikas (2014) for Israel. Islami and Kurz-Kim (2013), using some financial variables that have a causal relationship with the real economy, constructed a single composite financial stress indicator, the aim of which is to predict developments in the real economy in the euro area. They concluded that

their indicator can serve as an early warning indicator for negative impacts of financial stress on the real economy. Jakubík and Slacik (2013) developed a comprehensive financial instability index, which measures the level of financial market stress in some key Central, Eastern, and South-eastern European (CESEE) countries,[26] using a broad range of indicators, from money, to bonds, equity and foreign exchange markets. It is obvious that their index understands developments in money, foreign exchange, and equity and bond markets, and thus reflects sentiments in all of the relevant financial market segments in the countries considered. Koong et al. (2017), using a large set of financial and market-based variables, developed a financial stability index to measure financial stability in Malaysia. The authors adopted a series of forecasting tests and assumed that their index predicted the Malaysian business cycle, as well as delivering well regarding the financial downturns in Malaysia. Akosah et al. (2018) developed for Ghana a composite quantitative indicator to measure the performance of the financial system since the adoption of inflation targeting in 2017. Meanwhile, Loloh (2015) developed an aggregated financial soundness indicator for Ghana, while Kočišová (2014) constructed an aggregated banking system stability index for 10 selected countries (the Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic and Slovenia) that joined the European Union in 2004. However, Illing and Lui (2003) give a good description of how one might strive to build a composite financial stability index. They point out the choice of relevant variables, which must reflect the structure of the country's financial system.

The key advantages of this quantitative method reside in the calculation's simplicity and cover a large definition of financial stability by combining macroeconomics and financial variables. Also, the relevant index of this method offers the analysts the possibility to compare different financial systems in terms of stability and also allows them to observe the financial stability dynamics (Albulescu, 2008), offering the possibility to outline the stability, instability, and crisis areas. In terms of disadvantages, the technique includes several stages: the selection of individual indicators, the selection of the method for their normalization, and identification of a weighting method (which relies on the retained criteria and on the established weights). This method is used in this chapter to develop a financial aggregate index for the euro area. In addition to the aforementioned advantages, unlike the two previous methods ("early warning systems" (EWS) and "stress testing"), this technique allows us to make comparisons between different periods and systems, offering a clear picture of the stability level of development (Vintu and Negotei, 2018). The following section presents the details of its steps.

[26] The study includes nine selected countries in emerging Europe (including the Czech Republic, Hungary, Poland, the Slovak Republic, Bulgaria, Croatia, Romania, Russia and Ukraine).

The central banks' desire to monitor and analyze financial stability's threats and risks has led to the publication of financial stability reports. Studies related to this topic, including Gadanecz and Jayaram (2008), Oosterloo et al. (2007) and Čihák (2007), provide comprehensive surveys of the financial stability reports and the underlying indicators. Oosterloo et al. (2007), in particular, underline three principal motivations for the publication of financial stability reports. They point out that financial stability report publications, first, increase the transparency of the authorities responsible for financial stability; second, they contribute to financial stability; and, third, they fortify cooperation between the various participants implicated to maintain financial stability. From a general point of view, the greater part of financial stability presented in the financial stability reports center on various market segments. Basically, the focus relies upon the economy conditions and the areas of inspected vulnerabilities (Gadanecz and Jayaram 2008).

In fact, many emerging market economies widely focus on capital inflows, the balance of payment situation, and exchange rate movement, while developed economies center on their banks' exposure to emerging markets. Banking ratios are also broadly appraised in most reports. However, there is no common use of composite indicators in published financial stability reports. But there are some common areas when it comes to the specific variables used in the financial stability reports (Akosah et al., 2018).

Besides, in order to evaluate the risks and conditions that impact financial stability, the financial stability map was first introduced by Haldane et al. (2007) for the Bank of England and then by Dattels et al. (2010) for the USA. The aim of the map was to complement existing attempts, in addition to the IMF's widest surveillance and financial stability initiatives (Global FSR, 2007). As mentioned by Dattels et al. (2010), the map sought to understand a range of potential sources of instability and contagion between diverse segments of the financial markets and non-linear relations across inherent factors. It contained four risks and two conditions. The four risks comprised macroeconomic risks, emerging market risks, credit risk, and market risk; and the two conditions included monetary and financial conditions, and risk appetite.[27] Concerning the map's performance, the authors concluded that the map generally warned that risks were very low, whereas conditions were very loose, suggesting higher risks to financial stability in the period ahead.

[27] The monetary and financial conditions are assessed by the availability and cost of funding linked to global monetary and financial conditions, such as the real short-term interest rate, G-3 excess household and corporate liquidity, Goldman Sachs global financial conditions index, growth of custodial reserve holdings at the Federal Reserve Bank of New York, and G-3 Bank lending condition). Meanwhile, the risk appetite is evaluated by the willingness of investors to take on additional risk by adjusting exposure to the riskier asset classes, the consequent potential for increased losses, and the implications for the functioning of broader financial markets.

However, it is evident from the survey of literature that no aggregate financial stability index has been introduced for the euro area. The only such index developed for the euro area is the financial stability risk index introduced by Deghi et al. (2018) using the partial quantile regression method. Therefore, this chapter develops an aggregate financial stability index for the euro area using carefully picked macroeconomic variables (both external and internal) and bank-balance-sheet data (completed with financial soundness and monetary conditions indicators). Thus, the chapter offers a contribution to the debate on financial stability concerns for the euro area economy.

3. Empirical methodology

The methodology adopted to construct our quarterly aggregate financial stability index (AFSI) is as follows: we first compute for each country in our sample (eleven countries) the five sub-indexes (Financial Development Index (FDI), Financial Soundness Index (FSI), Financial Vulnerability Index (FVI), Monetary Conditions Index (MCI), World Economic Climate Index (WECI)), and we then aggregate them into a single AFSI. Then, we make an aggregation of the set AFSIs to obtain the euro area aggregate financial stability index. The weights allocated to both our AFSIs and AFSI sub-indexes are the arithmetic mean of weights based on both uniform and principal component methods using the expectation-maximization algorithm. We start by estimating the monetary condition sub-index and then we estimate the other sub-index.

3.1 Monetary conditions sub-index

In a small open economy, the monetary condition index (MCI) is defined as the weighted average of the real interest rate and the real exchange rate compared to their equilibrium values (Batini and Turnbull, 2000), as follows:

$$mci_t = \beta r_t + (1-\beta)(-z_t) \quad (1)$$

where r_t indicates the real interest rate in percent (p.a) at time *t*. The real interest rate is defined as the difference between the nominal interest rate i_t and the expected inflation rate $E_t(\pi_{t+1})$. So, we define the real interest rate r_t as: $r_t = i_t - E_t(\pi_{t+1})$. z_t indicates the real exchange rate (in ln*100)[28]: $z_t = s_t + p_t^* - p_t$, where s_t is the nominal exchange rate (local currency per unit of foreign currency), p_t indicates the domestic price level, and p_t^* the foreign price level.

[28] ln indicates logarithmic terms.

The monetary condition sub-index composition reflects the assumption of a small open economy. Not only the interest rate but also the exchange rate are important components that define the monetary stance – whether it is loose and stimulates demand, or whether it is tight and constrains demand. Therefore, the sub-index captures the impacts of monetary policy on aggregate demand and, as a consequence, on the output via two of the most important policy transmission channels -- the interest rate and exchange rate channels. The real interest rate impacts decisions to substitute between consumption today and saving today to consume in the future and to borrow funds to finance investment and consumption expenditure. Meanwhile, the real exchange rate impacts the substitution or shift in demand between domestically and foreign-produced goods, as it captures changes in relative prices.

The parameter β means that the weight here is positive and comprises between 0 and 1 ($\beta \in [0,1]$). Thus, we can see that the higher level of the real interest rate is consistent with the higher monetary condition index. A higher interest rate means a higher cost of borrowed money to finance consumption and investment, or larger incentives to save and postpone consumption, which, in turn, leads to constrained aggregate demand and output. The real exchange rate enters the equation with a minus sign because of its definition. The nominal exchange rate is a direct quote, which is the number of units of domestic currency per one unit of foreign currency. Therefore, the real exchange rate is determined in terms of foreign prices, converted to domestic currency, and relative to domestic price level. Depreciation of the domestic currency vis-a-vis foreign currency would correspond to a larger, more positive, or less negative value of the real exchange rate. More depreciated domestic currency, all other things being equal, gives exporters more domestic currency per one unit of foreign currency. Then a weaker, in real terms, domestic currency, should stimulate demand for domestically reproduced goods and services. Therefore, this implies more accommodative monetary conditions. So, a larger value of the real exchange rate then indicates more accommodative conditions. To obtain the correct impact of the real exchange rate in this definition on output, we add minus before the real exchange rate.

It is important to notice that although the MCI is defined here in real terms, it can also be defined in nominal terms. The advantages of favoring the real-term approach, rather than the nominal one, are as follows: first, macro-econometric models are based on real-term variables (Guillaumin and Vallet, 2017). Second, in the medium term, when inflationary effects can pass through the output gap, it can be difficult to interpret the nominal variables. Moreover, it has been shown that the evolution of nominal variables conducts more ambiguous information than real variables.[29]

[29] See, for example, Aubert (2003) for literature review.

Nevertheless, using MCI as a monetary stance measurement has some disadvantages. First, the index specification assumes that the interest rate and exchange rate are both monetary policy instruments, which is not always the case. Bindseil (2004) shows that, in practice, they can be operational targets. Second, even if the MCI were an operational target, it would not be appropriate in the case where non-policy variables might play a role in determining changes in both the interest rate and exchange rate (Eika et al., 1996; Ericsson et al., 1998).

In the next section, we will present the estimating methodology of the rest of the sub-index.

3.2 The other four sub-index

We estimate the rest of our sub-indexes using the statistical normalization approach introduced by Cheang and Choy (2009) and taken up by Akosah et al. (2018). All of our variables are normalized using the z-score to ensure that the overall index is not dominated by any individual variable. Underlying the normalization of variables is the concept of "stationarity," or the notion that the mean and variance of each variable does not vary over time (Brave and Butters, 2011). For this to hold, some variables must first be altered with a stationarity-inducing transformation prior to estimation. For this reason, we do some stationarity tests and use some transformation before normalizing the data. The zero mean and one standard deviation, z-score, is given as follows:

$$\widetilde{X_t} = \frac{(X_t - \mu_X)}{\sigma_X} \tag{2}$$

where $\widetilde{X_t}$ is the normalized series of the interest variable. X_t represents the value of interest variable at time *t*, μ_X and σ_X denotes, respectively, the mean and standard deviation of *X*.

This step is followed by calculating weights for the selected variables. The empirical literature suggests two approaches for computing weights for the index: the uniform weighting (see, for exemple, Jakubík and Slacik, 2013 and Albulescu, 2010); and the principal component method. However, the uniform averaging index is likely to be influenced or swayed by the most dominant variable (Akosah et al., 2018). Thus, we use the principal component analysis (PCA) method[30] for computing the weights of our sub-indexes.

The mathematics behind PCA[31] is as follows. Let us denote x_t the $1 \times N$ elements row vector of data at time *t*, and X_t the stacked matrix of data vector, where each column of this vector contains T observations of our sub-indicator normalized variable. The eigenvector-eigenvalue

[30] In the line of, for example, Brave and Butters (2011) or Arzamasov and Penikas (2014).
[31] See Appendix A and Theil (1971) for more details on the PCA method.

decomposition of the variance-covariance matrix[32] $X_T'X_T$ gives a set of weights referenced by the $1 \times N$ vector W corresponding to the eigenvector associated with the largest eigenvalue of this matrix. These weights are used to compute a weighted sum of the x_t at each point in time, such that the resulting index is obtained by:

$$I_t = X_t W \tag{3}$$

Where I_t represents the sub-index. In general, many missing values and frequency variations in the dataset can cause problems and render PCA not feasible. An alternative method that avoids these problems is the approach proposed by Stock and Waston (2002), which presents how this issue can be addressed by an iterative estimation strategy that relies on the incomplete data methods of the expectation-maximization (EM) algorithm of Watson and Engle (1983). This algorithm uses the information from the balanced panel of indicators to make the best possible prediction of the unbalanced indicators. The algorithm begins by estimating PCA on a balanced subset of the data to obtain an initial estimate of the index. The data for each of the financial indicators is then regressed on this estimate of the index, and the results of each regression are used to predict the missing data. The index is re-estimated by PCA on both the actual and predicted data. This process continues until the difference in the sum of the squared prediction errors between iterations reaches the desired level of convergence. However, a criticism addressed by Brave and Butters (2011) to this approach is that the Stock and Watson EM algorithm is a purely static estimation method that does not incorporate information along the time dimension into the construction of the index. Furthermore, it is restricted by the initial balanced panel of indicators, given its reliance on PCA.

Because of missing values for some countries' variables, we use this method instead as a starting point. We use a similar approach to Arzamasov and Penikas (2014), and Akosah et al. (2018), by taking the arithmetic mean of all the principal factors generated from the PCA-based EM algorithm to make sure that the generated weights are all positive. The arithmetic mean of the different principal factors obtained after running the PCA-based EM algorithm is as follows:

$$w_{ij} = \frac{\sum_{\{i=1\}}^{\{n\}} f_{ij}}{k} \tag{4}$$

where w_{ij} is the arithmetic mean of all principal factors, and *n* represents the total number of variables or sub-indexes implicated in the PCA-based EM algorithm.

Thus, the consolidated index for each of the four sub-indexes is calculated by the given equation:

[32] X_T' represents the transpose of the matrix X_T.

$$\widetilde{w_{ij}} = \frac{w_{ij}}{\sum_{\{i=1\}}^{\{n\}} w_{ij}} \quad (5)$$

Where, w_{ij} is the arithmetic mean of all principal factors, and *n* represents the total number of variables or sub-index implicated in the PCA-based EM algorithm.

Thus, the consolidated index for each our four sub-indexes is calculating by the given equation:

$$I_t = \omega\,(-X_t) \quad (6)$$

where ω represents the vector of the mean of weights obtained from the uniform and PCA-EM algorithm.[33] For each variable in the matrix X_t, the corresponding $\omega_j = \frac{\frac{1}{n}+\widetilde{w_{ij}}}{2}$. X_t is the matrix of the selected variables in the corresponding sub-index vector I_t. The minus sign before X_t allows us to ensure that the selected indicators have the same directional effect on the aggregate index. Thus, an increase (respectively, a decrease) in a given sub-index leads to an amelioration (respectively, a deterioration) in financial stability.

The final step consists of aggregating into the single aggregate financial stability indicator (AFSI) the five sub-indexes for each country of our sample. The aggregation is obtained as follows:

$$AFSI_t = \sum_i \alpha_i I_{it} \quad (7)$$

with $i = 1, \ldots, 5$. The five sub-indexes are, respectively, the Financial Development Index (FDI), the Financial Soundness Index (FSI), the Financial Vulnerability Index (FVI), the Monetary Conditions Index (MCI), and the World Economic Climate Index (WECI), where α_i represents the weight of the corresponding sub-index I_{it}. The weights allocated to our AFSIs are the arithmetic mean of weights based on both uniform and principal component methods using the expectation-maximization algorithm.

There are other ways to obtain the weights in equation (7). For example, the weights can be based on expert judgments and weights commonly used in the literature (see Cheang and Choy, 2009 and Akosah et al., 2018). Or, one can simply use the weights provided by the principal component, which mostly explains the variance (first principal component) of data (sub-indexes). In this chapter, for robustness, we use the two methods, in addition to the methodology explained above, and we make a comparison. Using the existing literature, the weights used for the AFSIs are as follows: FDI = 5%, FSI = 35%, FVI = 20%, MCI = 30%, and WECI = 10%. We discuss these weights in the following section.

[33] We make restrictions on the factor loadings to satisfy $\frac{\omega'\omega}{N} = I$.

4. Data description and estimation

4.1. The selected variables and data issues

The first thing to do in the construction of an aggregate financial stability index is to identify the set of variables and conditions that might support threats to financial stability (Cheang and Choy, 2009). In order to construct our quarterly aggregate financial indicator, we use the traditional financial soundness indexes, as well as indicators from the external sector, monetary and financial sector, balance of payments, foreign exchange and capital markets. The set of variables is presented in Table 1 and is carefully selected based on the condition that developments in those variables have potential influence on financial stability. Table 1 contains 23 variables[34] for our euro area financial stability index, and we collect quarterly data for 11 countries (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Spain and Portugal) from 2007Q1 to 2020Q4.

The financial development index (Table 1) provides a measure of the level of financial system development. The ratio of market capitalization to GDP catches the development of the capital markets, while the ratio of total credit to GDP gives information on the ability of credit institutions to further their intermediation functions. Augmentations in the values of these indexes are expected to lead to ameliorations in the sub-index. Indeed, the Herfindahl–Hirschmann Index (HHI) in the sub-index represents the degree of concentration in the banking sector. It is calculated by the sum of the squares of all the bank's percentage share of deposits. An increase in the HHI is interpreted as a positive effect on stability.

The retaining variables for the financial soundness sub-index measure the solvency of credit institutions in the financial system. The ratio of non-performing loans (NPLs) to total loans shows the banks' loans quality, while the capital to assets ratio measures their level of capitalization. The aim of the ratio is to identify troubles with asset quality in the loan portfolio and the degree of credit risk. The increase in the ratio might reflect degradation in the quality of the credit portfolio, despite the fact that it is generally a retrospective indicator, in that NPLs are identified when problems occur. On the one hand, the ratio of NPLs net of provisions to capital provides an indication of banks' capital capacity to resist potential losses in NLPs. The ratio of liquid assets to total assets, as the so-called liquid assets ratio, gives a measurement of banks' capacity to face expected and unexpected demands for cash. The capital adequacy ratio denotes the buffer that a

[34] For example, Albulescu (2008) used 18 variables; Morris (2011) used 19 variables; Cheang and Choy (2009) used 19 variables; Sere-Ejembi et al. (2014) used 18 variables; and Akosah et al. (2018) used 22 variables.

bank must have to face potential risks. In other words, it provides a measurement of banks' capacity to absorb unexpected losses and gives an indication of the banks' leverage.

Table 1: Selected variables under each Sub-index

Indicators	Subgroup
Market Capitalization/GDP Total Credit/GDP Herfindahl–Hirschmann Index (HHI)	Financial Development Index
Non-performing Loans to Total Gross Loans Non-performing Loans Net of Provisions to Capital Liquid Assets to Total Assets (Liquid Asset Ratio) Regulatory Capital to Risk-Weighted Assets, percent (Capital adequacy ratio) Customer Deposits to Total (Non-interbank) Loans Cost to Income Return on Assets Non-Interest Expenses to Gross Income Interest Margin to Gross Income	Financial Soundness Index
Inflation rate (CPI, year over year) Ratio of Net Foreign Assets to Net Domestic Assets Composite Index of Economic Activity General Budget Balance (% GDP) Current Account Balance (% GDP) Ratio of Foreign Currency Assets to Foreign Currency Liabilities Ratio of External Assets to Total Assets	Financial Vulnerability Index
Real Exchange Rate Real Interest Rate	Monetary Condition Index
Economic Growth in G-20 Inflation Rate in G-20	World Economic Climate Index

On the other hand, the cost to income used to identify banks' profitability defines the efficiency at which the bank is being run. The lower the ratio is, the better it is for the bank, suggesting more profitability for the banks. The return on assets ratio provides a measure of the profitability or efficiency of the banks in using their assets. It also designates the buffer that a bank disposes of in order to face potential risks. The interest margin to gross income ratio and the non-interest

expenses to gross income ratio are comprised in the sub-index. Although the interest margin to gross income ratio measures the relative share of net interest earnings with gross income and reveals the importance of net interest income and the capacity to absorb losses, the non-interest expenses to gross income ratio measures the extent to which high non-interest expenses weaken earnings.

Regarding the financial vulnerability sub-index, the set of indicators comprises macroeconomic variables, in addition to the funding structure of banking institutions. The sub-index indicates how well a financial system could react to given shocks. The inflation rate and general budget balance as a share of GDP are added as a signal of investor confidence in the economy since this may have implications for financial markets and financial stability. Moreover, the current account as a share of GDP reveals the country's exposure to external shocks. Meanwhile, the composite index of economic activity here gives the direction of global economic movements in future months. It helps businesses and investors to plan their activities around the expected performance of the economy and protects them from economic downturns. The ratio of foreign currency assets to foreign currency liabilities provides a measurement of the mismatch between foreign currency assets and liability. When the ratio is close to one, this indicates that there is a low risk of currency mismatch at the aggregate level. The foreign exchange rate covers banks' vulnerability to exchange movements in both directions. And, finally, the ratio of external assets to total assets measures the external position of the local bank sector.

The monetary condition sub-index comprises the real interest rate, calculated by the difference between the short-term interest rate and the inflation rate. The sub-index here supposes that the monetary conditions affect financial stability via the credit channel.

The world climate sub-index measures investors' confidence level in the financial system. The sub-index comprises two world macroeconomic indicators, which are world economic growth and world inflation rate.

Tables B.1 to B.11, in Appendix B, present unit root tests of the selected variables contained in Table 1 for each country of our sample. The results of these tests show that, for all countries, there are a few numbers of variables that are stationary in level. And they reveal that most variables are stationary in terms of differences. The variables that present a deterministic trend were regressed on the trend and the residuals of this regression were used for the analysis.

4.2. Estimation

For the 11 countries, the construction of the aggregate financial index for the euro area requires the following steps:

(i) estimate the monetary condition sub-index using equation (1),

(ii) estimate the financial development, financial soundness, financial vulnerability, and world economic climate sub-indexes using the EM-PCA method following equations (2), (4) and (6),

(iii) use PCA to summarize into a single indicator (aggregate financial stability index) the information contained in the variance of financial development, financial soundness, financial vulnerability, and monetary condition sub-indexes following equation (7),

(iv) use PCA to summarize into a single indicator (aggregate index for the euro area) the information contained in the variance of the 11 indicators obtained after step (iii).

For step (i), the estimation of the model in equation (1) requires calibration of parameter β. Generally, this parameter is within [0.3, 0.8] (must be in [0, 1]);[35] a lower value means that the economy is more open and that the exchange rate channel is relatively strong, while the interest rate channel is weaker. In this chapter we fix the value of the parameter to 0.7 for all countries.

Steps (ii) and (iii) are detailed in the methodology section. In step (iv) the aggregate index of the euro area is obtained using equations (4) and (6) on the financial stability index estimated separately for each country.

5. Results

5.1 Aggregate financial stability indexes

The financial stability indexes that we computed based on the indicators listed in Table 1 are displayed in Figure C.1 in Appendix C. As mentioned above, the estimation period covers March 2007 to December 2020. The figure contains the indexes for Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Spain, Portugal, and an aggregate of the 11 countries.[36]

[35] IMF, Monetary Policy Analysis and Forecasting online course.

[36] The resulting indexes are robust when we change the way we compute weights in equation (7). We present two alternative ways to obtain AFSI in Figures C.3 in Appendix C for robustness.

The different indexes' average is zero by construction. Therefore, a value of zero is interpreted as the average financial stability index for that country, whereas progressively larger positive values indicate progressively better-than-average conditions, and progressively more negative values indicate progressively worse-than-average conditions. Essentially, the average condition varies across countries. For instance, a value of zero for France corresponds to around -0.32%, while a value of zero in Ireland corresponds to around 0.02%. The shared region in the sample represents official recessions, as defined by NBER, CEPR, and ECRI. We identify three official recessions in our study period, which are the global financial crisis of 2008–9, the european debt crisis of 2011Q2, 2012Q3, and the COVID-19 pandemic crisis of 2020Q1, 2020Q2. Overall, we can see that the indexes fall sharply during recession and tend to reach relatively high values during good times for each country, and more particularly for the aggregate index of the 11 countries (see Figure 1). The dynamic of the aggregate index is very similar to the dynamic of the AFSI of the core countries, especially Germany, France, the Netherlands and Austria. This might lead one to believe that the financial stability of the euro area depends more on the financial stability of these countries.

Indeed, five distinct developments can be identified on the index dynamic. The first one is the period of financial strain following the global financial crisis (March 2007–December 2009); the second period sustains the amelioration in financial stability (March 2010–June 2011); the third period is characterized by a return to financial strain following the European debt crisis (September 2011–December 2012); the fourth period is marked by more stable financial conditions (March 2013–December 2018); and the last period sustains a return to financial stress following the COVID-19 pandemic crisis.

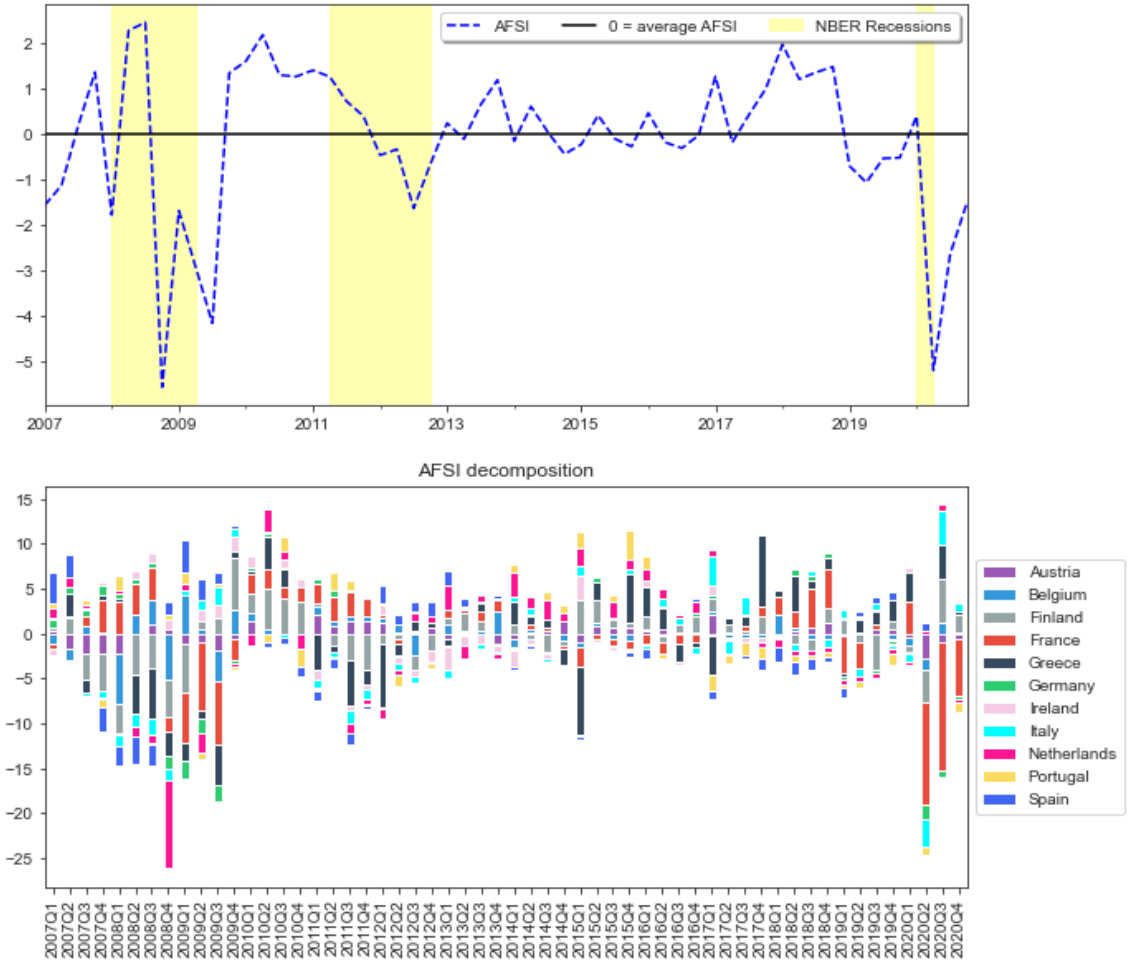
The first period is mainly characterized by considerable strain in banking sector stability, underpinned by deterioration in the AFSIs of all four core countries and some peripheral countries, especially Italy and Finland. The aggregate index for the euro area declines drastically, reaching its lowest level (-5.56% in December 2008) over the period of the study. Indeed, as we can see in the countries' AFSI decomposition, the world economic climate sub-index fell sharply within this period as a result of the worst recession affecting the world economy since the Great Depression in the 1930s. The crisis' impact through the euro area countries is also shown by declines in the financial vulnerability index (see Figures C.2.1 to C.2.11 in Appendix C). This is mainly due to the fall in current account balance, the ratio of foreign currency assets to foreign currency liabilities, and the ratio of external assets to total assets, which leads to deteriorating countries' terms of trade.

In addition, the financial soundness sub-index went down because of the decline in the real economy, which impacted the balance sheets of non-financial corporations and households, making the capacity to repay the contracted loans more difficult. This resulted in significant harm

to banks' asset quality. For example, non-performing loans as a percentage of gross loans went up from 2.82% in March 2008 to 4.02% in March 2009 for France. Likewise, the financial development index declined because of tighter credit conditions, increasing concentration in the banking sector and a downbeat stock market fundamental (see, for example, France, Germany and Spain AFSI decomposition in Appendix C) as wary investors began to liquidate their shares.

The European debt crisis period was preceded by an improvement in financial stability in almost all countries, as can be seen in the aggregate index decomposition. The aggregate index increased until June 2010 when Greece's problems began. Then followed a substantial impairment of the financial stability of peripheral member states, especially Greece, where the crisis took root, and Spain, Italy, Finland and Portugal. In Greece, for instance, the AFSI decomposition shows that financial soundness, financial vulnerability, and monetary condition indexes had already declined from June 2010. Monetary condition and financial soundness indexes remained deteriorated until March 2012. Meanwhile, the financial vulnerability index rose from 0.76% in June 2011 to 7.21% in June 2012, suggesting that agents became more optimistic about a resolution to the crisis, with the bond exchange taking place in Greece. The aggregate index finally became positive after December 2012.

Figure 1: Aggregate Financial Stability Index and its decomposition for euro area



The period before the COVID-19 pandemic crisis (March 2013–December 2018) was characterized by financial stability and improvement in the aggregate index. Then came a return to financial stress following the pandemic, a period that was marked by the deterioration of financial conditions, with the aggregate index declining sharply from 0.3% in March 2020 to -5.19% in June 2020. The decomposition of the aggregate index shows that all countries were affected, although the impact of the crisis differed from one country to another. Indeed, the crisis totally paralyzed the world economy.[37] As firms in the most affected sectors suddenly broken off to generate income, they were not able to pay their employees, banks, landlords and suppliers, leading the economy into a downward spiral. As a result, this reduced tax revenue, putting extra pressure on government finances and creating extreme volatility in the financial markets. To support the crisis, the European Central Bank, in coordination with the national central banks, decided to buy government bonds

[37] All economic sectors were affected: restaurants, hotels, bars, theatres, cinemas, and concert halls closed their doors and their income dried up. Events were cancelled, and the aviation and tourism industries came to an almost complete standstill. Demand for oil also largely dried up.

on the secondary market from the commercial banks, which in turn purchased them from their government upon issuance. This made it possible to maintain interest rates at a government low and to create room on commercial bank balance sheets to issue new loans to firms and households. As a consequence, this led the financial development sub-indexes of eurozone countries to increase (total credits to GDP increased, see countries' financial development indexes).

5.2 Financial cycle, financial risk monitoring indexes and aggregate financial stability index

In this section we present an application for our countries' aggregate financial stability indexes. The different AFSIs are compared to other financial monitoring risk indicators to illustrate their help in the financial monitoring exercise. Indeed, monitoring the risks to which the financial and non-financial sectors contribute, or are exposed, involves the authorities in financial stability using a set of indicators. These indicators are grouped into five classes of risk,[38] which are macroeconomic risk (GDP growth and its perspectives), the credit risk of non-financial agents (credit to households and non-profit institutions serving households as a percentage of GDP, for example), market risk (stock market index), liquidity, solvability and profitability risk (Eonia rate), and concentration, contagion, and interconnexion risk (economic activity concentration index). We find that for the eurozone countries over the last decade, when instability has been strictly related to the state of the financial system, as measured by AFSI, it has a potentially milder impact on financial cycles than when the instability is related to financial risk monitoring indicators.

5.2.1 Financial cycle estimation

One of the key goals of macroprudential policymaking is assimilating the development of the financial cycle, since its analysis allows policymakers to have good comprehension, anticipation, and the ability to prevent the consequences of their turnarounds. The financial cycle has no clear and consensual definition. However, Borio (2014) points out that the financial cycle is related to self-reinforcing interactions between perceptions of value and risk, attitudes toward risk, and financing constraints, which translate into booms followed by busts. Financial crises are akin to financial cycle peaks, and so the cycle helps to identify financial distress risks in their build-up phase. From an empirical point of view, two important stylized facts of the financial cycle are established. The first shows that the financial cycle's frequency is lower than the traditional business

[38] See Bennani et al. (2017) for more details.

cycle one.[39] And the second reveals that fluctuations in credit and property prices illustrate the financial cycle, both parsimoniously and effectively.[40]

In this chapter we use these two variables (credit-to-GDP ratio and real house prices) to compute the financial cycle for the countries in our sample and the eurozone. The methodology used is as follows. First, we use the band-pass filter[41] to estimate both credit and house-price cycles; and, second, we use PCA to combine the information from these two cycles into a summary index (financial cycle). The indexes obtained are summarized in Figure 4 and attest to the previous findings in the literature.[42] Indeed, Figure 4 shows the divergence between countries and a moderate financial cycle for the euro area as a whole.

5.2.2 Financial risk surveillance indexes and financial cycle

There is as yet no "true" financial risk monitoring index to ensure financial stability. Macroeconomic indexes, the credit risk of non-financial agents' indexes, the market index, the liquidity, solvability, and profitability indexes, and the concentration, contagion, and interconnexion indexes are the set of indicators used by policymakers to monitor financial stability.

Macroeconomic conditions can help to anticipate cyclical downturns and must be monitored. The relevant indicators here are GDP growth and its prospects, production or business indices such as the Purchasing Manager Index (PMI), order book dynamics, consumer prices, and commodity prices. For instance, Alfaro and Drehmann (2009) study the stylized facts of GDP before crises in order to see the extent to which they can warn about a crisis. Studies on the uncertainty or the degree of disagreement[43] between macroeconomic forecasting professionals show that an increase in this indicator can be a signal of future macroeconomic downturns. Other indicators relate to export performance, which reflects the economic dynamism of a country such as the net external position or exchange rate.

[39] Borio et al. (2012) show that the average length of financial cycles in a sample of seven industrialized countries since the 1960s has been around sixteen years, and that financial cycles normally have greater amplitude than business cycles. The length and amplitude of the financial cycle depend on the policies adopted (Borio et al., 2012), but the literature identifies a tendency for financial variables to evolve at a relatively slow pace.

[40] Borio et al. (2012). These variables tend to co-vary rather closely with one another, and the variability in the two series is dominated by low-frequency components.

[41] The band-pass filter allows us to decompose the time series into different components based on their different frequency ranges. For example, we can extract from the series the trend represented by the components with periodicities longer than the business cycle; estimate the gap represented by the components with business cycle periodicities; and obtain the noise represented by the components with shorter periodicities than the business cycle.

[42] See Merler (2015), for example.

[43] Uncertainty, or the degree of disagreement, is assessed by probability distributions, around growth forecasts, provided by surveys of macroeconomics forecasting professionals (Survey of Professional Forecaster).

Regarding the credit risk of non-financial agent monitoring, several indicators can be used. The first one that can be used is the indebtedness variable (bank loans), whereby the level of indebtedness can be measured as a percentage of GDP or in trend deviation. The Basel Committee in Banking Supervision (BCBS) recommends, especially, monitoring the total credit gap.[44] Previous studies have shown that this variable is a good leading indicator of banking crises (see Basel Committee in Banking Supervision, 2010; Drehmann and Juselius, 2014; Dembiermont et al., 2013). In the same way, the level of non-financial corporations' debt and the level of households and non-profit institutions serving household debt can be measured as a percentage of GDP or in trend deviation. The first one reveals the possible acceleration of aggregate counterparty risk, while the second is subject to specific monitoring, both in volume and in terms of the conditions for granting credit.

Regarding market risk, from a macroprudential point of view, it is essential to be able to control the proper functioning of the financial markets. In particular, phenomena of massive overvaluation, which could degenerate into financial crises, should be avoided. The issue is all the more important as this detection must be done as far upstream as possible to avoid market corrections that are too sudden, to which all agents are exposed and which could have systemic consequences (Bennani et al., 2017). Concretely, this surveillance is carried out on the stock markets, and more precisely on the level of stock market indices such as the CAC 40 in France, DAX 30 in Germany, or EURO STOXX 50 for the euro area. The experience has shown that an overvaluation of stock prices is often followed by a sudden readjustment, which can degenerate into a financial crisis. Table 2 (below) presents the set of stock market indices used in our analysis.

The liquidity risk for a financial agent is defined as the risk of not being able to use the usual means of refinancing to meet its commitments. For a bank, for instance, this risk materializes when it is unable to refinance itself in the short term (i.e., to renew short-term borrowing on the liabilities side of its balance sheet). Bank liquidity indicators primarily concern the interest rate conditions at which they refinance themselves on the interbank market. In the eurozone the Eonia rate is the interbank rate by reference.

[44] The credit gap is defined as the deviation of the credit-to-GDP ratio from a one-sided filtered trend.

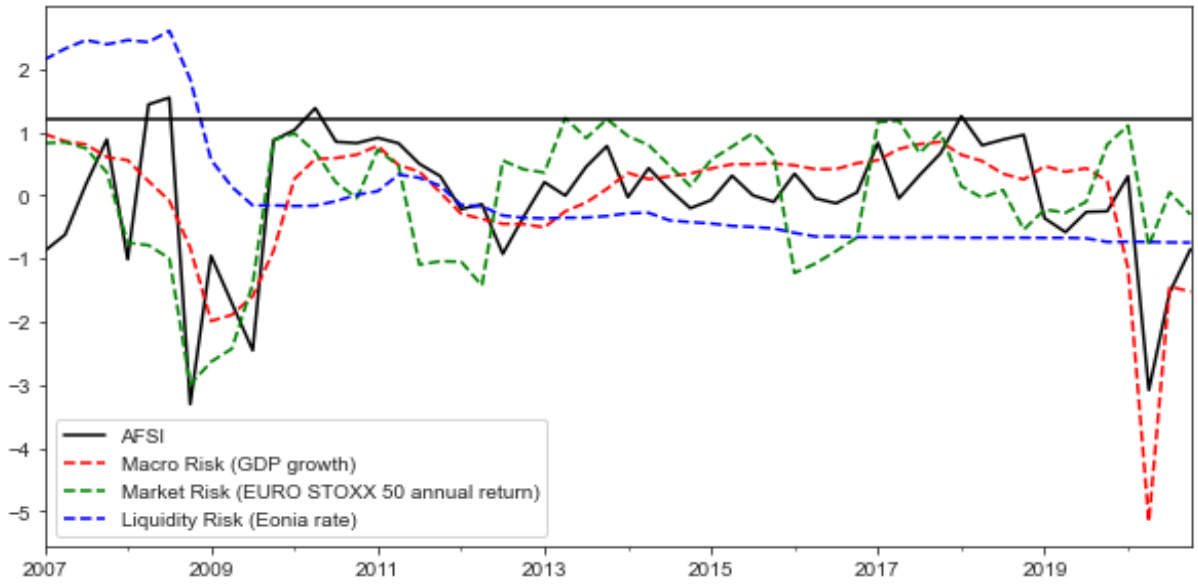
Table 2: Stock Index series in the euro area

Countries (country code)	Stock Index
Austria (AT)	ATX
Belgium (BE)	BEL 20
Finland (FI)	OMX Helsinki 25
France (FR)	CAC 40
Germany (DE)	DAX
Greece (GR)	Athens General Composite
Ireland (IE)	ISEQ
Italy (IT)	FTSE MIB
Netherlands	AEX
Portugal (PT)	PSI 20
Spain (ES)	IBEX 35

Figure 2 compares the AFSI developed here against some financial monitoring indicators[45] for the euro area. All indicators are de-meaned and standardized for comparison; they all fall during financial downturns. Their pairwise correlations range from approximately 0.13% between the financial stability index and liquidity risk index to over 30–35% between the financial stability index, market risk index, or macro risk index. The AFSI exceeds 1.2 standard deviation above its mean only two times but the peaks do not always correspond with the peaks of the other indexes, implying that these indicators as proxies of financial risk monitoring might carry slightly diverse information.

[45] We choose GDP as macroeconomic risk, stock market indexes as market risk, and the Eonia rate as liquidity risk.

Figure 2: AFSI for euro area compared against other proxies for financial stability surveillance indicators



Notes: The solid line represents the AFSI for Euro area compared against other proxies for financial stability surveillance indicators (macroeconomics risks, market risk and liquidity risk). All series are on the same scale (demeaned and standardized). The horizon line represents the 1.2 standard deviation limit.

Many studies offer fascinating insights into particular aspects of boom–bust developments,[46] while others are based on indicators that can reflect the peaks of the financial cycle (Alfaro and Drehmann, 2009). In this chapter we focus on analyzing the relationship between financial cycles and monitoring financial risk indicators. Based on the literature, suggesting that the peaks of financial cycles are closely related to the financial crisis, we suppose that these peaks correspond to the instant where shocks happen, thus leading to a financial downturn. To estimate the impacts of these shocks, we estimate a bivariate VAR with the financial cycle and each one of the monitoring financial risk proxies from Figure 2, separately. The bivariate VAR characterizes a parsimonious way to model the joint dynamics between these variables because of the short dataset (quarterly data from March 2007 to September 2020). The reduced form of the bivariate VAR model estimated here can be represented as follows:

$$X_t = G_0 + G_1 X_{t-1} + G_2 X_{t-2} + \cdots + G_p X_{t-p} + e_t \quad (8)$$

where $e_t$represents the vector of residuals at time *t*. Moreover, X_t is the vector of endogenous variables (monitoring financial risk proxy and the financial cycle). G_0 is a vector of constant terms,

[46] Especially those built on the bedrock of the dynamic stochastic general equilibrium approach.

while G_l $(l = 1, \dots, p)$ is parameter vector for the endogenous variable X_t. The monitoring financial risk proxy is ordered first for each estimation. By doing this, we assume that the monitoring financial risk proxy is not affected contemporaneously (but only with a lag) by a shock to the financial cycle. Meanwhile, the financial cycle is affected contemporaneously by a shock to monitoring the financial risk indicator. For instance, if the monitoring financial risk proxy in our model is the liquidity risk index (the Eonia rate), this means that the Eonia rate is not impacted by a shock to the financial cycle; rather, a shock to the Eonia rate contemporaneously impacts the financial cycle. This representation is called Cholesky ordering, which is equivalent to a structural SVAR with a restriction on monitoring the financial risk proxy parameter. To illustrate this, let us assume that the structural model of our VAR is as follows:

$$X_t = B(L)u_t \tag{9}$$

where u_t are structural economic shocks, white noise $E\left(u_{t-i}u'_{t-j}\right) = I$ for $i = j$ and $E\left(u_{t-i}u'_{t-j}\right) = 0$ for $i \neq j$. The impulse response function is $B(L) = B_0 + B_1 L + B_2 L^2 + \cdots$.

If $B(L)^{-1}$ exists, equation (9) can be approximated by a VAR model, as described by equation (8) or $G(L)X_t = e_t$. Thus, the VAR is estimated equation-by-equation to find the residuals $\widehat{e_t}$ and $\widehat{G_j}$. By taking the appropriate combination of the reduced form residuals e_t, we obtain the structural shocks $u_t = B_0^{-1}e_t$ and the structural IRF: $X_t = B(L)u_t$.

Here, we estimate equation (8), with the variables ordered as $[RiskInd_t, FinCy_t]$ and estimate $\hat{\Sigma}$. The Cholesky decomposition S, of $\hat{\Sigma}$ is the unique lower triangular matrix, such that $SS' = \hat{\Sigma}$. The identified impulse response functions are $x_t = G(L)^{-1}Su_t$ and the structural shocks are $u_t = S^{-1}e_t$. The contemporaneous[47] response is:

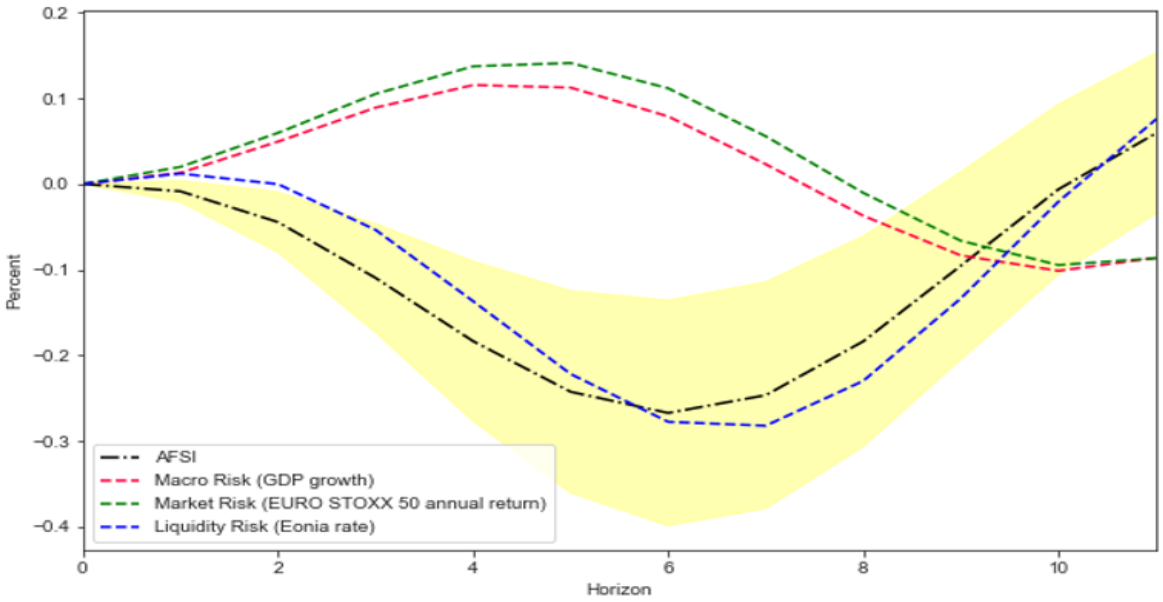
$$Su_t = \begin{bmatrix} s_1 & 0 \\ s_2 & s_4 \end{bmatrix} \tag{10}$$

We estimate each VAR by selecting its length based on Akaike information criterion, and we use Cholesky IRF for our analysis. The euro area, as a whole, recursive impulse responses of the financial cycle to one-standard-deviation financial risk shock, as measured by the different proxies, where the risk indicator is ordered first, are represented in Figure 3. The shared area corresponds to +/- one standard error confidence interval for AFSI shock. As expected, the financial cycle decreases after the financial shock by between 0.24 and 0.28% when the financial risk is measured

[47] See Ramey (2016) for more details.

by AFSI and liquidity risk index, respectively. The result is not the same for macro and market risk indexes. These indexes fall to estimate the expected effect since they go up after the shock.

Figure 3: Euro area financial cycle response to a 1 standard deviation shock in the different financial monitoring risk



Note: The shared region represents the +/- one standard error confidence interval for the aggregate financial stability index.

We repeat the same exercise for the 11 countries of our sample and display the results in Figure 5 in Appendix C. The financial cycle decreases after a financial shock, regardless of the index for Belgium, Finland, France, Germany and the Netherlands. However, we can see that when the instability shock is related to the financial condition alone, as measured by the AFSI, it has a potentially milder impact on the financial system. On the other hand, when the instability shock is related to the financial condition, as measured by the Eonia rate (liquidity risk indicator), its impact on the financial system appears stronger. For macro and market risk indexes, the impact appears to be small (see IRF for Finland, France, Germany and the Netherlands). The market risk indicator has a stronger effect on the financial cycle than other indexes for Belgium and Greece. Concerning Italy, the macro risk, market risk, and liquidity risk indexes fall to estimate the desirable intuition, since they go up after the shock. The market and liquidity risk indicators increase after the shock, before decreasing respectively, after one and two quarters, for Portugal and Spain.

To sum up, one can see that the result of this exercise is robust from one country to another. However, as robust as it is, it is clear that when the financial risk is measured by our AFSI, the

reaction of the financial cycle to the shock is common for all countries (the financial cycle decreases after the shock before going up), even if the magnitude of the shock differs from country to country. This is consistent with the intuition behand this exercise. For the euro area as a whole, when instability is related to the state of the financial system alone, as measured by AFSI, it has a potentially milder impact on the financial cycle than when the instability is related to financial risk monitoring indicators.

In view of this result, it is obvious that the aggregate financial stability index can be a "complement" and a useful tool for macroprudential policymakers in their exercise of financial stability surveillance. Even though it allows policymakers to have a clear picture of financial stability by offering them the possibility to identify stability, instability, and crisis areas, it seems to estimate better the intuitive response of the financial cycle after a shock compared to other financial stability monitoring indicators, such as macro risk, market risk, and liquidity risk indexes.

6. Summary and concluding remarks

The purpose of this chapter is to: (i) construct measure of financial stability indexes called aggregate financial stability indicators (AFSIs) for euro area countries; and (ii) assess their ability to be a monitoring financial stability tool, before and during a crisis, by comparing the response of the financial cycle to a shock, as measured by our AFSIs, with a shock measured by other financial monitoring risk indicators.

Our methodology is based on the approach proposed by Cheang and Choy (2009) and taken up by Akosah et al. (2018), with some differences. Our index includes a total of 23 variables from different markets, such as the equity market, credit market, money market, and the foreign exchange market, as well as other important macroeconomic indicators. The empirical normalization technique is used to normalize variables. The computed AFSIs are the weighted average of the composite sub-indices (financial development, financial soundness, financial vulnerability, monetary condition, and the world economic climate). The arithmetic mean of the uniform and principal component analysis using expectation-maximization algorithm weighting methods is used to assign weights to each variable to construct sub-indices, as well as to allocate weights to sub-indices to obtain the composite index. We use a set of euro area domestic and international events, which are ranked by NBER, CEPR, and ECRI as a benchmark to evaluate the appropriateness of our AFSI. The AFSIs are successful at closely tracking financial stability during these incidents, and they fall sharply during recession, tending to reach relatively high values during good times for each country, and more particularly for the aggregate index of the 11 countries.

The dynamic of the aggregate index is very similar to the dynamic of the AFSIs of the core countries, especially Germany, France, the Netherlands and Austria. This suggests that the financial stability of the euro area depends more on the financial stability of these countries. This seems obvious when one considers the economic and financial weight of these countries in the eurozone. This comparison attests to the comparative nature of the results of the methodology used, as highlighted by Albulescu (2008).

The comparison exercise of AFSIs to other financial monitoring risk indicators, using the VAR model impulse response to assess the dynamic of the financial cycle after a shock, measured by these different indicators, shows that the results are without a doubt robust from country to country because of the divergence of the financial cycle in the eurozone. However, the results show that when the financial risk is measured by our AFSIs, the reaction of the financial cycle to the shock is common for all countries (the financial cycle decreases after the shock before going up), even if the magnitude of the shock differs from country to country. For the euro area as a whole, when instability is related to the state of the financial system alone, as measured by AFSIs, it has a potentially milder impact on the financial cycle than when the instability is related to financial risk monitoring indicators. This chapter thus contributes to the debate on the measurement of financial stability by highlighting another property of the results from the so-called aggregate financial indexes through this comparison analysis.

The results of this study suggest that the aggregate financial stability index can be a "complement" and a useful tool for macroprudential policymakers in their exercise of financial stability surveillance. Even though it allows policymakers to have a clear picture of financial stability by offering them the possibility to identify stability, instability, and crisis areas, it seems to estimate better the intuitive response of the financial cycle after a shock compared to other financial stability monitoring indicators, such as macro risk, market risk, and liquidity risk indexes. Thus, the European central bank (euro area countries' central banks) should use AFSIs based on our methodology to assess the euro area's financial system stability (countries' financial system stability), as well as being the basis for finding stabilization policies. The flexibility of our AFSI method structure can, with simple variations and extensions, readily incorporate sector-specific financial stability risks, depending on the specific concerns of policymakers in certain cases. Such risks could include crypto currency risks or natural disaster risks (see, for example, Avril et al., 2022).

Appendix A. The mathematics behind the principal component analysis (PCA)

Principal component analysis (PCA) is one type of unsupervised learning algorithm (dimension reduction algorithm) using in machine learning. Without trying to give a full primer on PCA, from an optimization viewpoint, the primary objective function is the Rayleigh quotient.[48] The matrix that figures in the quotient is (some multiple of) the sample covariance matrix. This objective function is as follows:

$$\mathrm{S} = \frac{1}{\mathrm{n}} \sum_{\mathrm{i}=1\ldots\mathrm{n}} \mathrm{x_i x_i^T} = \frac{\mathrm{X^T X}}{\mathrm{n}}$$

where each $\mathrm{x_i}$ is a vector of p features (variables) and X is the matrix, such that the ith row is $\mathrm{x_i^T}$.

PCA seeks to solve a *sequence* of optimization problems. The first in the sequence is the unconstrained problem:

$$\text{maximize } \frac{u^T \mathrm{Su}}{u^T \mathrm{u}}, \mathrm{u} \in \mathrm{R^p}$$

Since $\mathrm{u}^T\mathrm{u} = \|\mathrm{u}\|_2^2 = \|\mathrm{u}\|\|\mathrm{u}\|$, the above unconstrained problem is equivalent to the following constrained problem:

$$\text{maximize } \mathrm{u}^T\mathrm{Su}$$

$$\text{subject to } \mathrm{u}^T\mathrm{u} = 1$$

This is where the matrix algebra comes in. Since S is a symmetric positive semidefinite matrix (by construction), it has an eigenvalue decomposition of the form:

$$\mathrm{S} = \mathrm{Q}\Lambda\mathrm{Q^T}$$

where Q is an orthogonal matrix (so $\mathrm{QQ^T}$=I) and Λ is a diagonal matrix with non-negative entries λ_i, such that $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p \geq 0$.

Hence, $\mathrm{u}^T\mathrm{Su} = \mathrm{u}^T\mathrm{Q}\Lambda\mathrm{Q^T}\mathrm{u} = \mathrm{w}^T\Lambda\mathrm{w} = \sum_{\mathrm{i}=1}^{\mathrm{p}} \lambda_i w_i^2$. Since u is constrained in the problem to have a norm of one, so is w, since $\|\mathrm{w}\|_2 = \|\mathrm{Q}^T\mathrm{u}\|_2 = \|\mathrm{u}\|_2 = 1$, by virtue of Q being orthogonal.

But if we want to maximize the quantity $\sum_{\mathrm{i}=1}^{\mathrm{p}} \lambda_i w_i^2$ under the constraints that $\sum_{\mathrm{i}=1}^{\mathrm{p}} w_i^2 = 1$, the best we can do is to set $\mathrm{w} = \mathrm{e}_1$, that is $\mathrm{w}_1 = 1$ and $\mathrm{w_i} = 0$ for $i > 1$.

[48] Also known as the Rayleigh–Ritz ratio, named after Walther Ritz and Lord Rayleigh.

Now backing out the corresponding u, which is what we sought in the first place, we get:

$$\mathrm{u}^* = \mathrm{Qe}_1 = \mathrm{q}_1$$

where q_1 denotes the first column of Q, that is, the eigenvector corresponding to the largest eigenvalue of S. The value of the objective function is also easily seen to be λ_1.

The remaining principal component vectors are then found by solving the sequence (indexed by i) of optimization problems:

$$\text{maximize } \mathrm{u}^T\mathrm{Su}$$

$$\text{subject to } \mathrm{u}^T\mathrm{u} = 1$$

$$\mathrm{u} = 0, \forall 1 \leq j < i$$

So, the problem is the same, except that we add the additional constraint that the solution must be orthogonal to all of the previous solutions in the sequence. It is not difficult to extend the argument above inductively to show that the solution to the problem is, indeed, q_i (with i the eigenvector S).

The PCA solution is also often expressed in terms of the singular value decomposition of X. To see why, let $\mathrm{X} = \mathrm{UDV}^T$. Then, $n\mathrm{S} = \mathrm{X}^T\mathrm{X} = \mathrm{VD}^2\mathrm{V}^T$ and so $\mathrm{V} = \mathrm{Q}$ (strictly speaking, up to sign flips) and $\Lambda = \frac{\mathrm{D}^2}{n}$.

The principal components are found by projecting X onto the principal component vectors. From the SVD formulation just given, it is easy to see that:

$$\mathrm{XQ} = \mathrm{XV} = \mathrm{UDV}^T\mathrm{V} = \mathrm{UD}$$

The simplicity of representation of both the principal component vectors and the principal components themselves, in terms of the SVD of the matrix of features, is one of the reasons why the SVD features so prominently in some treatments of PCA.

Appendix B. Unit root tests

Table B.1: Unit root tests for Austria

	ADF				PP		KPSS	
	Level		First difference		Level		Level	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Composite Activity Indicator	-3.615*	0.029	-2.868*	0.004	-1.935	0.636	0.07*	0.348
Cost to Income	1.098	0.929	-1.022	0.279	0.515	0.828	0.048*	0.597
Total Credit / GDP	-1.999	0.287	-6.391**	0.000	1.234	0.944	0.14*	0.06
Current Account Balance	-2.638	0.085	-5.162**	0.000	-2.058	0.262	0.483	0.044
Customer Deposits to Total (Non-interbank) Loans	-2.222	0.198	-1.394	0.152	-3.209	0.083	0.99	0.003
G20 GDP Growth Rate	-4.674**	0.000	-4.113**	0.000	-1.05	0.265	0.053*	0.536
G20 Inflation Rate	-3.05*	0.03	-4.138**	0.000	-1.763	0.399	0.05*	0.573
General Budget Balance	-3.376	0.055	-7.349**	0.000	-1.202	0.21	0.654	0.017
Herfindahl – Hirschmann Index (HHI)	-1.908	0.054	-7.374**	0.000	-2.083*	0.036	0.074*	0.314
Interest Margin to Gross Income	-3.045*	0.031	-5.974**	0.000	-2.942*	0.041	0.63	0.019
Interest Rate	-1.313	0.175	-3.819**	0.000	-2.445*	0.014	0.89	0.004
Liquid Assets to Total Assets (Liquid Asset Ratio)	-2.469	0.123	-7.26**	0.000	-4.088**	0.001	0.104*	0.146
Market capitalization/GDP	0.336	0.784	-2.131*	0.032	-6.027**	0.000	0.127*	0.083
Non-interest Expenses to Gross Income	-2.043	0.268	-11.475**	0.000	-3.684*	0.004	0.107*	0.136
Non-performing Loans Net of Provisions to Capital	-0.583	0.462	-6.382**	0.000	-1.918	0.323	0.264*	0.171
Non-performing Loans to Total Gross Loans	-0.578	0.464	-6.464**	0.000	-0.589	0.459	0.277*	0.158
Real Exchange Rate	0.322	0.781	-4.212*	0.004	0.66	0.859	0.271*	0.164
Regulatory Capital to Risk-Weighted Assets, percent	-4.216*	0.004	-3.129*	0.002	-2.316	0.425	0.142*	0.058
Return on Assets	-2.627	0.087	-3.8**	0.000	-4.508**	0.001	0.318*	0.12
Ratio of external assets to total assets	-2.186*	0.028	-3.525**	0.000	-2.955*	0.003	1.091	0.002
Ration of Net Foreign Assets to Net Domestic Assets	-1.967*	0.047	-10.792**	0.000	-2.009*	0.043	0.864	0.005
Ratio of foreign currency assets to foreign currency liabilities	-0.656	0.431	-7.665**	0.000	-2.104	0.243	0.217*	0.237
Inflation Rate (yoy)	-0.362	0.552	-5.085**	0.000	-1.861	0.35	0.053*	0.531
Real Interest Rate	-1.073	0.256	-7.5**	0.000	-1.244	0.196	0.782	0.008
Real Effective Exchange Rate (log)	0.431	0.809	-4.35*	0.003	0.625	0.852	0.269*	0.166
Monetary Condition Index	1.256	0.946	-7.376**	0.000	2.008	0.99	0.104*	0.147

Notes: ***, **, * indicates the rejection of the null hypothesis at 1%, 5% and 10% per cent level of significance respectively (t-statistic).
Null Hypothesis: ADF (Augmented Dicky-Fuller) and PP (Phillips-Peron) tests, the series has a unit root; KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, the series is stationnary.

Table B.2: Unit root tests for Belgium

	ADF				PP		KPSS	
	Level		First difference		Level		Level	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Composite Activity Indicator	-2.937	0.151	-1.134	0.233	-2.474	0.341	0.067*	0.376
Cost to Income	0.993	0.915	0.13	0.726	-1.128	0.704	0.062*	0.427
Total Credit / GDP	-3.571*	0.032	-6.162**	0.000	-2.461	0.348	0.132*	0.073
Current Account Balance	-1.728	0.08	-5.657**	0.000	-2.595*	0.009	0.061*	0.434
Customer Deposits to Total (Non-interbank) Loans	-0.345	0.559	-8.238**	0.000	-1.748	0.407	0.408*	0.069
G20 GDP Growth Rate	-4.674**	0.000	-4.113**	0.000	-1.05	0.265	0.053*	0.536
G20 Inflation Rate	-3.05*	0.03	-4.138**	0.000	-1.763	0.399	0.05*	0.573
General Budget Balance	-0.779	0.379	-8.42**	0.000	-0.826	0.359	0.238*	0.205
Herfindahl – Hirschmann Index (HHI)	-1.661	0.091	-7.951**	0.000	-1.751	0.076	1.052	0.002
Interest Margin to Gross Income	-1.232	0.2	-4.389**	0.000	-0.394	0.539	0.694	0.013
Interest Rate	-1.313	0.175	-3.819**	0.000	-2.445*	0.014	0.89	0.004
Liquid Assets to Total Assets (Liquid Asset Ratio)	-0.566	0.469	-7.102**	0.000	-0.562	0.47	0.467	0.048
Market capitalization/GDP	-1.97*	0.047	0.061	0.704	-0.84	0.354	0.105*	0.142
Non-interest Expenses to Gross Income	0.114	0.995	-7.686**	0.000	-5.217**	0.000	0.257*	0.18
Non-performing Loans Net of Provisions to Capital	-0.198	0.615	-3.435**	0.001	-0.205	0.612	0.369*	0.087
Non-performing Loans to Total Gross Loans	-0.196	0.615	-7.682**	0.000	-0.219	0.607	0.309*	0.128
Real Exchange Rate	-2.982*	0.037	-5.109**	0.000	-1.818	0.371	0.221*	0.23
Regulatory Capital to Risk-Weighted Assets, percent	-4.991**	0.000	-2.996*	0.003	-3.887*	0.002	0.587	0.024
Return on Assets	-2.824	0.055	-2.622*	0.008	-5.87**	0.000	0.77	0.009
Ratio of external assets to total assets	-1.645	0.094	-6.705**	0.000	-1.953	0.308	0.414*	0.066
Ration of Net Foreign Assets to Net Domestic Assets	-4.221*	0.004	-5.763**	0.000	-2.442	0.357	0.09*	0.208
Ratio of foreign currency assets to foreign currency liabilities	-0.957	0.306	-8.65**	0.000	-0.837	0.355	0.89	0.004
Inflation Rate (yoy)	-0.738	0.396	-4.45**	0.000	-1.766	0.397	0.05*	0.57
Real Interest Rate	-2.251*	0.023	-5.988**	0.000	-1.614	0.101	0.13*	0.078
Real Effective Exchange Rate (log)	-3.028*	0.032	-5.331**	0.000	-1.818	0.371	0.22*	0.232
Monetary Condition Index	0.67	0.861	-5.899**	0.000	0.888	0.899	0.09*	0.21

Notes: ***, **, * indicates the rejection of the null hypothesis at 1%, 5% and 10% per cent level of significance respectively (t-statistic).
Null Hypothesis: ADF (Augmented Dicky-Fuller) and PP (Phillips-Peron) tests, the series has a unit root; KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, the series is stationnary.

Table B.3: Unit root tests for Finland

	ADF				PP		KPSS	
	Level		First difference		Level		Level	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Composite Activity Indicator	-3.149	0.095	-3.472**	0.001	-1.709	0.747	0.778	0.008
Cost to Income	2.658	0.999	-1.042	0.268	0.907	0.902	0.083*	0.247
Total Credit / GDP	-3.985*	0.009	-4.104**	0.001	-2.601	0.279	1.048	0.002
Current Account Balance	-2.116*	0.033	-7.817**	0.000	-2.144*	0.031	0.543	0.031
Customer Deposits to Total (Non-interbank) Loans	-3.975*	0.01	-9.254**	0.000	-2.102	0.244	0.131*	0.075
G20 GDP Growth Rate	-4.674**	0.000	-4.113**	0.000	-1.05	0.265	0.053*	0.536
G20 Inflation Rate	-3.05*	0.03	-4.138**	0.000	-1.763	0.399	0.05*	0.573
General Budget Balance	-8.843**	0.000	-4.816**	0.000	-1.714	0.082	0.565	0.027
Herfindahl – Hirschmann Index (HHI)	-2.259	0.457	-3.484**	0.001	-2.182	0.5	0.759	0.009
Interest Margin to Gross Income	-2.211	0.202	-4.049**	0.000	-3.389*	0.011	0.42*	0.064
Interest Rate	-1.313	0.175	-3.819**	0.000	-2.445*	0.014	0.89	0.004
Liquid Assets to Total Assets (Liquid Asset Ratio)	0.82	0.888	-0.929	0.317	-3.551*	0.034	0.133*	0.072
Market capitalization/GDP	-3.105	0.105	-4.042*	0.008	1.89	0.987	0.086*	0.231
Non-interest Expenses to Gross Income	-3.6*	0.006	-5.554**	0.000	-6.675**	0.000	0.144*	0.055
Non-performing Loans Net of Provisions to Capital	-1.966	0.302	-8.037**	0.000	-2.395	0.382	1.018	0.002
Non-performing Loans to Total Gross Loans	0.338	0.785	-4.083**	0.000	0.787	0.883	0.126*	0.085
Real Exchange Rate	-2.187	0.211	-5.661**	0.000	-0.466	0.51	0.751	0.01
Regulatory Capital to Risk-Weighted Assets, percent	0.652	0.857	-2.077*	0.036	-2.072	0.562	0.122*	0.093
Return on Assets	-4.016*	0.008	-1.854	0.061	-1.651	0.093	0.446*	0.055
Ratio of external assets to total assets	-2.657	0.082	-6.857**	0.000	-2.353	0.155	0.082*	0.256
Ration of Net Foreign Assets to Net Domestic Assets	-2.466*	0.013	-5.587**	0.000	-2.519*	0.011	0.063*	0.415
Ratio of foreign currency assets to foreign currency liabilities	-4.01**	0.000	-1.693	0.086	-2.162	0.22	0.066*	0.382
Inflation Rate (yoy)	-2.159*	0.03	-5.41**	0.000	-1.379	0.156	0.054*	0.515
Real Interest Rate	-1.524	0.12	-6.548**	0.000	-1.701	0.084	0.453*	0.053
Real Effective Exchange Rate (log)	-2.227	0.197	-4.393**	0.000	-0.493	0.499	0.756	0.009
Monetary Condition Index	0.176	0.74	-6.652**	0.000	-2.548	0.305	0.085*	0.239

Notes: ***, **, * indicates the rejection of the null hypothesis at 1%, 5% and 10% per cent level of significance respectively (t-statistic).
Null Hypothesis: ADF (Augmented Dicky-Fuller) and PP (Phillips-Peron) tests, the series has a unit root; KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, the series is stationnary.

Table B.4: Unit root tests for France

	ADF				PP		KPSS	
	Level		First difference		Level		Level	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Composite Activity Indicator	-2.705	0.234	-4.169**	0.001	-2.445	0.356	0.134*	0.071
Cost to Income	-0.29	0.58	-1.411	0.147	-1.752	0.405	0.077*	0.29
Total Credit / GDP	2.911	1	-4.843**	0.000	4.073	1	1.199	0.001
Current Account Balance	0.066	0.706	-7.488**	0.000	0.416	0.805	0.121*	0.096
Customer Deposits to Total (Non-interbank) Loans	-5.337**	0.000	-2.78*	0.005	-2.568	0.1	0.131*	0.074
G20 GDP Growth Rate	-4.674**	0.000	-4.113**	0.000	-1.05	0.265	0.053*	0.536
G20 Inflation Rate	-3.05*	0.03	-4.138**	0.000	-1.763	0.399	0.05*	0.573
General Budget Balance	-3.405	0.051	-7.491**	0.000	-0.466	0.51	0.304*	0.132
Herfindahl – Hirschmann Index (HHI)	-1.797	0.069	-7.35**	0.000	-2.253	0.188	1.006	0.002
Interest Margin to Gross Income	-2.876*	0.048	-4.456*	0.002	-2.016	0.28	0.518	0.036
Interest Rate	-1.313	0.175	-3.819**	0.000	-2.445*	0.014	0.89	0.004
Liquid Assets to Total Assets (Liquid Asset Ratio)	-2.767*	0.006	-4.958**	0.000	-2.078*	0.036	0.137*	0.065
Market capitalization/GDP	-2.566	0.296	-2.471	0.123	-5.494**	0.000	0.141*	0.059
Non-interest Expenses to Gross Income	-2.333	0.162	-3.536**	0.000	-3.896*	0.002	0.374*	0.085
Non-performing Loans Net of Provisions to Capital	-1.68	0.088	-7.862**	0.000	-0.163	0.627	0.606	0.022
Non-performing Loans to Total Gross Loans	-3.314*	0.014	-2.902*	0.004	-0.369	0.549	0.625	0.019
Real Exchange Rate	-0.855	0.348	-5.328**	0.000	-1.187	0.215	1.006	0.002
Regulatory Capital to Risk-Weighted Assets, percent	-1.433	0.566	-13.581**	0.000	-4.192*	0.005	0.137*	0.065
Return on Assets	-3.09*	0.027	-3.603**	0.000	-3.387*	0.011	0.104*	0.148
Ratio of external assets to total assets	-2.831	0.186	-4.831**	0.000	-3.241	0.077	0.526	0.034
Ration of Net Foreign Assets to Net Domestic Assets	-1.753	0.076	-9.303**	0.000	-1.863	0.06	0.392*	0.076
Ratio of foreign currency assets to foreign currency liabilities	-3.782*	0.003	-9.506**	0.000	-3.825*	0.003	0.13*	0.076
Inflation Rate (yoy)	-3.316*	0.014	-2.904*	0.004	-1.272	0.188	0.077*	0.287
Real Interest Rate	-2.212*	0.026	-6.44**	0.000	-2.052*	0.038	0.764	0.009
Real Effective Exchange Rate (log)	-0.797	0.372	-5.181**	0.000	-1.163	0.223	1.007	0.002
Monetary Condition Index	-0.001	0.684	-6.54**	0.000	0.002	0.685	0.114*	0.115

Notes: ***, **, * indicates the rejection of the null hypothesis at 1%, 5% and 10% per cent level of significance respectively (t-statistic).
Null Hypothesis: ADF (Augmented Dicky-Fuller) and PP (Phillips-Peron) tests, the series has a unit root; KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, the series is stationnary.

Table B.5: Unit root tests for Germany

	ADF				PP		KPSS	
	Level		First difference		Level		Level	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Composite Activity Indicator	-5.526**	0.000	-4.476**	0.000	-2.272	0.45	0.064*	0.402
Cost to Income	0.945	0.908	-1.089	0.25	-2.968*	0.038	0.121*	0.096
Total Credit / GDP	0.009	0.687	-4.224**	0.000	1.355	1.000	0.743	0.01
Current Account Balance	-0.13	0.639	-8.03**	0.000	-1.428	0.569	0.744	0.01
Customer Deposits to Total (Non-interbank) Loans	-3.143	0.096	-2.995*	0.003	0.406	0.802	0.116*	0.108
G20 GDP Growth Rate	-4.674**	0.000	-4.113**	0.000	-1.05	0.265	0.053*	0.536
G20 Inflation Rate	-3.05*	0.03	-4.138**	0.000	-1.763	0.399	0.05*	0.573
General Budget Balance	-2.601	0.279	-4.522**	0.000	-1.644	0.095	0.111*	0.124
Herfindahl – Hirschmann Index (HHI)	-2.634	0.086	-7.882**	0.000	-2.629	0.087	0.116*	0.11
Interest Margin to Gross Income	-0.855	0.348	-1.83	0.064	-0.404	0.535	0.078*	0.286
Interest Rate	-1.313	0.175	-3.819**	0.000	-2.445*	0.014	0.89	0.004
Liquid Assets to Total Assets (Liquid Asset Ratio)	-1.215	0.206	-7.005**	0.000	-1.571	0.498	0.138*	0.063
Market capitalization/GDP	1.693	0.979	-1.507	0.124	-4.189*	0.005	0.072*	0.327
Non-interest Expenses to Gross Income	-2.609	0.276	-4.556**	0.000	1.106	0.93	0.728	0.011
Non-performing Loans Net of Provisions to Capital	-2.068*	0.037	-2.095	0.549	-0.9	0.329	1.03	0.002
Non-performing Loans to Total Gross Loans	-3.411**	0.001	-0.557	0.981	-1.318	0.174	1.109	0.001
Real Exchange Rate	-2.069	0.257	-5.618**	0.000	-0.939	0.313	0.833	0.006
Regulatory Capital to Risk-Weighted Assets, percent	-2.286	0.177	-2.824*	0.005	-2.097	0.246	0.948	0.003
Return on Assets	-0.617	0.448	-3.309**	0.001	-0.654	0.432	0.252*	0.186
Ratio of external assets to total assets	-2.24	0.192	-1.633	0.097	-1.494	0.127	0.563	0.028
Ration of Net Foreign Assets to Net Domestic Assets	-1.433	0.142	-5.842**	0.000	-2.609	0.091	0.097*	0.175
Ratio of foreign currency assets to foreign currency liabilities	-1.625	0.098	-5.485**	0.000	-1.631	0.097	0.135*	0.067
Inflation Rate (yoy)	-1.336	0.168	-3.682**	0.000	-1.298	0.179	0.063*	0.421
Real Interest Rate	-1.621	0.099	-7.851**	0.000	-1.706	0.083	0.836	0.006
Real Effective Exchange Rate (log)	-2.09	0.249	-5.607**	0.000	-0.885	0.335	0.832	0.006
Monetary Condition Index	-0.137	0.637	-7.43**	0.000	-0.194	0.616	0.115*	0.113

Notes: ***, **, * indicates the rejection of the null hypothesis at 1%, 5% and 10% per cent level of significance respectively (t-statistic).
Null Hypothesis: ADF (Augmented Dicky-Fuller) and PP (Phillips-Peron) tests, the series has a unit root; KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, the series is stationnary.

Table B.6: Unit root tests for Greece

	ADF				PP		KPSS	
	Level		First difference		Level		Level	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Composite Activity Indicator	-0.142	0.992	-4.681**	0.001	-0.544	0.982	0.926	0.004
Cost to Income	-2.178	0.214	-1.455	0.136	-1.458	0.554	0.193*	0.282
Total Credit / GDP	-2.469	0.123	-2.187*	0.028	-2.699	0.074	0.331*	0.111
Current Account Balance	-1.678	0.088	-7.701**	0.000	-1.747	0.076	0.852	0.006
Customer Deposits to Total (Non-interbank) Loans	-1.224	0.203	-6.375**	0.000	-1.155	0.226	0.714	0.012
G20 GDP Growth Rate	-4.674**	0.000	-4.113**	0.000	-1.05	0.265	0.053*	0.536
G20 Inflation Rate	-3.05*	0.03	-4.138**	0.000	-1.763	0.399	0.05*	0.573
General Budget Balance	-2.351	0.406	-5.061**	0.000	-2.146	0.52	0.801	0.007
Herfindahl – Hirschmann Index (HHI)	-1.454	0.136	-7.735**	0.000	-1.738	0.411	0.108*	0.133
Interest Margin to Gross Income	-0.639	0.438	-7.543**	0.000	-0.714	0.407	0.493	0.041
Interest Rate	-1.658	0.092	-3.426**	0.001	-3.001*	0.003	0.878	0.005
Liquid Assets to Total Assets (Liquid Asset Ratio)	-0.577	0.464	-5.77**	0.000	-0.363	0.551	0.136*	0.067
Market capitalization/GDP	-3.722*	0.004	-2.841*	0.004	-7.573**	0.000	0.355*	0.096
Non-interest Expenses to Gross Income	-2.898*	0.046	-8.08**	0.000	-2.704	0.073	0.118*	0.102
Non-performing Loans Net of Provisions to Capital	-2.183	0.212	-8.47**	0.000	-0.416	0.53	0.143*	0.056
Non-performing Loans to Total Gross Loans	-0.159	0.629	-2.872*	0.004	-1.574	0.497	0.959	0.003
Real Exchange Rate	-1.16	0.224	-2.346*	0.018	-0.961	0.304	0.145*	0.053
Regulatory Capital to Risk-Weighted Assets, percent	-3.13	0.099	-5.946**	0.000	-2.11	0.541	0.089*	0.213
Return on Assets	-4.012**	0.000	-11.14**	0.000	-4.329**	0.000	0.051*	0.555
Ratio of external assets to total assets	-1.934	0.051	-3.986**	0.000	-2.207*	0.026	0.093*	0.193
Ration of Net Foreign Assets to Net Domestic Assets	-2.139*	0.031	-5.959**	0.000	-2.578*	0.01	0.088*	0.221
Ratio of foreign currency assets to foreign currency liabilities	-0.348	0.557	-6.507**	0.000	-0.56	0.471	0.472	0.047
Inflation Rate (yoy)	-1.889	0.056	-5.3**	0.000	-1.471	0.132	0.133*	0.071
Real Interest Rate	-4.562**	0.001	-5.793**	0.000	-2.145*	0.031	0.1*	0.162
Real Effective Exchange Rate (log)	-1.255	0.193	-6.14**	0.000	-1.11	0.242	0.145*	0.053
Monetary Condition Index	-2.002	0.6	-5.928**	0.000	-2.234	0.471	0.12*	0.099

Notes: ***, **, * indicates the rejection of the null hypothesis at 1%, 5% and 10% per cent level of significance respectively (t-statistic).

Null Hypothesis: ADF (Augmented Dicky-Fuller) and PP (Phillips-Peron) tests, the series has a unit root; KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, the series is stationnary.

Table B.7: Unit root tests for Ireland

	ADF				PP		KPSS	
	Level		First difference		Level		Level	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Composite Activity Indicator	-3.385	0.053	-7.409**	0	-2.283	0.444	1.077	0.002
Cost to Income	-4.307*	0.003	-3.324*	0.014	0.493	0.823	0.093*	0.194
Total Credit / GDP	-0.222	0.606	-7.327**	0.000	-0.209	0.61	0.274*	0.161
Current Account Balance	-2.549*	0.01	-6.183**	0.000	-2.506*	0.012	0.086*	0.228
Customer Deposits to Total (Non-interbank) Loans	-4.251**	0.001	-1.234	0.2	-1.578	0.495	0.14*	0.06
G20 GDP Growth Rate	-4.674**	0.000	-4.113**	0.000	-1.05	0.265	0.053*	0.536
G20 Inflation Rate	-3.05*	0.03	-4.138**	0.000	-1.763	0.399	0.05*	0.573
General Budget Balance	-1.381	0.155	-7.355**	0.000	-1.508	0.123	0.329*	0.113
Herfindahl – Hirschmann Index (HHI)	0.862	0.895	-1.976*	0.046	-1.471	0.839	0.713	0.012
Interest Margin to Gross Income	-4.271*	0.003	-9.522**	0.000	-4.378**	0.000	0.081*	0.265
Interest Rate	-1.313	0.175	-3.819**	0.000	-2.445*	0.014	0.89	0.004
Liquid Assets to Total Assets (Liquid Asset Ratio)	-2.636	0.263	0.772	0.88	-2.512	0.322	0.104*	0.145
Market capitalization/GDP	-3.123*	0.025	-2.196*	0.027	-0.913	0.323	0.214*	0.242
Non-interest Expenses to Gross Income	-3.955*	0.01	-6.171**	0.000	-4.598**	0.000	0.078*	0.283
Non-performing Loans Net of Provisions to Capital	-0.91	0.325	-3.094*	0.002	-0.708	0.409	0.466	0.049
Non-performing Loans to Total Gross Loans	-0.868	0.342	-2.141*	0.031	-0.69	0.417	0.298*	0.137
Real Exchange Rate	-1.196	0.212	-4.758**	0.000	-1.528	0.119	1.065	0.002
Regulatory Capital to Risk-Weighted Assets, percent	1.407	0.96	-6.816**	0.000	1.425	0.961	1.087	0.002
Return on Assets	-1.2	0.21	-7.015**	0.000	-1.932	0.051	0.132*	0.073
Ratio of external assets to total assets	-2.604	0.278	-9.482**	0.000	-2.594	0.282	0.766	0.009
Ration of Net Foreign Assets to Net Domestic Assets	-2.013*	0.042	-3.149*	0.002	-3.781**	0.000	0.213*	0.244
Ratio of foreign currency assets to foreign currency liabilities	-1.294	0.181	-1.771	0.073	-1.786	0.07	0.135*	0.069
Inflation Rate (yoy)	-5.351**	0.000	-4.478**	0.000	-2.236*	0.024	0.065*	0.397
Real Interest Rate	-2.611*	0.009	-5.063**	0.000	-1.909	0.054	0.06*	0.451
Real Effective Exchange Rate (log)	-1.149	0.228	-4.752**	0.000	-1.606	0.102	1.081	0.002
Monetary Condition Index	-3.883*	0.013	-4.166**	0.000	-1.514	0.122	0.076*	0.297

Notes: ***, **, * indicates the rejection of the null hypothesis at 1%, 5% and 10% per cent level of significance respectively (t-statistic).
Null Hypothesis: ADF (Augmented Dicky-Fuller) and PP (Phillips-Peron) tests, the series has a unit root; KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, the series is stationnary.

Table B.8: Unit root tests for Italy

	ADF				PP		KPSS	
	Level		First difference		Level		Level	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Composite Activity Indicator	-3.158*	0.023	-3.667**	0.000	-2.383	0.147	0.341*	0.105
Cost to Income	-0.312	0.571	-0.566	0.469	-1.075	0.725	0.069*	0.356
Total Credit / GDP	0.411	0.804	-3.991**	0.000	0.523	0.83	0.396*	0.074
Current Account Balance	-2.523	0.317	-7.35**	0.000	-2.557	0.3	0.114*	0.116
Customer Deposits to Total (Non-interbank) Loans	1.32	0.952	-3.499**	0.000	-4.521**	0.000	0.732	0.011
G20 GDP Growth Rate	-4.674**	0.000	-4.113**	0.000	-1.05	0.265	0.053*	0.536
G20 Inflation Rate	-3.05*	0.03	-4.138**	0.000	-1.763	0.399	0.05*	0.573
General Budget Balance	-9.163**	0.000	-5.899**	0.000	-1.071	0.257	0.124*	0.089
Herfindahl – Hirschmann Index (HHI)	-2.53	0.108	-8.413**	0.000	-2.653	0.082	0.636	0.018
Interest Margin to Gross Income	-0.567	0.469	-15.831**	0.000	-1.992	0.29	0.96	0.003
Interest Rate	-1.313	0.175	-3.819**	0.000	-2.445*	0.014	0.89	0.004
Liquid Assets to Total Assets (Liquid Asset Ratio)	-2.577	0.098	-2.063*	0.037	-2.089	0.249	0.603	0.022
Market capitalization/GDP	-2.62	0.271	-1.58	0.107	-6.062**	0.000	0.475	0.046
Non-interest Expenses to Gross Income	-3.101*	0.027	-6.795**	0.000	-5.85**	0.000	0.09*	0.207
Non-performing Loans Net of Provisions to Capital	-2.69	0.076	-2.236*	0.024	-0.479	0.505	0.301*	0.135
Non-performing Loans to Total Gross Loans	-2.645	0.084	-1.513	0.122	-1.696	0.433	0.332*	0.111
Real Exchange Rate	-0.673	0.424	-5.704**	0.000	-1.156	0.226	0.106*	0.138
Regulatory Capital to Risk-Weighted Assets, percent	-2.783	0.203	-9.855**	0.000	-7.99**	0.000	0.113*	0.118
Return on Assets	-2.139*	0.031	-9.244**	0.000	-5.157**	0.000	0.253*	0.185
Ratio of external assets to total assets	-3.608*	0.029	-7.711**	0.000	-3.747*	0.019	0.811	0.007
Ration of Net Foreign Assets to Net Domestic Assets	-3.019*	0.003	-11.117**	0.000	-3.664**	0.000	0.577	0.025
Ratio of foreign currency assets to foreign currency liabilities	-0.383	0.543	-3.888**	0.000	-0.44	0.521	0.356*	0.095
Inflation Rate (yoy)	-1.782	0.071	-3.88**	0.000	-1.289	0.182	0.065*	0.394
Real Interest Rate	-2.221*	0.025	-5.622**	0.000	-1.964*	0.047	0.424*	0.063
Real Effective Exchange Rate (log)	-1.346	0.165	-4.72**	0.000	-1.152	0.227	0.103*	0.15
Monetary Condition Index	-0.085	0.655	-6.584**	0.000	-2.181	0.5	0.124*	0.089

Notes: ***, **, * indicates the rejection of the null hypothesis at 1%, 5% and 10% per cent level of significance respectively (t-statistic).
Null Hypothesis: ADF (Augmented Dicky-Fuller) and PP (Phillips-Peron) tests, the series has a unit root; KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, the series is stationnary.

Table B.9: Unit root tests for Netherlands

	ADF				PP		KPSS	
	Level		First difference		Level		Level	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Composite Activity Indicator	-2.63	0.266	-4.36*	0.003	-1.804	0.703	1.068	0.002
Cost to Income	-1.144	0.23	-0.736	0.398	-2.43	0.133	0.122*	0.095
Total Credit / GDP	-2.739	0.068	-1.353	0.163	0.364	0.792	0.555	0.029
Current Account Balance	-2.21	0.203	-3.314**	0.001	-1.839	0.361	0.123*	0.092
G20 GDP Growth Rate	-4.674**	0.000	-4.113**	0.000	-1.05	0.265	0.053*	0.536
G20 Inflation Rate	-3.05*	0.03	-4.138**	0.000	-1.763	0.399	0.05*	0.573
General Budget Balance	-0.96	0.304	-7.368**	0.000	-1.126	0.236	0.454*	0.052
Herfindahl – Hirschmann Index (HHI)	-1.471	0.132	-7.415**	0.000	-1.659	0.452	0.112*	0.12
Interest Margin to Gross Income	-3.972*	0.002	-8.649**	0.000	-7.552**	0.000	0.176*	0.32
Interest Rate	-1.313	0.175	-3.819**	0.000	-2.445*	0.014	0.89	0.004
Liquid Assets to Total Assets (Liquid Asset Ratio)	-1.656	0.092	-5.274**	0.000	-2.616	0.09	0.076*	0.298
Market capitalization/GDP	-2.202	0.489	-3.139*	0.024	-5.724**	0.000	0.112*	0.119
Non-interest Expenses to Gross Income	-0.359	0.553	-1.565	0.111	-7.953**	0.000	0.134*	0.07
Non-performing Loans Net of Provisions to Capital	-2.556	0.102	-5.935**	0.000	-0.285	0.582	0.461*	0.05
Non-performing Loans to Total Gross Loans	-3.486*	0.008	-5.296**	0.000	-3.236*	0.018	0.269*	0.166
Real Exchange Rate	-2.41	0.139	-6.011**	0.000	-1.702	0.43	0.568	0.027
Regulatory Capital to Risk-Weighted Assets, percent	2.351	0.997	-7.657**	0.000	2.116	0.993	0.13*	0.077
Return on Assets	-3.593*	0.006	-8.359**	0.000	-3.679*	0.004	0.1*	0.164
Ratio of external assets to total assets	-2.827	0.055	-7.044**	0.000	-2.826	0.055	0.192*	0.283
Ration of Net Foreign Assets to Net Domestic Assets	-2.84	0.183	-7.361**	0.000	-2.845	0.181	0.979	0.003
Ratio of foreign currency assets to foreign currency liabilities	-0.89	0.333	-4.311**	0.000	-2.567	0.1	0.577	0.026
Inflation Rate (yoy)	-1.079	0.253	-7.226**	0.000	-2.209	0.203	0.085*	0.235
Real Interest Rate	-1.304	0.178	-7.272**	0.000	-1.431	0.142	0.762	0.009
Real Effective Exchange Rate (log)	-2.385	0.146	-5.94**	0.000	-1.702	0.43	0.566	0.027
Monetary Condition Index	0.59	0.845	-7.72**	0.000	0.864	0.896	0.106*	0.138

Notes: ***, **, * indicates the rejection of the null hypothesis at 1%, 5% and 10% per cent level of significance respectively (t-statistic).

Null Hypothesis: ADF (Augmented Dicky-Fuller) and PP (Phillips-Peron) tests, the series has a unit root; KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, the series is stationnary.

Table B.10: Unit root tests for Portugal

	ADF				PP		KPSS	
	Level		First difference		Level		Level	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Composite Activity Indicator	0.163	0.736	-6.088**	0.000	-1.58	0.800	0.396*	0.074
Cost to Income	-4.137*	0.006	-3.108*	0.002	-0.251	0.595	0.146*	0.052
Total Credit / GDP	-0.585	0.461	-2.414*	0.015	-0.36	0.553	0.731	0.011
Current Account Balance	-2.43*	0.015	-2.257*	0.023	-1.624	0.099	0.934	0.004
Customer Deposits to Total (Non-interbank) Loans	4.209	1.000	-7.449**	0.000	2.842	1.000	0.141*	0.06
G20 GDP Growth Rate	-4.674**	0.000	-4.113**	0.000	-1.05	0.265	0.053*	0.536
G20 Inflation Rate	-3.05*	0.03	-4.138**	0.000	-1.763	0.399	0.05*	0.573
General Budget Balance	-0.954	0.307	-7.506**	0.000	-0.958	0.305	0.518	0.036
Herfindahl – Hirschmann Index (HHI)	-1.344	0.166	-7.361**	0.000	-1.646	0.094	0.982	0.003
Interest Margin to Gross Income	-2.521	0.111	-9.947**	0.000	-2.528	0.109	0.252*	0.186
Interest Rate	-1.313	0.175	-3.819**	0.000	-2.445*	0.014	0.89	0.004
Liquid Assets to Total Assets (Liquid Asset Ratio)	-2.218	0.48	-6.555**	0.000	-2.138	0.525	0.994	0.003
Market capitalization/GDP	-2.233	0.194	-2.356	0.403	-5.173**	0.000	0.121*	0.096
Non-interest Expenses to Gross Income	-4.128**	0.001	-2.789*	0.005	-3.951*	0.002	0.323*	0.117
Non-performing Loans Net of Provisions to Capital	-0.574	0.465	-6.108**	0.000	-1.653	0.456	0.528	0.034
Non-performing Loans to Total Gross Loans	-0.542	0.479	-3.167*	0.002	-0.532	0.483	0.576	0.026
Real Exchange Rate	-1.709	0.083	-2.202*	0.027	-1.472	0.547	1.042	0.002
Regulatory Capital to Risk-Weighted Assets, percent	-2.046	0.576	-3.616*	0.005	-2.373	0.394	0.128*	0.08
Return on Assets	-2.27*	0.022	-6.3**	0.000	-3.208**	0.001	0.231*	0.215
Ratio of external assets to total assets	-1.593	0.105	-6.535**	0.000	-1.839	0.063	1.023	0.002
Ration of Net Foreign Assets to Net Domestic Assets	-1.741	0.078	-1.823	0.065	-6.691**	0.000	1.023	0.002
Ratio of foreign currency assets to foreign currency liabilities	-1.678	0.088	-7.689**	0.000	-1.977*	0.046	1.099	0.002
Inflation Rate (yoy)	-2.19*	0.027	-4.329**	0.000	-1.708	0.083	0.049*	0.595
Real Interest Rate	-2.632*	0.008	-2.871*	0.004	-1.803	0.068	0.136*	0.067
Real Effective Exchange Rate (log)	-1.011	0.284	-6.374**	0.000	-1.47	0.548	1.044	0.002
Monetary Condition Index	0.577	0.842	-4.011**	0.000	-0.007	0.682	0.103*	0.152

Notes: ***, **, * indicates the rejection of the null hypothesis at 1%, 5% and 10% per cent level of significance respectively (t-statistic).

Null Hypothesis: ADF (Augmented Dicky-Fuller) and PP (Phillips-Peron) tests, the series has a unit root; KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, the series is stationnary.

Table B.11: Unit root tests for Spain

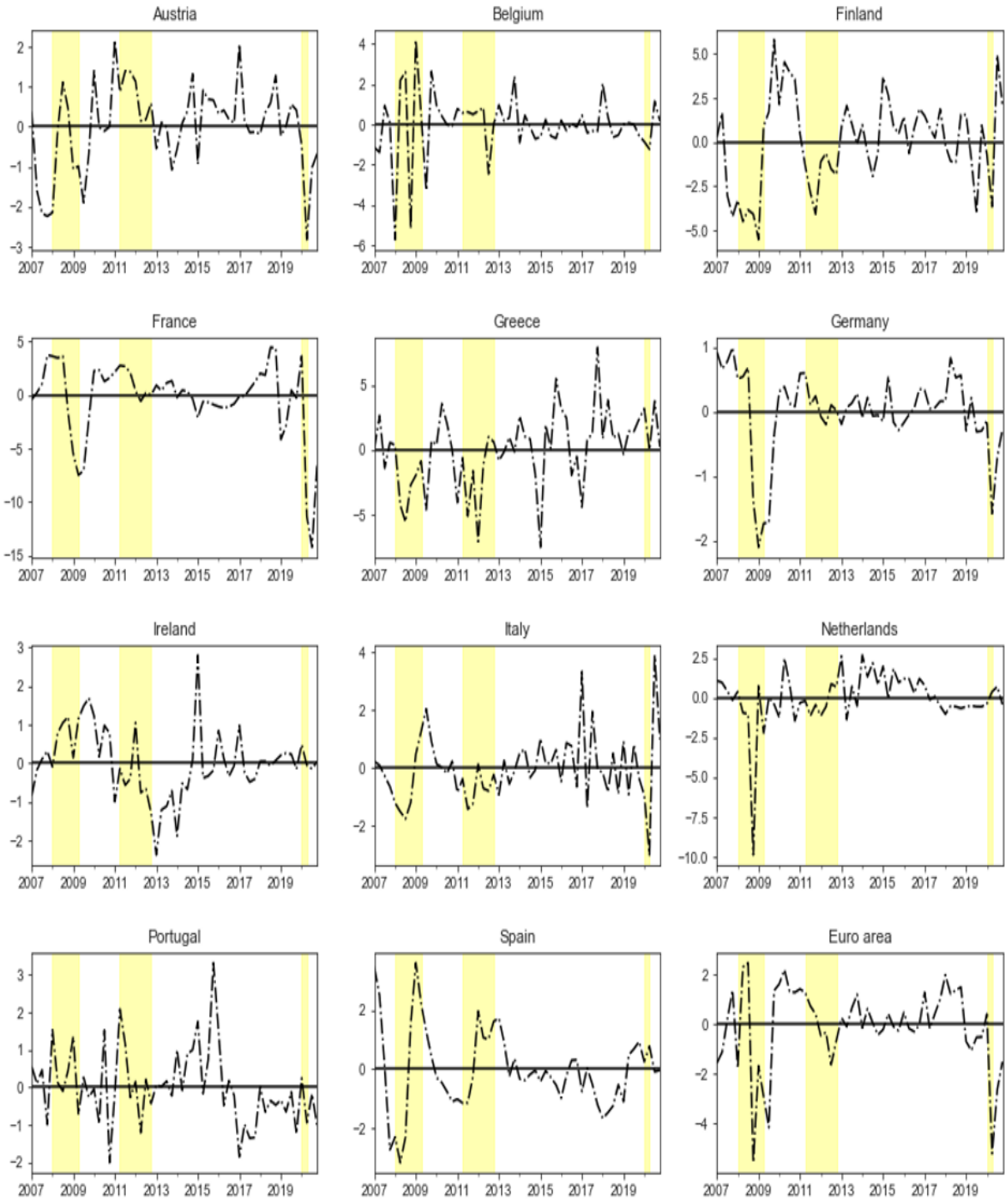
	ADF				PP		KPSS	
	Level		First difference		Level		Level	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Composite Activity Indicator	-2.198	0.491	-4.349**	0.000	-1.953	0.627	0.657	0.016
Cost to Income	0.884	0.899	-2.839*	0.004	1.014	0.918	0.071*	0.338
Total Credit / GDP	-3.669*	0.005	1.628	1.000	-0.677	0.422	1.028	0.002
Current Account Balance	-2.518*	0.011	-1.445	0.139	-2.601*	0.009	0.964	0.003
Customer Deposits to Total (Non-interbank) Loans	-2.057	0.262	-4.449**	0.000	-1.88	0.341	0.934	0.004
G20 GDP Growth Rate	-4.674**	0.000	-4.113**	0.000	-1.05	0.265	0.053*	0.536
G20 Inflation Rate	-3.05*	0.03	-4.138**	0.000	-1.763	0.399	0.05*	0.573
General Budget Balance	-1.028	0.277	-2.46*	0.013	-0.94	0.313	0.242*	0.199
Herfindahl – Hirschmann Index (HHI)	-2.077	0.254	-2.713	0.231	-2.106	0.242	1.021	0.002
Interest Margin to Gross Income	-3.386*	0.011	-8.21**	0.000	-3.198*	0.02	0.191*	0.287
Interest Rate	-1.313	0.175	-3.819**	0.000	-2.445*	0.014	0.89	0.004
Liquid Assets to Total Assets (Liquid Asset Ratio)	-1.512	0.825	-6.579**	0.000	-0.858	0.96	0.68	0.014
Market capitalization/GDP	-1.828	0.064	-1.466	0.133	-3.611*	0.006	0.034*	0.822
Non-interest Expenses to Gross Income	-2.432	0.363	-3.029*	0.002	-3.23	0.079	0.118*	0.102
Non-performing Loans Net of Provisions to Capital	-0.606	0.452	-3.776**	0.000	-2.439	0.131	0.295*	0.14
Non-performing Loans to Total Gross Loans	-0.982	0.295	-1.686	0.087	-1.878	0.343	0.312*	0.125
Real Exchange Rate	-1.143	0.23	-4.166**	0.000	-1.567	0.5	0.126*	0.085
Regulatory Capital to Risk-Weighted Assets, percent	-3.673*	0.024	-9.079**	0.000	-3.836*	0.015	1.186	0.001
Return on Assets	-2.759*	0.006	-7.839**	0.000	-2.667*	0.007	0.139*	0.062
Ratio of external assets to total assets	-3.08	0.111	-9.174**	0.000	-2.99	0.135	0.715	0.012
Ration of Net Foreign Assets to Net Domestic Assets	-0.147	0.633	-7.348**	0.000	-0.147	0.633	0.574	0.026
Ratio of foreign currency assets to foreign currency liabilities	-2.69	0.076	-7.254**	0.000	-2.632	0.086	0.145*	0.053
Inflation Rate (yoy)	-1.013	0.283	-2.752*	0.006	-1.573	0.109	0.065*	0.391
Real Interest Rate	-2.445*	0.014	-5.948**	0.000	-2.037*	0.04	0.104*	0.148
Real Effective Exchange Rate (log)	-0.826	0.359	-4.725**	0.000	-0.594	0.457	0.125*	0.087
Monetary Condition Index	-0.044	0.67	-6.28**	0.000	-2.284	0.443	0.086*	0.232

Notes: ***, **, * indicates the rejection of the null hypothesis at 1%, 5% and 10% per cent level of significance respectively (t-statistic).

Null Hypothesis: ADF (Augmented Dicky-Fuller) and PP (Phillips-Peron) tests, the series has a unit root; KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, the series is stationnary.

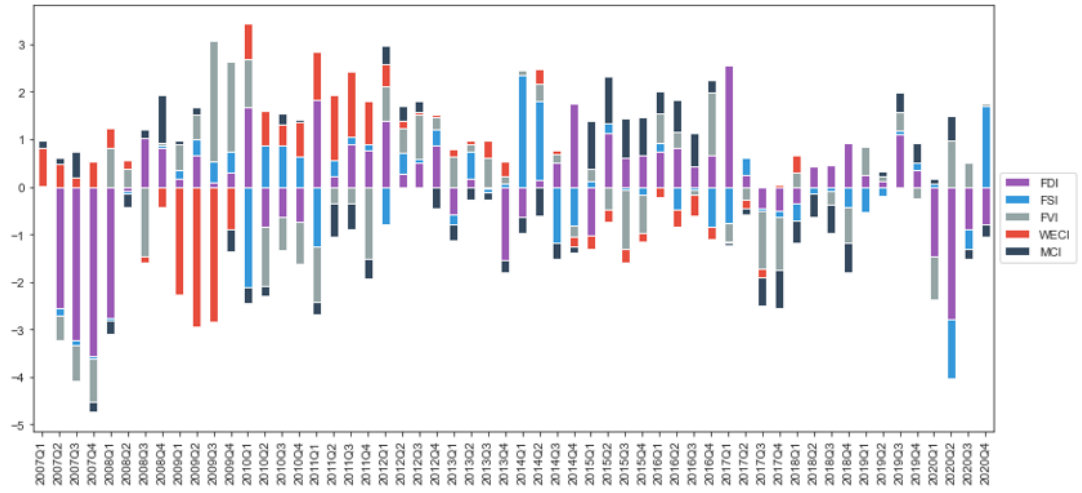
Appendix C. Aggregate financial stability indexes

Figure C.1: Aggregate Financial Stability Indexes for euro area countries



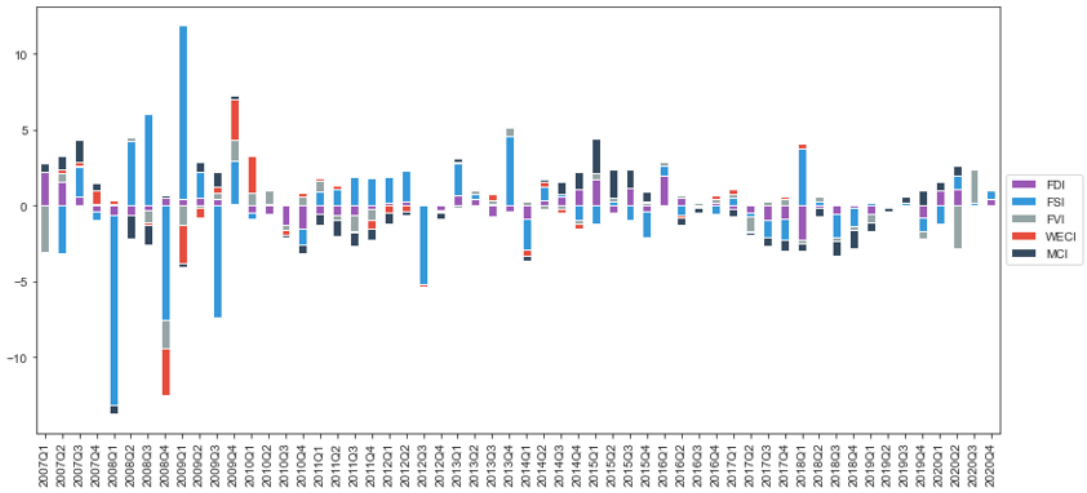
Notes: 0 = average financial stability. The shared regions correspond to respectively the global financial crisis of 2008-2009, the European debt crisis and the pandemic crisis Covid-19.

Figure C.2.1: AFSI decomposition for Austria



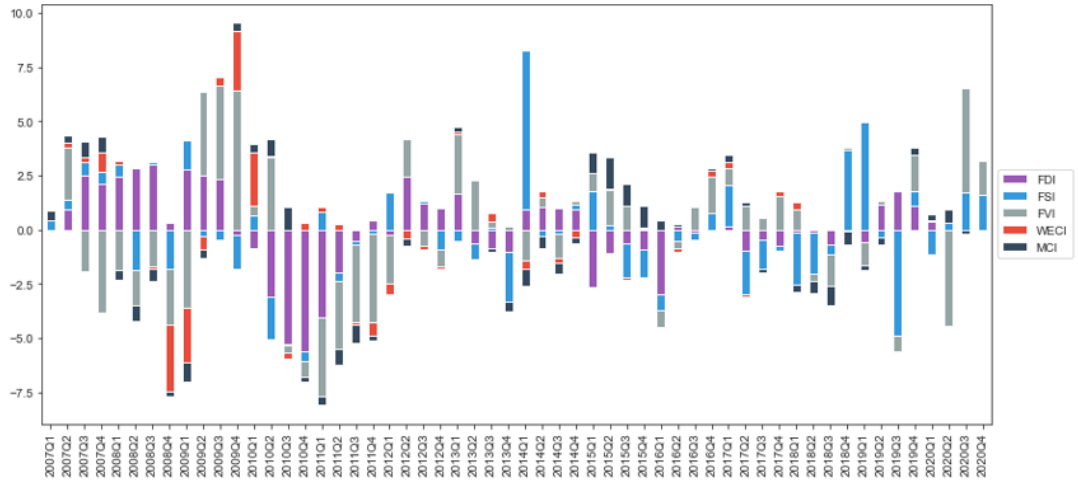
Note: FDI: Financial Development Index, FSI: Financial Soundness Index, FVI: Financial Vulnerability Index, WECI: World Economic Climate Index and MCI: Monetary Condition Index.

Figure C.2.2: AFSI decomposition for Belgium



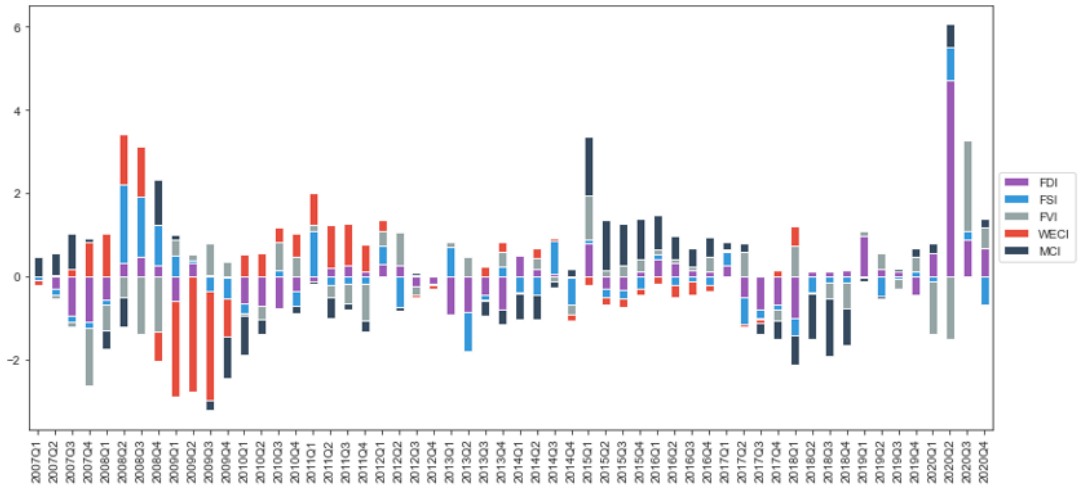
Note: FDI: Financial Development Index, FSI: Financial Soundness Index, FVI: Financial Vulnerability Index, WECI: World Economic Climate Index and MCI: Monetary Condition Index.

Figure C.2.3: AFSI decomposition for Finland



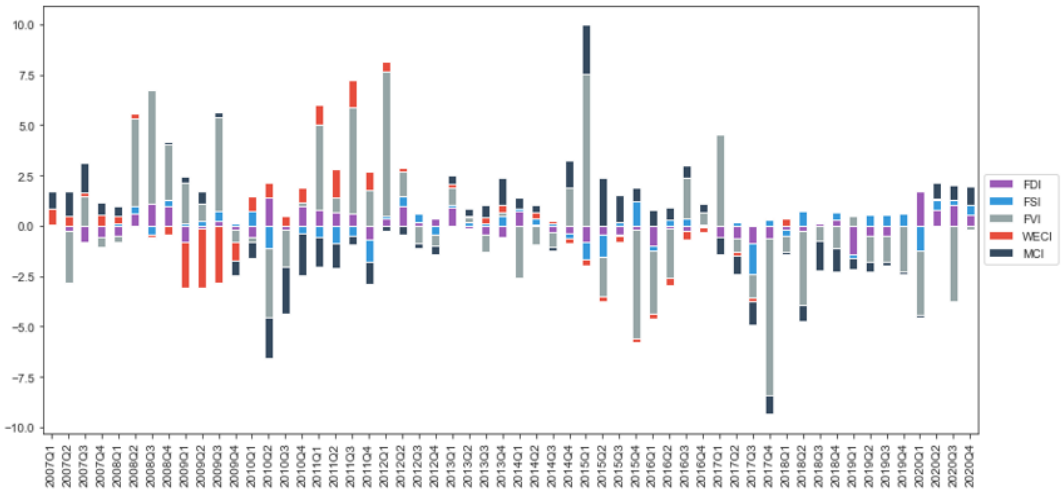
Note: FDI: Financial Development Index, FSI: Financial Soundness Index, FVI: Financial Vulnerability Index, WECI: World Economic Climate Index and MCI: Monetary Condition Index.

Figure C.2.4: AFSI decomposition for France



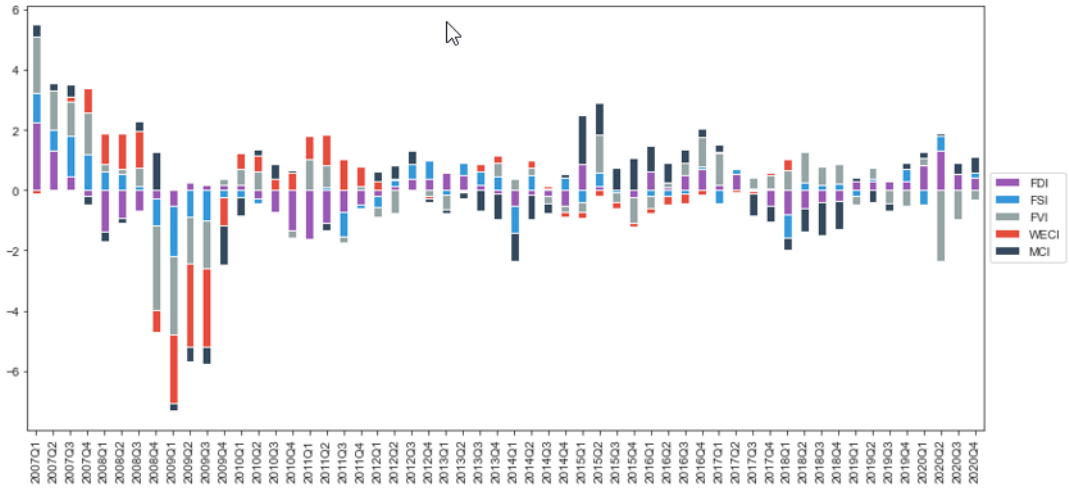
Note: FDI: Financial Development Index, FSI: Financial Soundness Index, FVI: Financial Vulnerability Index, WECI: World Economic Climate Index and MCI: Monetary Condition Index.

Figure C.2.5: AFSI decomposition for Greece



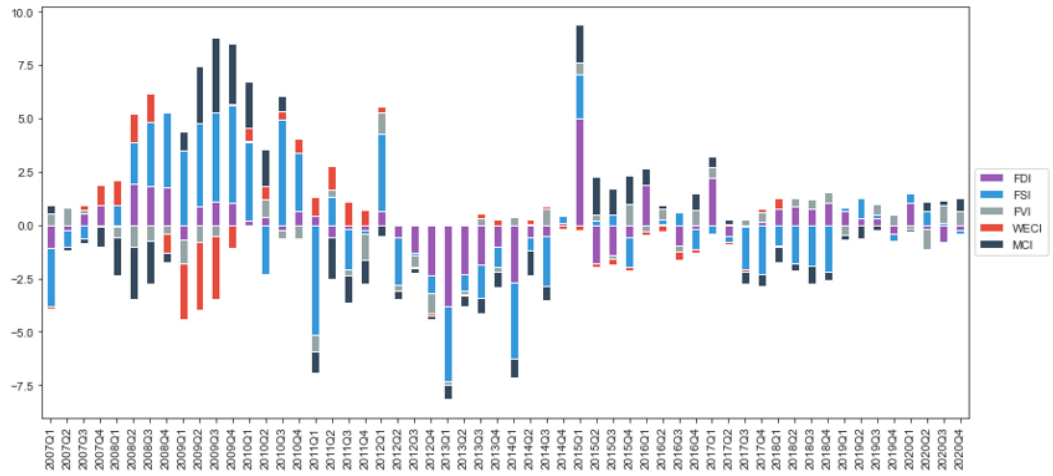
Note: FDI: Financial Development Index, FSI: Financial Soundness Index, FVI: Financial Vulnerability Index, WECI: World Economic Climate Index and MCI: Monetary Condition Index.

Figure C.2.6: AFSI decomposition for Germany



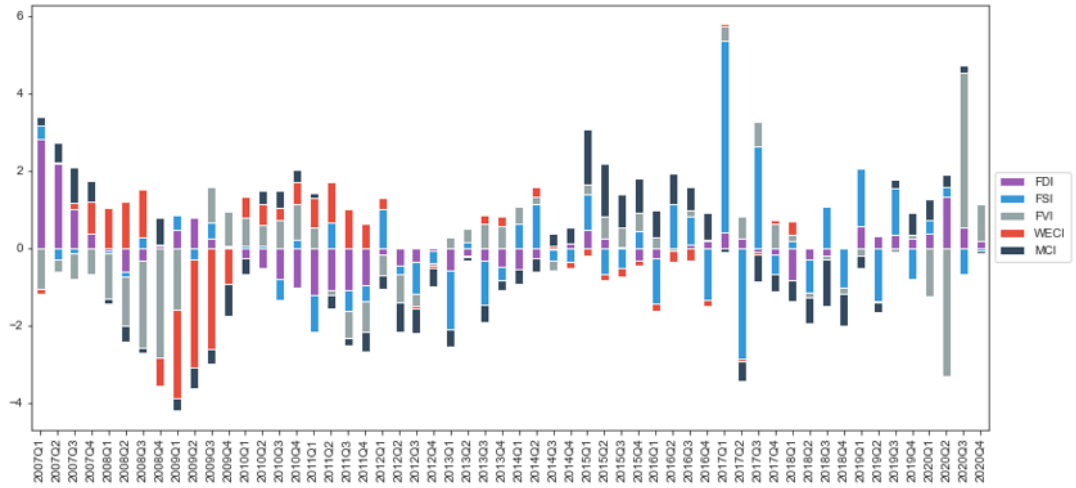
Note: FDI: Financial Development Index, FSI: Financial Soundness Index, FVI: Financial Vulnerability Index, WECI: World Economic Climate Index and MCI: Monetary Condition Index.

Figure C.2.7: AFSI decomposition for Ireland



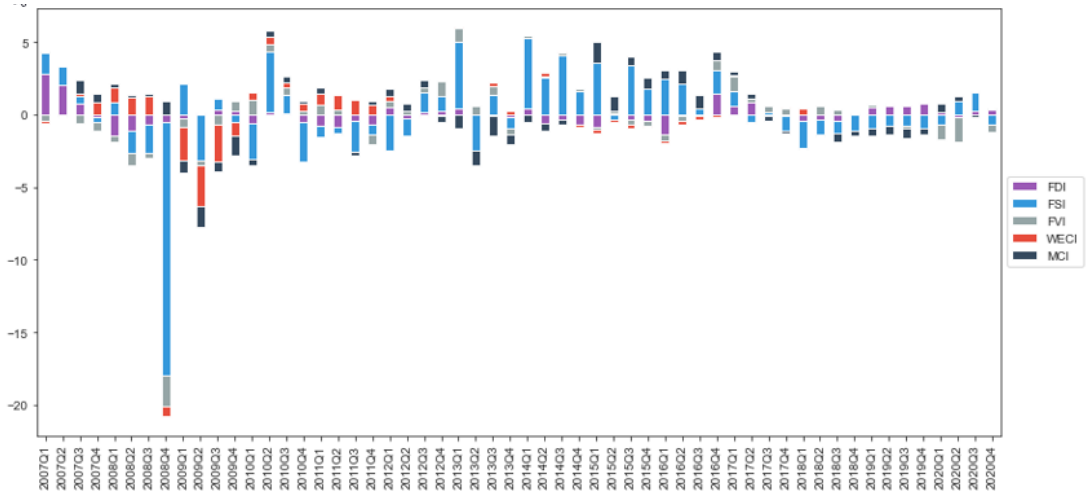
Note: FDI: Financial Development Index, FSI: Financial Soundness Index, FVI: Financial Vulnerability Index, WECI: World Economic Climate Index and MCI: Monetary Condition Index.

Figure C.2.8: AFSI decomposition for Italy



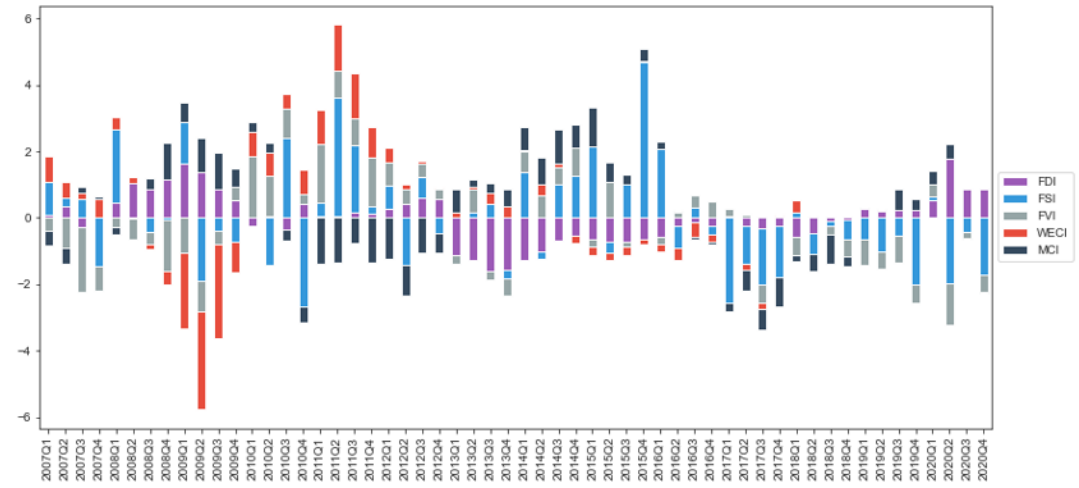
Note: FDI: Financial Development Index, FSI: Financial Soundness Index, FVI: Financial Vulnerability Index, WECI: World Economic Climate Index and MCI: Monetary Condition Index.

Figure C.2.9: AFSI decomposition for Netherlands



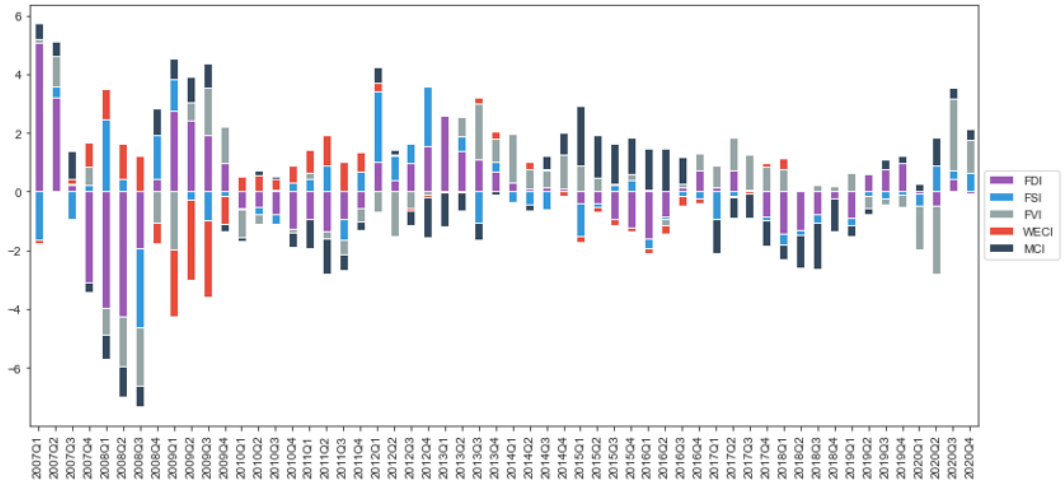
Note: FDI: Financial Development Index, FSI: Financial Soundness Index, FVI: Financial Vulnerability Index, WECI: World Economic Climate Index and MCI: Monetary Condition Index.

Figure C.2.10: AFSI decomposition for Portugal



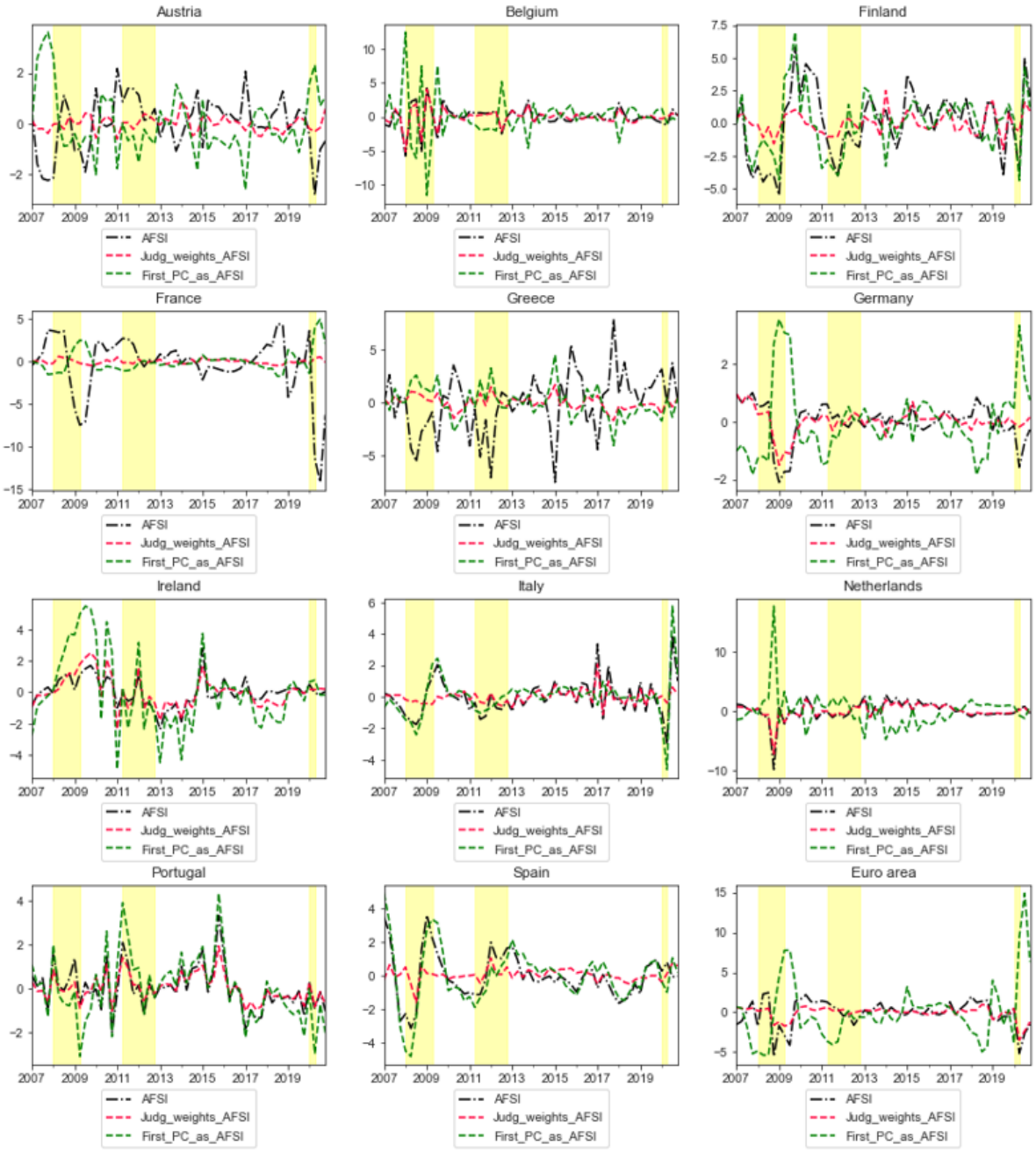
Note: FDI: Financial Development Index, FSI: Financial Soundness Index, FVI: Financial Vulnerability Index, WECI: World Economic Climate Index and MCI: Monetary Condition Index.

Figure C.2.11: AFSI decomposition for Spain



Note: FDI: Financial Development Index, FSI: Financial Soundness Index, FVI: Financial Vulnerability Index, WECI: World Economic Climate Index and MCI: Monetary Condition Index.

Figure C.3: Robustness, AFSIs by different methods for euro area countries



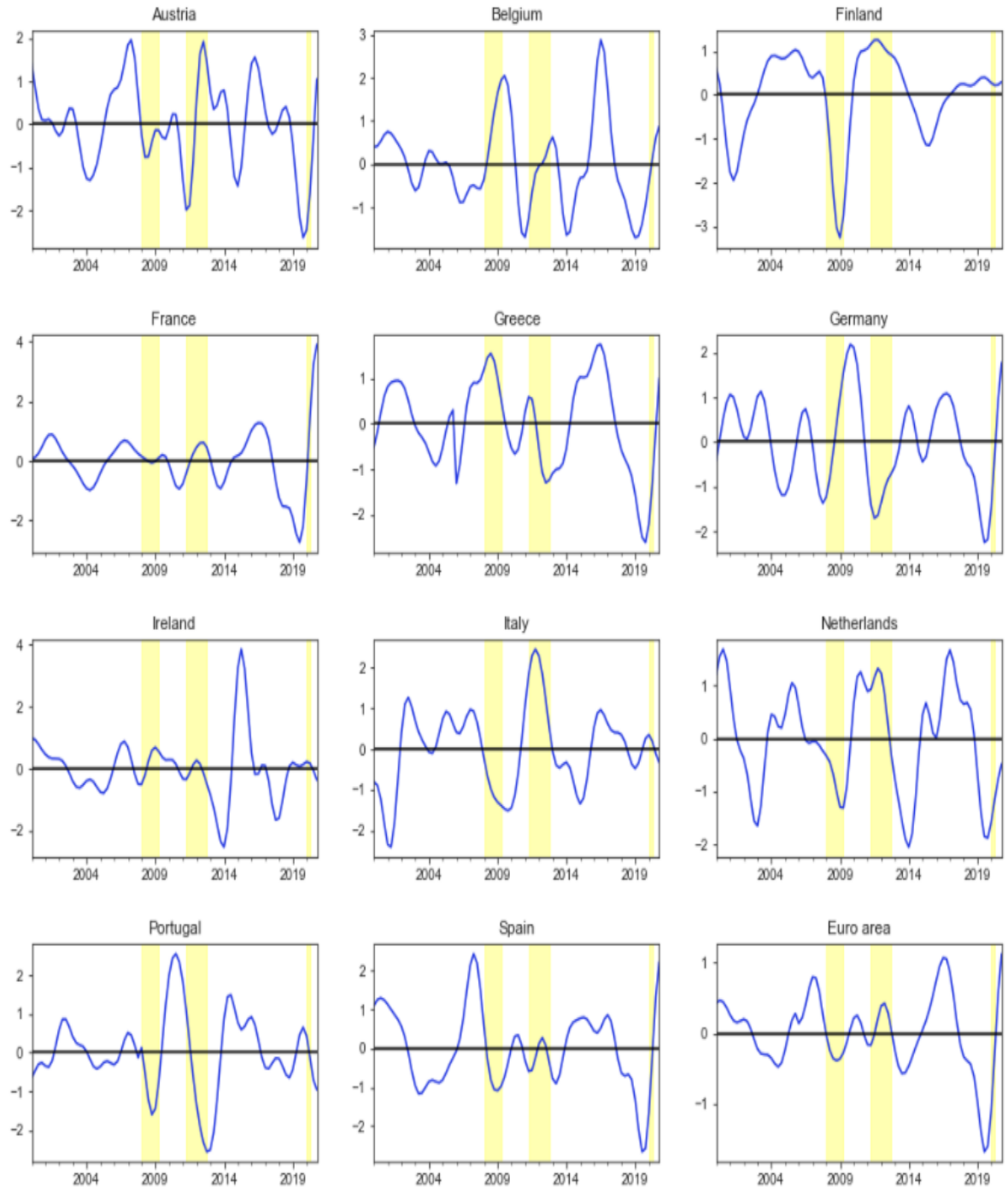
Notes: The shared regions correspond to respectively the global financial crisis of 2008-2009, the European debt crisis and the pandemic crisis Covid-19.

- The **black line** is the AFSI obtaining by the arithmetic mean of weights based on both uniform and principal component (see section 3.2 above).
- The **green line** represents the AFSI obtaining using the principal component which have the higher variance.
- The **red line** corresponds to the AFSI obtaining by fixing weights in the following equation:

$$AFSI_t = \alpha_1 FDI + \alpha_2 FSI + \alpha_3 FVI + \alpha_4 MCI + \alpha_5 WECI$$

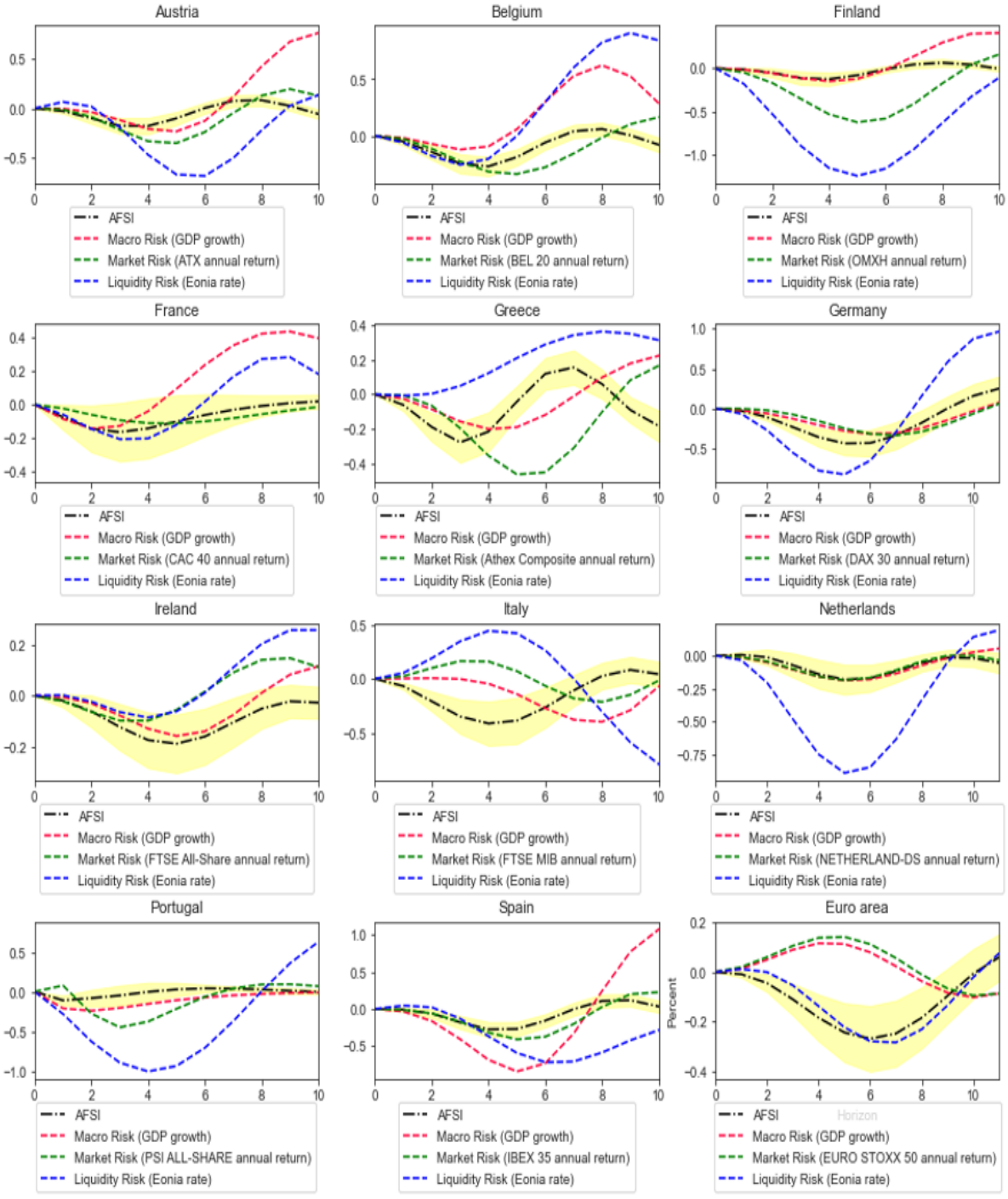
Where $\alpha_1 = 5\%$, $\alpha_2 = 35\%$, $\alpha_3 = 20\%$, $\alpha_4 = 30\%$ and $\alpha_5 = 10\%$. This weighting follows Cheang et al. (2009).

Figure C.4: Financial Cycles for euro area countries



Notes: These cycles are measured by a frequency (Band-Pass) filter capturing medium-term cycles in credit-to-GDP ratio and real house prices. The Band-Pass filter is another type of univariate filter which allows to extract from a time series a part composed of any given range of frequencies. For example, we can extract from the time series the trend represented by the components with periodicities longer than the business cycle. We can estimate the gap represented by the components with business cycle periodicities.
The shared regions correspond to respectively the global financial crisis of 2008-2009, the European debt crisis and the pandemic crisis Covid-19.

Figure C.5: Financial cycle response to a 1 standard deviation shock in the different financial monitoring risk



Notes: The shared region represents the +/- one standard error confidence interval for the aggregate financial stability index. The **black line** represents the response of financial cycle to one standard deviation shock of aggregate financial stability index (AFSI), obtaining by the arithmetic mean of weights based on both uniform and principal component (see section 3.2 above), as financial monitoring risk. The **red line** represents the response of financial cycle to one standard deviation shock of GDP growth rate (Macro risk) as financial monitoring risk. The **green line** represents the response of financial cycle to one standard deviation shock of stock market annual return (Market risk) as financial monitoring risk. The **blue line** represents the response of financial cycle to one standard deviation shock of Eonia rate (Liquidity risk) as financial monitoring risk.

Chapter 2

Quarterly projection model for macroprudential policy analysis and financial stability in the euro area

Chapter 2

Quarterly projection model for macroprudential policy analysis and financial stability in the euro area

Abstract: This chapter enhances systemic risk assessment and Basel III implementation by extending the new Keynesian (NK) quarterly projection model (QPM) to encompass macroprudential policy in the euro area. The integration of macroprudential and financial blocks enhances the understanding of the interaction between monetary policy, macroeconomic variables, and financial stability. The chapter employs calibration and Bayesian estimation for model parametrization and assesses its strengths and weaknesses through impulse response functions and historical shock decompositions. The results demonstrate satisfactory model dynamics and highlight the role of macroprudential measures in promoting financial stability. The QPM proves effective in quantifying the impact of financial shocks on the banking system and macroeconomy, enabling evaluation of the effects of capital banking instruments. Policymakers and analysts can use this comprehensive tool to better understand complex economic dynamics, inform policy decisions, and promote financial stability.

Keywords: Forecasting and Policy Analysis, Quarterly Projection Model, Monetary Policy, Macroprudential Policy, Financial Stability, Credit Cycle, Leverage Ratio, Euro Area.

JEL classification: C54, E47, E52, E58.

1. Introduction

The countries of the eurozone have divergent[49] conjunctural trajectories (economic and financial cycles),[50] which makes the eurozone a heterogeneous monetary zone. Indeed, this heterogeneity existed when the common currency was created but decreased during the subsequent decade (Le Cacheux, 2016). Thus, during this period, the economic and financial cycles of the member countries of the monetary union converged, relatively speaking (see, for instance, Berger, 2014). This languishing convergence was broken by the financial crisis of 2008, and especially by the measures designed to resolve the sovereign debt crisis (OECD, 2021; N'Goran, 2022).

These economic and financial-cycle divergences among eurozone members render the action of the monetary policy – the only instrument for macroeconomic adjustment – ineffective (Couppey-Soubeyran and Dehmej, 2017).[51] Indeed, monetary policy is designed for the average eurozone member and not for each individual member state. And this ignores the fact that, in the presence of growth and inflation differentials, area-wide inflation targeting would destabilize national economies whose characteristics diverge from the average. Thus, in a period of crisis, such as the 2008–9 global financial crisis, instead of allowing regulation of the financial cycle, monetary policy contributes to, and accentuates, intra-zone divergence (see Bank of Spain, 2009; Schnabl, 2013; Georgiadis, 2015). National fiscal policy actions in support of monetary policy, on the other hand, can be very useful in responding to a financial crisis in the downward phase of the cycle. However, it is during the ascending phase when imbalances are formed, imbalances that, given the weight of the banking and financial sector, are often financial before being economic (see Kindleberger, 1978; Allen and Gale, 1999; Bennani et al., 2017a; Corrado and Schuler, 2019); fiscal policy is therefore insufficient (Martin and Philippon, 2017). However, it is possible to minimize the formation of these financial imbalances by regulating the financial cycle, which is the countercyclical part of macroprudential policy (Schularick and Taylor, 2012). If this is the case, what is the basis for the success of macroprudential policy in the eurozone?

Badarau et al. (2020) answer this question by pointing out that the success of macroprudential policy (MaP) in the euro area rests on two mistakes that should be avoided: ignoring national heterogeneity; and failing to consider the linkages between member states. Indeed, the macroprudential policy is primarily an instrument of financial stability through the prevention of systemic risk, which involves two actions. One – countercyclical – aims to counter the movement

[49] This divergence of member countries' cycles is caused by the diversity of their economic structures and institutions. See Berger (2014) and OECD (2021).
[50] For a complete literature review and an assessment, see, for example, N'Goran (2022).
[51] The single monetary policy is not designed to manage this heterogeneity and resolve divergences within the eurozone.

of the financial cycle, that is, to slow down financial booms and busts in the upward phase, and to limit financing restrictions and asset price falls (real estate, stock markets, etc.) in the downward phase. The other – cross-cutting – objective is to increase the resilience of banking groups, which, notably through their size, interconnections, and market power, contribute to systemic risk (Alessandri et al., 2009; Henry and Kok, 2013; Bennani et al., 2017b). While national divergences do not prevent cross-cutting action at the level of the eurozone, countercyclical action may seem more difficult to carry out within a monetary zone marked by divergences that are both economic and financial.[52] Its regulatory tools – countercyclical tools – are among other procyclical capital requirements and countercyclical capital buffers, and the first discussion about this comes from Borio (2003). The insight for a countercyclical capital tool is that banks should improve their capital in good times and reduce it in bad times (Jiménez et al., 2015). A higher level of requirements in expansions should help to moderate lending. Lower capital requirements in times of crisis should reduce the incentives for banks to further reduce lending and thus deepen the recession.

However, the question remains: *How do we combine the action of these instruments with that of monetary policy while considering heterogeneity between countries, in order to ensure financial stability within the Economic and Monetary Union (EMU) of the European Union (EU)?* This is the question that we will seek to answer in this chapter. Specifically, we will seek to quantify the overall impact of financial shocks on the banking system and the macroeconomic environment of the euro area. Also, we will estimate the macroeconomic effect of a capital bank instrument.

Indeed, this chapter is motivated by the following facts. On the one hand, the recent COVID-19 pandemic illustrated the role of monetary policy in financial stability[53] and reopened the debate about the link between monetary policy and financial stability. On the other hand, it is clear that, despite all the interest in and discussion about macroprudential policies and, in particular, countercyclical policies and tools, there are: (i) no empirical studies on how these instruments can work over a business/lending cycle, and (ii) no empirical studies in the euro area that assess the links between financial stability, macroprudential policy, and monetary policy. Most discussions are theoretical or assessments that are numerically simulated (Repullo et al., 2010; Fei et al., 2012; Badarau et al., 2020). The analytical framework and practical tools for policymakers, in the context

[52] In other words, in a heterogeneous currency area, it is not only economic cycles that diverge, but also, and perhaps even more so, financial cycles. See, for example, Antonin et al. (2014), Couppey-Soubeyran and Dehmej (2016) and N'Goran (2022).

[53] During the crisis, the European Central Bank, in coordination with the national central banks, with the goal of providing support in the crisis, decided to buy government bonds on the secondary market from the commercial banks, which in turn purchased them from their government upon issuance. This made it possible to keep government interest rates low and to create room on commercial bank balance sheets to issue new loans to firms and households (Claeys, 2020).

of the ongoing policy debate on the role of monetary and macroprudential policies in smoothing economic cycles and limiting financial vulnerabilities,[54] remain limited, especially in a monetary zone where economic and financial cycles are divergent between member countries.

The goal of this chapter is to contribute to finding better ways of monitoring systemic risk and implementing Basel III requirements, by extending the new Keynesian (NK) quarterly projection model (QPM) to address macroprudential policy in the euro area. The main focus will be on the role of macroprudential policy in moderating credit growth in the context of its interaction with monetary policy and financial stability. Our key innovation is the introduction of a financial stability variable (developed in Chapter 1) in a new block (financial stability block) of the QPM model. This will allow us to assess not only the link between financial stability and monetary policy but also the link between financial stability and macroprudential policy.

The remainder of this chapter is structured as follows. Section 2 reviews previous relevant literature. Section 3 presents the QPM structure and its extension to macroprudential policy analysis. Section 4 discuss model parametrization, calibration, and estimation processes. Section 5 evaluates the model, provides counterfactual policy analysis and forecasting, interprets economic development, and identifies structural shocks. Section 6 concludes.

2. Literature review

The first chapter related to our analysis framework refers to Juillard et al. (2008) and Benes et al. (2017). Indeed, the contribution of Juillard et al. (2008) is part of a series of three papers[55] written in the context of a larger project to estimate a small quarterly global projection model[56] (GPM) initiated by the International Monetary Fund (IMF). The authors estimated a small quarterly projection model for the US, the euro area, and the Japanese economies. By incorporating oil prices in the model and using Bayesian techniques estimation, they traced the impacts of shocks to oil prices and showed how the model can be used to construct efficient baseline forecasts that incorporate judgment imposed on the near-term outlook. They found that, quantitatively, the effects of the oil price movement are largest in the United States and smallest in Japan, because the estimated coefficients for the effects of oil price movements on equilibrium output and in inflation are higher in the US than in the other economies. Historically, their model is based on the quarterly

[54] See, for example, IMF (2015) and Adrian and Liang (2018).
[55] See Ermolaev et al. (2008) and Laxton et al. (2008) for the two previous ones.
[56] The GPM project is designed to improve the toolkit for studying both own-country and cross-country linkages.

projection model (QPM) created by the staff of the Bank of Canada in August 1993, and the first related publication refers to Black et al. (1994).

More recently, the QPM has been widely used for generating forecasts and risk evaluation as well as conducting policy analysis for developing and emerging economies. For instance, Benes et al. (2017) described the principal features of the production version of QPM, which is a forward-looking open-economy gap model, calibrated for India's economy. They included several India-specific features like the importance of the agricultural sector and food prices in the inflation process, the features of monetary policy transmission, and the implications of an endogenous credibility process for monetary policy formulation. Also, a simple QPM model was extended with a fiscal sector block by Chandranath et al. (2018) to serve as a core forecasting model in the process of the Central Bank of Sri Lanka's move toward flexible inflation targeting. They included forward-looking endogenous interest rate and foreign exchange rate policy rules that allow for flexible changes in policy behavior. The authors used the Bayesian estimation technique with relatively tight priors to improve model calibration and data fit. Meanwhile, Musil et al. (2018) proposed a small structural model at the core of the forecasting and policy analysis system for the Belarusian economy and macroeconomic analysis. The authors added wages, directed lending, and dollarization to their QPM, outlining that adding these elements allows for analysis of the implication of activist wage policy, state program lending, and dollarization for the macroeconomic stability and strength of the policy transmission mechanism. Using QPM, Ravnik and Bokan (2018) paid attention to the open economy features of the model, financial stability issues related to the high degree of credit euroization, and monetary policy modeling.

From a macroprudential perspective, Benes et al. (2017) highlighted financial variables to address macroprudential and financial stability issues. Recently, Adrian (2020) and Adrian et al. (2020a, 2020b) developed NK models and featured intertemporal trade-offs between output volatility and financial vulnerability over time, among other complementary work by Alam et al. (2019), Brandao et al. (2020), and Chen et al. (2020) on macroprudential policy effectiveness and measures. IMF (2015) and Svensson (2018) pointed out that moving monetary and macroprudential policy in the same direction could have strong adverse effects on output. Building on the contribution of Guo et al. (2019),[57] Karam et al. (2021) added two additional blocks to the traditional QPM, focusing on the credit dynamic and macroprudential to analyze the interaction of monetary and macroprudential policies for the Philippines. The authors stressed that the model produces plausible dynamic and sensible forecasts and that its simplicity makes it useful for policy analysis.

[57] Guo et al. (2019) analyzed the monetary policy stance and inflationary pressures during the 2018 exchange rate stress period, with a focus on the impact of exchange rate and trade dynamics.

Their model embedded insights from more complex dynamic stochastic general equilibrium (DSGE) models into a simple QPM framework to facilitate structural data analysis, forecasting, and policy analysis.

Indeed, since the appearance of macroprudential instruments, the standard modeling approach has been the DSGE model.[58] Important contributions have been made by smaller static or multi-period analytical models, including Jeanne (2014), Korinek and Sandri (2016), and Kara (2016). For instance, Jeanne (2014) presented a simple framework that enabled, first, a comparison of the welfare impacts of domestic prudential policies and prudential capital account policies in a small open economy. Second, the general equilibrium effects of the uncoordinated use of these policies were assessed, and the case for coordination of macroprudential and monetary policies at global level was investigated. The study highlighted three important conclusions: (i) domestic prudential policies are generally preferable to capital controls, but realistic constraints on the use of the former may justify using the latter; (ii) the fact that these policies have international spillovers does not per se imply that they should be subject to international rules or coordination; and (iii) international coordination may be justified if there is a global demand shortage. Korinek and Sandri (2016), for their part, analyzed the desirability of capital controls versus macroprudential regulation in mitigating financial instability; they found that it is necessary to use both instruments in emerging economies that are at risk of contractionary exchange rate depreciations.

Some of the literature has specialized in addressing the specific challenges that emerge in the context of EMU using core-periphery models. These studies include Gerali et al. (2010), Angelini et al. (2014), Quint and Rabanal (2014), Rubio and Carrasco-Gallego (2016), Martin and Zhang (2017), Bielecki et al. (2019), Darracq Pariès et al. (2019), Badarau et al. (2020), and Fernandez-Gallardo and Paya (2020). For example, Gerali et al. (2010) studied the roles of credit supply factors in business cycle fluctuations by introducing an imperfectly competitive banking sector into a DSGE model with financial friction. They found that (i) the existence of a banking sector partially attenuates the effects of demand shocks, while it helps to propagate supply shocks; (ii) shocks originating in the banking sector explained the largest share of the fall in output in 2008 in the euro area, while macroeconomic shocks played a limited role; and (iii) an unexpected destruction of bank capital has a substantial impact on the real economy and particularly on investment. Meanwhile, Angelini et al. (2014) also used simple rules in a DSGE model featuring a banking sector to analyze the interaction between capital requirements and monetary policy. They found

[58] In DSGE models, modern macroeconomic theory is used to elucidate and predict co-movements of aggregate time series over the business cycle. See, for example, Smets and Wouters (2003), Christiano et al. (2005), Del Negro and Schorfheide (2012), and Christiano et al. (2018) for a detailed presentation.

that when economic dynamics are driven by supply shocks, active use of capital requirements generates modest benefits in terms of volatility of the target variables compared to a situation when only the central bank carries out stabilization policies.

Quint and Rabanal (2014) studied the optimal mix of monetary and macroprudential policy rules by estimating the DSGE model for the euro area. There were two main results from this study: (i) the introduction of a macroprudential rule would help to reduce macroeconomic volatility and improve EMU-wide welfare, but at the same time macroprudential policies "lend a hand" to monetary policy by reducing accelerator effects, requiring smaller responses of the nominal interest; and (ii) the effects of macroprudential regulations can affect savers and borrowers differently. The policy that improves welfare in the EMU the most reduces the welfare of borrowers by inducing a countercyclical response of the lending–deposit spread. Rubio and Carrasco-Gallego (2016) used a DSGE model with housing to compute the effects of Basel I, II, and III regulations and its interactions with monetary policy. Their model included three types of agents: savers, borrowers, and banks. They found that monetary policy needs to be more aggressive when the capital requirement ratio (CRR) increases because the money multiplier decreases. However, this policy combination brings a more stable economic and financial system.

Martin and Zhang (2017), through a portfolio theory framework with two countries, examined the specific role of short-term risks, as perceived by investors, in the formation of sovereign bond yields. Their model included three assets: a risk-free monetary rate and two sovereign bonds, including default and volatility risks when the holding period is less than the maturity of the bond. Their empirical results demonstrated that the decline in German and French long-term rates from March 2011 to September 2016 was partially due to the decrease in both risk premium and covariances with periphery countries. The authors argued that these declines amplify the mechanisms of flight-to-quality. In order to check whether monetary or macroprudential policy could have prevented the periphery's violent boom and bust after euro adoption, Bielecki et al. (2019) estimated a DSGE model for two euro area regions (core and periphery) and conducted a series of historical counterfactual experiments in which monetary and macroprudential policy followed optimized rules using area-wide welfare as the criterion. They showed that a common monetary policy could have better stabilized output in both regions, but not the housing market or the periphery's trade balance. On the other hand, region-specific macroprudential policy could have substantially smoothed the credit cycle in the periphery and reduced the build-up of external imbalances.

Darracq Pariès et al. (2019) developed the first structural two-country macro model with financial friction and calibrated it to individual euro area countries in the macroprudential policy literature

to explain the transmission mechanism of macroprudential policies and their interaction with monetary policy within a monetary union. They showed that there are synergies and trade-offs between monetary and macroprudential policies and that these interactions may become even more pronounced in a monetary union where monetary policy, by definition, focuses on area-wide economic and financial conditions. Using a small static core-periphery model calibrated to the euro area, based on the well-known three-equation new Keynesian model and introducing a banking sector in the vein of the IS-LM-CC framework of Bernanke and Blinder (1988), Badarau et al. (2020) re-evaluated the claim that strictly national implementation of MaP is invariably preferable in a heterogeneous monetary union. Their results showed that, while national rules deliver a good performance in general, under certain conditions internalization is preferable. In order to assess the development and impact of MaP in the euro area, Fernandez-Gallardo and Paya (2020) computed a new index capturing the direction of macroprudential policy and highlighting its principal stylized facts since the creation of the euro in 1999. Then, they combined a narrative approach and a structural VAR method to track exogenous expected and unanticipated variations in macroprudential policies. The authors found that unanticipated or surprise shocks and anticipated or new macroprudential policy shocks exhibited differentiated effects on macroeconomic variables, and that they both contribute over the medium term to safeguarding financial stability.

The question that often arises among these studies is the issue of stability and the scale at which macroprudential policy should be conducted. In this regard, Brzoza-Brzezina et al. (2015) emphasized that MaP must be implemented at national level in order to have a positive impact. However, they only considered asymmetric shocks, focusing on borrower-based instruments and not considering structural heterogeneity. Poutineau and Vermandel (2017), on the other hand, concluded similarly regarding the countercyclical capital buffer (CCyB). They integrated both interbank and corporate cross-border lending in their model and compared national and union-wide stabilization rules across different degrees of integration. As a result, the authors pointed out that national rules always perform better, but the performance of the union-wide rule improves with higher levels of corporate lending integration. However, this result remains open to criticism: according to this result, the interbank lending rate does not impact the relative performance of these rules. For instance, Badarau et al. (2020) found that, given the central role of this channel in the genesis of the crisis, it is surprising that greater integration of interbank lending does not affect the relative performance of these rules. Using a static analytical model, Dehmej and Gambacorta (2019) demonstrated that distortions in eurozone monetary policy can be corrected by MaP actions only when regulators follow a national rule. However, Badarau et al. (2020), by studying how

macroprudential regulators should set the CCyB in the presence of cross-border spillovers,[59] found that countercyclical capital regulation can, under national stabilization regimes, produce potentially destabilizing spillover effects between members of a heterogeneous monetary union via interbank lending. Rubio (2018) also noted that accounting for heterogeneity in the prevalence of variable rate mortgages leads to high volatility in the periphery, so a supranational approach to setting the loan-to-value (LTV) instrument is warranted.

From an empirical perspective, many studies have looked at the impacts of MaP on macroeconomic variables and their link with monetary policy, including Claessens et al. (2013), Kuttner and Shim (2016), Cerutti et al. (2017), Akinci and Olmstead-Rumsey (2018), Alam et al. (2019), and Richter et al. (2019). Claessens et al. (2013) used panel data regressions to analyze how changes in the balance sheets of some 2,800 banks in 48 countries over 2000–10 responded to specific macroprudential policies. They found that measures aimed at borrowers (caps on debt-to-income and loan-to-value (LTV) ratios) and at financial institutions (limits on credit growth and foreign currency lending) are effective in reducing asset growth. Using data from 57 economies and periods of up to 3 decades, Kuttner and Shim (2016) assessed the effectiveness of 9 non-interest rate policies on housing credit. They found that introductions or reductions in the maximum debt-service-to-income ratio, and increases in housing-related taxes, have significant negative effects on housing credit, with a typical tightening action lowering the real credit growth rate by 4–6 percentage points and 3–4 percentage points, respectively, over the subsequent 4 quarters. In the same way, Cerutti et al. (2017) documented the use of various macroprudential policies in a large sample of countries over the 2000–13 period using a novel dataset, and they studied the relationships between the use of these policies and developments in credit and housing markets to investigate the effectiveness of macroprudential policies in dampening financial cycles. Their analysis showed that macroprudential policies are used more frequently in emerging economies, with foreign-exchange-related policies, in particular, used more intensively. Borrower-based policies are used more in advanced countries. They also found that policies are generally associated with reductions in the growth rate in credit, with a weaker association in more developed and more financially open economies, and they can impact the growth in house prices. Finally, they demonstrated that using policies can be associated with greater cross-border borrowing, suggesting that countries face issues of avoidance.

[59] The authors took a two-country version of the standard three-equation NK model like Dehmej and Gambacorta (2017) and introduced a banking sector through a fourth financial friction equation that determines the bank lending rate as a function of the conditions on the market for loans to the non-financial sector, taking inspiration from the IS-LM-CC model by Bernanke and Blinder (1988).

Akinci and Olmstead-Rumsey (2018) developed a novel index of MaP in 57 advanced and emerging economies covering the period from 2000Q1 to 2013Q4, with tightening and easing recorded separately. Then, using a dynamic panel data model, they evaluated the effectiveness of MaP in curbing credit growth and house-price appreciation. The main findings of their analysis were as follows: (i) MaP has been used far more actively since the global financial crisis in both advanced and emerging economies; (ii) MaP has primarily targeted the housing sector, especially in advanced economies; (iii) MaP is usually changed in tandem with bank reserve requirements, capital flow restrictions, and monetary policy; (iv) their study suggested that macroprudential tightening is associated with lower bank credit growth, housing credit growth, and house-price appreciation; and (v) targeted policies – for example, those specifically intended to limit house-price appreciation – seem to be more effective, especially in economies where the banking sector is important. Alam et al. (2019) presented a new comprehensive database of macroprudential policies (iMaPP) that combines information from various sources. Using a method that aims to better address endogeneity problems and exploiting the unique features of this database, the authors found strong and non-linear effects on the household credit of LTV changes. The effects per 1 percentage point LTV tightening diminish with the size of the LTV adjustment, probably because of policy leakage effects. Richter et al. (2019), using a narrative identification approach, identified the causal impact of changes in maximum LTV ratios (which is an important component of the macroprudential toolkit) on output and inflation. They found that changes in maximum LTV ratios seem to have relatively moderate effects on output and inflation. The output effects tend to be imprecisely estimated and small in advanced economies.

Several of these studies have tried to construct an index that aggregates actions taken over a number of macroprudential policy instruments to capture the variation in MaP, others have included both emerging and advanced economies,[60] and others have analyzed a particular group of countries. For instance, Vandenbussche et al. (2015) used a novel database to construct 29 types of macroprudential policy change and test whether changes in these policies affected house-price inflation in the last decade in Central Eastern and South Eastern European (CESEE) countries. Their results showed that some MaP did have an impact, while others did not. In particular, raising the minimum capital adequacy ratio was followed by a significant deceleration in house prices. They argued that these results bode well for one of the main macroprudential tools introduced as part of the Basel III reforms: the CCyB. Meanwhile, Budnik and Kleibl (2018) and Budnik (2020) analyzed European Union member states. Budnik (2020) employed detained information on the use of capital-based, borrower-based, and liquidity-based instruments in 28 European Union

[60] See, for example, Kuttner and Shim (2016), Alam et al. (2019), and Richter et al. (2019).

countries for 1995–2017, and a macroeconomic panel set-up, to analyze the credit impact of policy instruments commonly applied to contain systemic risk. They found a significant impact of capital buffers, profit distribution restrictions, specific and general loan–loss provisioning regulations, sectoral risk weights and exposure limits, borrower-based measures, caps on long-term maturity and exchange rate mismatch, and asset-based capital requirements, on credit to the non-financial private sector. These works used different econometric methodologies. Cerutti et al. (2017) and Budnik and Kleibl (2018), for example, used dynamic panel regression to assess the correlation between changes in prudential instruments and the evolution of financial stability. Their results showed that dynamic panel regression methods can address some of the limitations of correlation analysis. Generally, these studies have used GMM methods for endogeneity control.

On the other hand, structural VAR models have been used to analyze reverse causality and effects between MaP and monetary policies, including Kim and Mehrotra (2017), Klingelhöfer and Sun (2019), and Fernandez-Gallardo and Paya (2020). For instance, Fernandez-Gallardo and Paya (2020) assessed the effect of an unanticipated or surprise shock, and an anticipated or news shock on economic variables that are the objective of both macroprudential and monetary policies. The authors found that there are differences in the dynamics following each type of shock, and that they both contribute over the medium term to safeguarding financial stability by moderating systemic risk and, importantly, by lowering the procyclicality of credit growth. Meanwhile, Kim and Mehrotra (2017), and Klingelhöfer and Sun (2019), used a recursive ordering identification strategy by means of a Cholesky decomposition to examine the causal effects of exogenous variations in macroprudential policy actions and to provide economically interpretable impulse responses. Klingelhöfer and Sun (2019) found that a macroprudential policy shock lowers credit and that there is no explicit trade-off between macroprudential and monetary policies. Their results were consistent with the thesis proposed by Beau et al. (2012) and Svensson (2018), stating that the two policies can act independently of each other. On the other hand, Kim and Mehrotra (2017) showed that the quantitative effect of the monetary policy rate is similar to the macroprudential policy instrument, and therefore a trade-off arises between the two policies.

In light of this literature review, two important points emerge. First, since it appeared, macroprudential policy analysis has focused on empirical models of the VAR and GMM type, and DSGE models (a framework based on micro-simulation), which remain complicated models. Other models, such as QPM, offer a much simpler analytical framework, combining empirical analysis and DSGE model ideas to facilitate structured data analysis, forecasting, and policy analysis. However, unlike DSGE models, the QPM model coefficients are not inevitably functions of structural parameters, and the structure of the model does not meet all of the relevant conditions

for market clearing and consistency of stocks and flows (Mæhle et al., 2021). By being a gap model, QPM differentiates between "equilibrium" or "trend" (driven by long-term fundamentals) and the deviations from these equilibria called a "gap" (assimilated as business cycle fluctuations). Their semi-structured nature (i.e., the exclusion of certain restrictions) makes them more flexible in terms of replicating data and including country-specific features in comparison to fully micro-founded models, such as DSGE models. The QPM is also a suitable tool for policy analysis and forecasting. Nonetheless, it is essential to note that the QPM is not a purely forecasting device like, for example, a simple reduced-form vector-autoregressive model (VAR).

Very few studies have used this analytical framework – to our knowledge, only one study has done so to date: Karam et al. (2021). Second, in the euro area, no empirical studies have assessed the links between financial stability, macroprudential policy, and monetary policy. For that reason, we use Karam et al.'s (2021) QPM methodology in this chapter, albeit with some differences, to examine the role of macroprudential policy in achieving economic and financial stability in the euro area. Indeed, the authors demonstrated the extent to which the QPM can be a practical tool for policymakers when analyzing the role of macroprudential and monetary policies in smoothing business cycles and mitigating financial vulnerabilities. Moreover, they pointed out that the QPM provides an analytical framework that facilitates structured data analysis, forecasting, and policy analysis. Our key innovation is the introduction of a new financial stability block to their model. This novel block is constructed by following Tan and Wang (2015), Ma et al. (2017), and Sui et al. (2022); it allows us to assess not only the link between financial stability and monetary policy but also the link between financial stability and macroprudential policy. Also, the model's structure allows us to consider the heterogeneity among euro area countries and to analyze the cross-correlation[61] of macroprudential policy shocks among euro area member states. The following section presents and discusses the model.

3. QPM structure and its extension to macroprudential policy analysis

3.1. QPM in its simplest version

The quarterly projection model (QPM), in its simplest version, refers to a new Keynesian (NK) model. This model is based on the idea of monopolistic competition and features nominal rigidities: (i) the model assumes that prices are sticky, meaning the prices do not adjust immediately as the

[61] See, for example, Juillard et al. (2008).

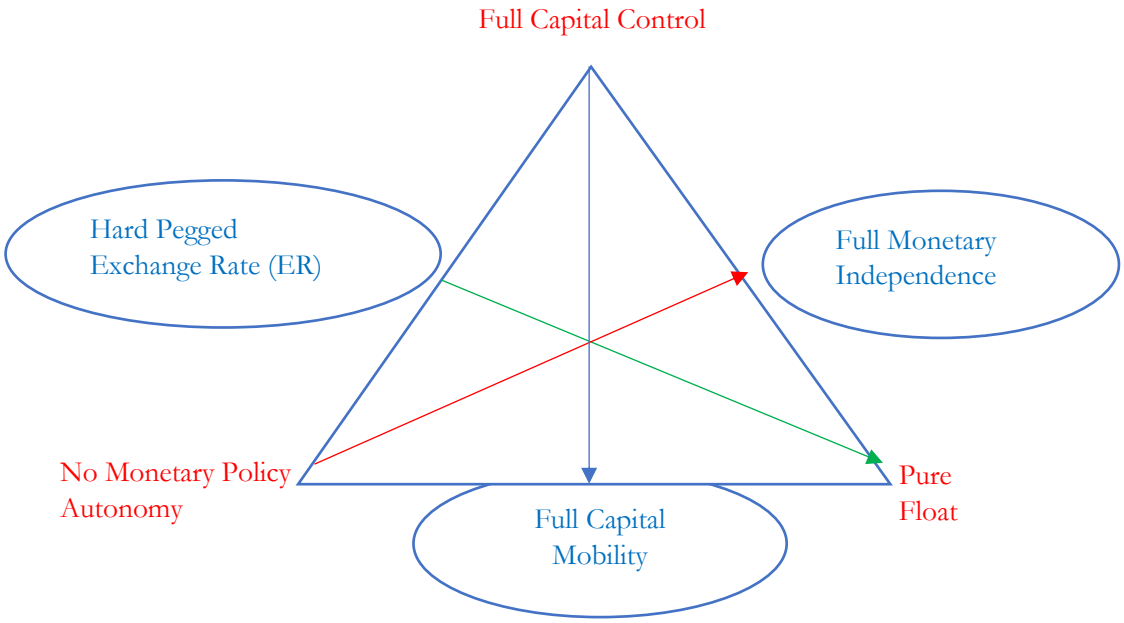
underlying costs of production change; (ii) output in the short run is demand-determined; (iii) the model equation resembles the log-linearized of micro-founded DSGE (dynamic stochastic general equilibrium) models, or in other words, the equations that are derived from optimization problems of economic agents or firms; (iv) some parts of the model are ad hoc, so they differ from the log-linearized equations in DSGE models, which usually helps us to better approximate the data; and (v) unlike DSGE models, equation coefficients in the QPM are not derived from deep structural parameters, such as discount factor or risk aversion, but the coefficients are directly calibrated. This idea of monopolistic competition and nominal rigidities makes the QPM canonical because it assumes: first, an inflation-targeting central bank, which uses the interest rate as a key policy variable; second, a flexible exchange rate determination; and, third, rational expectations, which means that agents build their expectations about macroeconomic variables, such as inflation or the exchange rate, they use the model to project these variables, and they use the projections as their best guess or expectations about the inflation and exchange rates in the future.

Also, the canonical QPM has some central characteristics, as follows. (i) It is a structural model because each key equation has an economic interpretation, but the equations are not fully micro-founded. In other words, for every key model equation that exists in the model we can explain an underlying economic mechanism that this equation approximates. For example, how the central bank sets the interest rate or how the output is determined. (ii) It is a general equilibrium model because it describes how the equilibrium is established in the economy as a whole and not just in certain markets or sectors. (iii) The model is stochastic because it allows for stochastic shocks in its equations. Later, you will see a set of the so-called structural shocks in the key equations for domestic variables, such as aggregate demand shock, cost push shock, exchange rate shock, and monetary policy shock. (iv) This model also assumes the rational formation of expectations for inflation and the exchange rate or, in other words, model-consistent expectations. Finally, (v) the QPM is a suitable tool for monetary policy analysis and forecasting.

From a monetary policy analysis point of view, the canonical QPM is based on some assumptions of the policy trilemma (see Mundell, 1963; and Ito and Kawai, 2014). Indeed, the policy trilemma states that countries cannot have all three elements simultaneously: a fixed exchange rate, monetary policy independence, and full capital mobility. Therefore, countries must decide simultaneously whether to preserve the monetary policy autonomy, what exchange rate arrangement to use, and whether to have capital controls. Here, the set of assumptions consistent with the canonical model include full capital mobility, which means there are no restrictions on the exchange of foreign-denominated assets for domestic and from domestic to foreign; and full monetary independence,

which means that the central bank has instruments to actively alter monetary conditions to achieve the policy objective.

Figure 1: Policy trilemma



Thus, the key policy in the QPM model that the central bank steers is the policy interest rate. The exchange rate means that the central bank does not use the exchange rate as a nominal anchor and therefore does not have an exchange rate target that it attempts to achieve.

The QPM model has two large parts: domestic and foreign. The model emphasizes the domestic part, which has four key blocks: (i) the aggregate demand, which relates the economics activity (measured by the output gap) to monetary conditions and foreign demand (which is measured by the output gap in the trading partner); (ii) the Phillips curve, which describes how inflation reacts to expected inflation and marginal costs; (iii) the UIP (uncovered interest rate parity) condition, which establishes a non-arbitrage condition between investing in domestic and foreign assets; and (iv) the monetary policy rule, which captures how the central bank reacts by changing the nominal interest rate in response to deviations in inflation from its target and to the output gap. These four blocks are expressed in equations that we will detail in the following sections.

3.1.1 The aggregate demand (output gap) block

The output gap is the first equation of the canonical QPM model. It resembles a Euler equation, which can be found in the literature on micro-founded DSGE models (see, for example,

Fernández-Villaverde et al., 2016). We refer to it as an aggregate demand equation, or the IS curve. It relates the output gap for domestic economy to monetary conditions and to the output gap in the main trading partner:

$$\hat{y}_t = b_1\hat{y}_{t-1} - b_2 mci_t + b_3\hat{y}_t^* + \varepsilon_t^y \quad (1)$$

$$mci_t = b_4\hat{r}_t + (1 - b_4)(-\hat{z}_t) \quad (2)$$

where $\hat{y}_t$ represents the output gap;[62] $\hat{y}_{t-1}$ is the lagged output gap, which captures the persistence of the business cycle and enters the equation with the positive coefficient b_1 (which measures the persistence of the output gap); mci_t represents the real monetary condition index and enters with the coefficient minus b_2; and $\hat{y}_t^*$ corresponds to the foreign output gap, which enters with a positive coefficient b_3. The equation includes a structural demand shock ε_t^y.

The monetary condition index (equation (2)) is essentially a weighted average of two variables: the real interest rate gap ($\hat{r}_t$)[63] – where the real interest rate (r_t) is expressed as $r_t = i_t - E_t\{\pi_{t+1}\}$ with i_t the nominal interest rate and $E_t\{\pi_{t+1}\}$ the expected inflation rate at t for $t+1$; and the real exchange rate gap ($\hat{z}_t$) – where the real exchange rate (z_t) is expressed as $z_t = s_t + p_t^* - p_t$ with s_t the nominal exchange rate, p_t^* the foreign consumer price index, and p_t the domestic consumer price index.[64] These gaps are the deviations of variables from the equilibrium or long-term trends. This indicates that the equilibrium values of the real interest rate and the real exchange rate are consistent with the neutral monetary conditions. In other words, when the real interest rate and the real exchange rate are at equilibrium levels, both gaps are 0 (Batini and Turnbull, 2000). And the monetary conditions index is also 0. The index is a weighted average. Coefficient b_4 is a weight of the interest rate in this index. The index composition reflects our assumption of a small open economy. Not only the interest rate but also the exchange rate are important components defining the monetary stance, whether they are loose and stimulate demand or tight and constrain demand. Therefore, the index captures the impact of monetary policy on aggregate demand and,

[62] By definition, the output gap ($\hat{y}_t = y_t - \bar{y}_t$) is a deviation of the log of real output (GDP in volume (y_t)) from its potential or long-term rate ($\bar{y}_t$). The long-term rate of output growth is $\Delta\bar{y}_t = \rho_{\bar{y}}\Delta\bar{y}_{t-1} + (1 - h_y)\Delta\bar{y}_{ss} + \varepsilon_t^{\bar{y}}$, where $\Delta\bar{y}_{ss}$ is the rate of output growth in the steady state (also called the non-inflationary output growth), and the coefficient $\rho_{\bar{y}}$ controls the speed of convergence to the steady state with smaller values, implying that the current values of the trend variables approach their respective steady states faster. It is important to note that the long-term rate of output is modeled as autoregressive processes of order one for the respective rates of change.

[63] The real interest rate gap is $\hat{r}_t = r_t - \bar{r}_t$, where $\bar{r}_t$ denotes the long-term (equilibrium) real interest rate and egal to $\bar{r}_t = \rho_{\bar{r}}\bar{r}_{t-1} + (1 - h_r)\bar{r}_{ss} + \varepsilon_t^{\bar{r}}$, where $\bar{r}_{t-1}$ represents the equilibrium of the real interest rate at the previous period and $\bar{r}_{ss}$ the steady-state level of domestic real interest rate.

[64] The real exchange rate gap ($\hat{z}_t = z_t - \bar{z}_t$) is defined as a deviation of the real exchange rate from its long-term rate ($\bar{z}_t$). Its long-term rate is $\Delta\bar{z}_t = \rho_{\bar{z}}\Delta\bar{z}_{t-1} + (1 - h_z)\Delta\bar{z}_{ss} + \varepsilon_t^{\bar{z}}$, where $\bar{z}_{t-1}$ refers to the exchange rate at the previous period and $\Delta\bar{z}_{ss}$, the real exchange rate appreciation/depreciation.

therefore, on the output via two of the (often) most important policy transmission channels: the interest rate and the exchange rate channels. The real interest rate impacts decisions to substitute between consumption today and savings today to consume in the future and to borrow funds to finance investment and consumption expenditure. The real exchange rate impacts substitution or shifts in demand between domestically and foreign-produced goods, as it captures changes in relative prices.

3.1.2 The aggregate supply equation (Phillips curve or inflation block)

The second equation in the canonical QPM is written for the headline inflation. It is similar to a Phillips curve equation (Mæhle et al., 2021; Phillips, 1958), which appears in the literature related to DSGE models:

$$\pi_t = a_1\pi_{t-1} + (1 - a_1)E\{\pi_{t+1}\} + a_2 rmc_t + \varepsilon_t^{\pi} \quad (3)$$

$$rmc_t = a_3\hat{y}_t + (1 - a_3)\hat{z}_t \quad (4)$$

Equation (3) describes the relationship between the headline inflation index at time t and the real marginal costs index, where π_t denotes inflation at time t, and π_{t-1} denotes the inflation rate at the previous period, which enter the equation with the coefficient a_1. a_1 measures the persistence of inflation; $E\{\pi_{t+1}\}$ represents the expected rate of inflation at the next period, and it enters with the coefficient $(1 - a_1)$; rmc_t is the real marginal cost index at time t; and ε_t^{π} refers to the structural shock (the cost push shock). So, equation (3) is a structural stochastic equation.

Concerning the real marginal cost (equation (4)), this index is a weighted average of two gap variables, the output gap ($\hat{y}_t$), which enters with the coefficient a_3, and the exchange rate gap ($\hat{z}_t$), which enters with the coefficient $(1 - a_3)$. As we see above, the gaps are deviations of variables from the equilibrium or long-term trends. This implies that when the output gap and the real exchange rate gap are closed, their values are at zero, and there are no extra inflationary or deflationary pressures associated with costs. The output gap in the real marginal cost index approximates the marginal cost of domestic producers, while the real exchange rate gap approximates the marginal cost of importers.

3.1.3 Uncovered interest rate parity (UIP) with backward-looking behavior block

The third equation in the canonical QPM is the modified uncovered interest rate parity condition. The equation establishes the link between the nominal change rate and the interest rate differential and the country risk premium; it is defined as follows:

$$s_t = (1 - e_1)E_t s_{t+1} + e_1 \left[s_{t-1} + \frac{2(\pi_t^T - \bar{\pi}_t^* + \Delta\bar{z}_t)}{4} \right] + \frac{i_t^* - i_t + prem_t}{4} + \varepsilon_t^s \qquad (5)$$

where s_t corresponds to the nominal exchange rate at time t; s_{t-1} is the nominal exchange rate at the previous period; $E_t s_{t+1}$ denotes the expected rate of the nominal exchange rate at the next period; π_t^T refers to the domestic long-term inflation rate (inflation target), while $\bar{\pi}_t^*$ represents the foreign long-term inflation rate; and $\Delta\bar{z}_t$ represents the trend changes in the real equilibrium exchange rate. The parameter e_1 $(0 < e_1 \leq 1)$ allows us to control the tightness of the exchange rate management, which is a policy choice, and setting it should be part of the internal policy discussion. $e_1 = 1$ means a hard peg exchange rate arrangement; i_t^* corresponds to the foreign interest rate, while i_t is the domestic interest rate (the policy rate); $prem_t$ is exogenous and represents the country risk premium; and ε_t^s corresponds to the structural shock.

Let $\mathbf{A} = (1 - e_1)E_t s_{t+1}$; $\mathbf{B} = e_1 \left[s_{t-1} + \frac{2(\pi_t^T - \bar{\pi}_t^* + \Delta\bar{z}_t)}{4} \right]$ and $\mathbf{C} = \frac{i_t^* - i_t + prem_t}{4}$.

A is the forward-looking expectations with weight $(1 - e_1)$; **B** is the backward-looking component of the expected exchange rate at time $t + 1$ with weight e_1; and **C** refers to the interest rate differential and the country risk premium.

The backward-looking component is the level of the exchange rate at time $t + 1$ that would take place if the exchange rate to time $t - 1$ were depreciated by two periods up to time $t + 1$. For this reason, we multiply the equilibrium rate of depreciation, given by the purchasing power parity (PPP) condition, by 2. We include this component in the UIP condition because we use quarterly data. Indeed, the exchange rate can be very volatile and jumpy, especially at high frequencies, indicating that new information is readily incorporated into its determination. However, at quarterly frequency, the exchange rate tends to display some inertia, consistent with some backward-looking behavior. To accommodate this feature of the data, we must include a backward-looking component in the UIP condition.

3.1.4 Monetary policy function, or the interest rate policy rule block

The interest rate or policy rule used in the canonical model assumes that the central bank uses the interest rate as the main policy variable; it can be described as follows:

$$i_t = g_1 i_{t-1} + (1 - g_1)\{i_t^n + g_2(E_t[\pi_{t+N}^4] - \pi_{t+N}^T) + g_3 \hat{y}_t\} + \varepsilon_t^i \quad (6)$$

where i_t is the interest rate at time t and the instrument that the central bank changes in response to important developments in the economy; i_{t-1} is the interest rate at the previous period, assimilated as the smoothing component; and i_t^n corresponds to the neutral interest rate.

$E_t[\pi_{t+N}^4] - \pi_{t+N}^T$ is the deviation of expected inflation from is target, while $\hat{y}_t$ refers to the output gap; and ε_t is the monetary shock. The parameters g_1, g_2, and g_3 refer to the lag of interest rate, the deviation of expected inflation from the target, and the output gap, respectively.

The policy rule describes how the interest rate will be adjusted if output is different from the potential output. So, the interest rate reacts to the output gap. If the output gap is different from 0, then the interest rate will change. Also, the interest rate will be adjusted if the expected inflation is off-target; in other words, if there is any difference between the expected year-on-year inflation at period $t + N$ and the target for inflation at that time. The policy rule accounts for non-systematic changes in policy too, and it is captured by a policy shock ε_t. The smoothing component (the lag of interest rate) accounts for *"wait and see"* considerations when setting the policy rate. It means capturing the notion that central banks generally avoid changes in policy rate that are too abrupt. The lag also means that changes in policy made today will continue to affect the economy in the next period, albeit to a lesser extent, because of the parameter g_1, which is less than 1. Therefore, the policy will move gradually and not abruptly in response to current or expected developments, which brings more realism to the central bank's behavior in the model.

Lastly, the policy rule responds to changes in the natural or neutral nominal interest rate, which is defined as the sum of the equilibrium real interest rate and the expected year-on-year inflation N quarter ahead. The policy rule can be described as follows:

$$i_t^n = \bar{r}_t + E_t[\pi_{t+N}^4] \quad (7)$$

The neutral interest rate, i_t^n, represents the level of the interest rate that is consistent with the economy operating at its potential level of output. This means that when the output gap is equal to 0, and with inflation equal to its target, the interest rate will eventually converge to its neutral or natural level. Thus, the natural level of the interest rate denotes a neutral stance of the monetary policy, whereby the policy rate does not introduce any inflationary or deflationary stimuli.

Therefore, a response of the policy rate to a change in the neutral rate should not be seen as tightening or easing policy.

3.2. QPM extension for credit behavior, the banking sector, macroprudential policy instrument, and financial stability objective

The first QPM extension related to the macroprudential policy analysis is Karam et al. (2021). Starting from the simple version of the QPM, the authors added two new blocks (credit block and macroprudential policy block) and focused on analyzing the interplay between monetary and macroprudential policies, aiming to enhance the comprehension of unintended consequences and temporal trade-offs. In this chapter, we add a financial stability block, based on the aggregate financial stability indicator (AFSI) calculated by N'Goran (2022), to analyze how policymakers can set both monetary and macroprudential policies to achieve economic and financial stability. We now present the credit cycle block, macroprudential policy block, and financial stability block.

3.2.1 Credit cycle block

The credit cycle block supposes that business cycle factors and financial shocks are the principal driving forces of the credit cycle. In other words, the business cycle position and the lending rate (the credit price) are the key factors. The model also includes a retroaction channel from the credit cycle to the economic cycle. Similar to a typical financial framework (see, for example, Bernanke et al., 1999), the model supposes that the credit gap block is linear. And the credit default risks of contractors are caught by the credit risk premium, which is given by the business cycle.

The main identities and behavioral equations start by transforming the outstanding credit into flow of credit by making the first difference of the stock of outstanding credit (CR). The flow of credit (NCR) is considered the new credit issued, and it is defined as follows:

$$NCR_t = CR_t - CR_{t-1} \tag{8}$$

Dividing the elements of equation (8) by the nominal GDP gives us both the flow of nominal credit to GDP (ncr) and the ratio of outstanding nominal credit to GDP (cr). Then, the ratio of credit flow to GDP is decomposed into gap and trend components, as translated by equation (9):

$$ncr_t = \widehat{ncr}_t + \overline{ncr}_t \tag{9}$$

where $\widehat{ncr}_t$ is the gap part, reflecting the cyclical credit dynamics, and $\overline{ncr}$ corresponds to the trend growth, catching the structural part of credit.

The credit gap (cyclical demand for credit to finance production) is determined by the business cycle and the cost of lending. Current and future cash flow, concerning credit to finance production, support the contracted loans. The output gap approximates the revenue dynamics and the demand for credit (increasing with the expansion of the economy, production, and revenue). The credit cost is reflected by the gap component of the real lending rate – a higher (respectively lower) real interest rate gap reduces (respectively increases) the demand for credit. Therefore, the credit gap is as follows:

$$\widehat{ncr}_t = \rho^{\widehat{ncr}}\widehat{ncr}_{t-1} + \alpha_1\hat{y}_t - \alpha_2\hat{r}_t^L + \varepsilon_t^{\widehat{ncr}} \tag{10}$$

where $\hat{y}_t$ represents the output gap, $\hat{r}_t^L$ is the real lending rate, and $\varepsilon_t^{\widehat{ncr}}$ is the credit demand shock, which drives credit expansion beyond business cycle considerations.

The trend of credit flow to GDP is defined by the long-term country fundamentals. And the rate of change in the trend variable is assumed following a simple AR[65] process for simplification:

$$\Delta\overline{ncr}_t = \rho^{\Delta\overline{ncr}}\Delta\overline{ncr}_{t-1} + (1-\rho^{\overline{ncr}})\Delta\overline{ncr}^{ss} + \varepsilon_t^{\Delta\overline{ncr}} \tag{11}$$

where $\Delta\overline{ncr}$ is the rate of change in the credit flow to GDP trend, $\Delta\overline{ncr}^{ss}$ represents the steady-state rate of growth, and $\varepsilon_t^{\Delta\overline{ncr}}$ is the shock to the equilibrium rate of growth. $\Delta\overline{ncr}^{ss}$ is defined as zero – reflecting that credit increases at the same GDP growth rate in steady state – since the share of outstanding credit to GDP cannot grow indefinitely.

The credit trend in level terms is:

$$\overline{ncr}_t = \overline{ncr}_{t-1} + \frac{\Delta\overline{ncr}_t}{4} + \varepsilon_t^{\overline{ncr}} \tag{12}$$

$\varepsilon_t^{\overline{ncr}}$ represents a shock shifting the level of the trend directly, and $\varepsilon_t^{\Delta\overline{ncr}}$in equation (11) is a shock to the trend growth with persistent effects on growth.[66]

The model links the lending rate and the policy interest rate via the unobserved 1-year benchmark rate,[67] which is consistent with current and expected policy rates. This 1-year benchmark rate is

[65] Similarly, like all long-term trends in the QPM (see Mæhle et al., 2021).
[66] Both types of shock are introduced to smooth the estimate of the credit gap.
[67] The choice of the 1-year maturity for the benchmark rate is arbitrary, given that data on the exact average maturity of loans is not available. This assumption can be subject to further scrutiny and reconsidered if found to be inconsistent with an observed 1-year rate or with the average maturity of loans.

based on the term structure on the forward policy rates over the current and subsequent 3 quarters.[68] It is defined as follows:

$$rs_t^{1y} = \rho^{rs1y} rs_{t-1}^{1y} + \frac{\left(1-\rho^{rs1y}\right)[rs_t + rs_{t+1} + \cdots + rs_{t+3}]}{4} + prem^{TERM} + \varepsilon_t^{rs1y} \quad (13)$$

where rs_t^{1y} is the 1-year benchmark rate, $(rs_t + \cdots + rs_{t+3})$ represents the term-structure of the forward policy rates from the current and following 3 quarters. $prem^{TERM}$ refers to the term premium,[69] and ε_t^{rs1y} is the shock to the benchmark rate, which makes it deviate from the 1-year rate implied by the structure of the forward policy rates. ρ^{rs1y} represents the persistence parameter controls (the passthrough of the policy rate to the 1-year benchmark rate).

The observed lending rate is equal to the 1-year benchmark rate adjusted for credit risk and regulatory requirements. Its expression is as follows:

$$rs_t^L = rs_t^{1Y} + prem_t^C + sp_t \quad (14)$$

rs_t^L is the lending rate, and sp_t is the spread that reflects regulatory requirements imposed on banks;[70] $prem_t^C$ represents the credit premium. It is required to account for the probability of borrower default. Credit premium dynamics expand the business cycle.[71] Also, the model includes the VIX, which measures the fluctuations in risk appetite in the global business cycle (see, for example, Rey, 2013)[72] and submits the credit premium. Thus, the credit premium is:

$$prem_t^C = \rho^{premC} prem_{t-1}^C - \alpha_3 E_t \hat{y}_{t+1} + \alpha_4 vix_t + \varepsilon_t^{premC} \quad (15)$$

where ε_t^{premC} represents the shock to the credit premium. This equation supposes that the credit premium is zero in its steady state.[73]

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[68] This is a no-arbitrage condition, between investing at the 1-year benchmark rate over the 1-year future period, and rolling the investment over at quarterly frequency (i.e., four times in the same 1-year period) with the yields from the sequence of the policy rates.

[69] The term premium, assumed to be constant, is the margin that banks require for maturity transformation to compensate for the additional uncertainty and illiquidity associated with longer maturities. The term premium can potentially be changed to be a time-varying process. This would, however, complicate the model in linking the time-varying term premium with the business cycle. The challenge lies in distinguishing the unobserved term premium from the unobserved credit premium.

[70] The spread is the margin that banks can impose to meet regulatory capital requirements. In the model, capital accumulation can only be done by retaining profits, with a positive margin.

[71] Since the model assumes that the default rate varies inversely with the future business cycle (approximated by the expected output gap) – low during high economic activity and high in economic downturn. The link to expected output gap shrinks the credit premium during booms (further stimulating credit growth) and increases it during busts.

[72] See also, for example, Miranda-Agrippino and Rey (2020) for a larger discussion.

[73] The premia's handling here is restricted by the availability of data. In general, the term premium in equation (13) would change over time, and the credit premium in equation (15) must not be zero in a steady state. Nevertheless, in order to include these properties in the model, the 1-year benchmark interest rate must be observed. Unfortunately, data are not available, so they are treated as unobserved. Thus, the capacity to identify term and credit premia is limited. Therefore, the constant term premium in equation (13) may also incorporate the constant non-zero level of the steady-

The real lending rate at time t (r_t^L), is calculated based on the Fisher equation, as follows:

$$r_t^L = rs_t^L - E_t\pi_{t+1} \tag{16}$$

Then, it is decomposed into gap ($\hat{r}_t^L$) and trend ($\bar{r}_t^L$) parts:

$$r_t^L = \hat{r}_t^L + \bar{r}_t^L \tag{17}$$

The equilibrium real lending rate, which is the natural real rate ($\bar{r}$), adjusted by the term premium, is as follows:

$$\bar{r}_t^L = \bar{r} + prem^{TERM} \tag{18}$$

To assess the effects of the credit cycle on the business cycle and the impact of the credit cycle shock on output, two main modifications must be made in the aggregate demand equation.

First, the real lending rate must be incorporated in the monetary condition index. Thus, equation (2) above becomes:

$$mci_t = b_4(b_5\hat{r}_t + (1 - b_5)\hat{r}_t^L) + (1 - b_4)(-\hat{z}_t) \tag{19}$$

Second, the credit demand shock is included in the output gap equation (equation (1)):

$$\hat{y}_t = b_1\hat{y}_{t-1} - b_2 mci_t + b_3\hat{y}_t^* + b_6\varepsilon_{t-1}^{\widehat{ncr}} + \varepsilon_t^{\hat{y}} \tag{20}$$

where $\varepsilon_{t-1}^{\widehat{ncr}}$ is the lag of credit gap shock from equation (10).[74] The lag of shock allows us to explain the dynamics of the observed data and to facilitate unobserved shocks and gap identification.

3.2.2 Macroprudential policy block

This block depends on the credit block and consists of a bank and a representative macroprudential authority. This macroprudential block is inspired by Bennani et al. (2017a; 2017b) and highlights the link between regulatory capital (based on risk), the leverage ratio, and the countercyclical buffer. The interaction between the risk-based solvency ratio and the leverage ratio leads banks to adopt complex incentives. The banking sector accumulates capital by extending credit to the economy. The model focuses on credit for production on the asset side of the balance sheet, and capital is presented on the liability side.[75] The total asset-to-GDP ratio equation is:

state credit premium, and some of the time variation in our estimate of the credit premium could be due to variation in the term premium (see Karam et al., 2021).

[74] Here, the focus is on the shock to the credit gap, rather than the credit gap itself, to capture the impact of credit developments on output.

[75] Other assets (e.g., holding government bonds, reserves) and liabilities (e.g., deposits) are not modeled explicitly to keep the model tractable.

$$ta_t = ncr_t + ta^{wedge} + \varepsilon_t^{ta} \quad (21)$$

where ta_t represents the total asset-to-GDP at t, ta_t^{wedge} refers to the constant term used to calibrate the credit-to-GDP ratio to match total asset-to-GDP, and ε_t^{ta} is the shock to the asset side of bank balance sheets.

The amount of required capital (Tier 1) under the leverage ratio depends on an exposure measure (em_t), which covers total assets (unweighted) and certain off-balance sheet items. It is assumed that the leverage ratio is set at a minimum of 3%, in accordance with the decision of Governors and Heads of Supervision, GHOS (a group from the Bank for International Settlements), of January 2016. The amount of required capital (bc_t) under the leverage ratio is therefore represented by the following equation:

$$bc_t = 3\% \times em_t + \varepsilon_t^{bc} \quad (22)$$

where bc_t is required capital at time t, em_t represents exposure measure, and ε_t^{bc} is the shock to capital.

The requirements in terms of the Tier 1 solvency ratio (sr_t) depend on risk-weighted assets (rwa_t) and are given by:

$$sr_t = 8.5\% \times rwa_t + \varepsilon_t^{sr} \quad (23)$$

where sr_t denotes the solvency ratio at time t, rwa_t represents risk-weighted assets, and ε_t^{sr} is the shock-to-solvency ratio.

The required capital and the leverage ratio require the same amount of capital when $8.5\% \times rwa_t = 3\% \times em_t$, from which it follows that:

$$rwa_t = 35\% \times em_t + \varepsilon_t^{rwa} \quad (24)$$

where ε_t^{rwa} is the shock to risk-weighted assets at time t.

To simplify the model, we suppose that the exposure measure in equations (22) and (24) is equivalent to the total asset-to-GDP ratio ($em_t \approx ta_t$).

The banks are confronted with macroprudential regulatory requirements set through the ratio of capital to total assets. The ratio is considered to be a leverage ratio.[76] The leverage ratio target[77] is set countercyclically, with the aim of moderating the credit cycle, following this simple rule:

$$bc_t^{TAR} = \rho^{bc^{TAR}} bc_{t-1}^{TAR} + \left(1 - \rho^{bc^{TAR}}\right)\left(bc_{SS}^{TAR} + \phi \widehat{ncr}_t\right) + \varepsilon_t^{bc^{TAR}} \quad (25)$$

where bc_t^{TAR} is the leverage ratio target, bc_{SS}^{TAR} denotes the steady-state level of the leverage ratio, $\rho^{bc^{TAR}}$ represents the degree of persistence in setting the instrument, $\widehat{ncr}_t$ corresponds to the credit gap for newly issued loans, and $\varepsilon_t^{bc^{TAR}}$ is the shock to the target level. The extent of policy countercyclicality is indicated by the parameter ϕ.

The return on assets (roa) is determined by the following equation:

$$roa_t = \frac{rs_t^L - rs_t}{4} + cost^{adj} + \varepsilon_t^{roa} \quad (26)$$

where $cost^{adj}$ represents a constant to shift the return on assets to match data. The lending rate can be a proxy for the return on assets, and the policy rate can be viewed as a cost on the liability side that covers bank deposits or central bank loans to banks.

With these equations, we include the countercyclical capital buffer (CCyB), which constitutes a cyclical capital requirement. The CCyB is a supervisory tool used by financial authorities to strengthen banks' resilience during periods of economic expansion and to mitigate the risks associated with financial cycles. The main objective of the CCyB is to incentivize banks to raise additional capital in times of excessive economic growth. Calibration of the CCyB allows us to analyze the structural dynamic interaction between the banking sector and the real economy. Specifically, the Basel-III-type capital buffer rule (see Bennani et al., 2017b) equation is as follows:

$$v_t = \rho^v v_{t-1} + (1 - \rho^v) bc_{SS}^{TAR} + \phi^v (ncr_t - \Delta\overline{ncr}^{ss}) + \epsilon_t^v \quad (27)$$

where ρ^v measures the persistence of CCyB, bc_{SS}^{TAR} denotes the steady-state level of required capital (the leverage ratio), ϕ^vrepresents the systematic reaction coefficient to developments in the

[76] The ratio does not use risk-weighted assets. The leverage ratio is a natural choice following the Basel III and Basel IV regulations and the CCyB recommendations. The definition of the leverage ratio, compatible with the Basel III and Basel IV rules, namely, "capital to risk-weighted assets," is used but without risk weights, because the data on risk weights for universal and commercial bank assets are not available. This is not to be confused with an inverse definition in financial economics, with capital in the denominator (for example, assets/capital or debt/capital) (see Basel III and IV).

[77] The target ratio is not new: it is driven by the Basel regulatory reforms concerning capital adequacy requirements – Basel IV introduced a leverage ratio requirement (defined as the lower limit) that is expected to come into practice with the implementation of Basel IV.

credit-to-GDP (ncr_t) deviations from the steady-state level ($\Delta\overline{ncr}^{ss}$), and ϵ_t^v denotes discretionary unanticipated deviation from the rule.

3.2.3 Financial stability block

This block is motivated by the financial system's stylized facts. Indeed, financial shocks may have a significant effect on macroeconomic developments, as shown in much of the empirical literature (Svensson, 2012; Claessens et al., 2012; Furlanetto et al., 2019). Since the model is a gap model, financial stability (fs) is decomposed into gap ($\widehat{fs}_t$) and trend ($\overline{fs}_t$):

$$fs_t = \widehat{fs}_t + \overline{fs}_t \tag{28}$$

Thus, the financial stability gap equation that captures the evolution of financial stability is defined following Tan and Wang (2015), Ma et al. (2017), and Sui et al. (2022). The equation is described as follows:

$$\widehat{fs}_t = \varphi_1 \widehat{fs}_{t-1} + \varphi_2 \hat{y}_t + \varphi_3 i_t - \phi \widehat{ncr}_t + \varepsilon_t^{\widehat{fs}} \tag{29}$$

where φ_1 captures the persistence of financial stability, φ_2 measures the effect of the output on financial stability, φ_3 captures the monetary policy (nominal interest rate) impact on financial stability, ϕ corresponds to the parameter in equation (23) above and denotes the countercyclical regulation of macroprudential policy on financial stability, and ε_t^{fs} is the financial stability shock.

As shown by Sui et al. (2022), financial stability has feedback on aggregate demand and the interest rate (monetary policy). To assess this feedback, both aggregate demand and monetary policy rule equations must be modified by including the financial stability variable.

Thus, the aggregate demand equation (equation (20)) becomes:

$$\hat{y}_t = b_1 \hat{y}_{t-1} - b_2 mci_t + b_3 \hat{y}_t^* + b_6 \varepsilon_{t-1}^{\widehat{ncr}} + b_7 \widehat{fs}_t + \varepsilon_t^{\hat{y}} \tag{30}$$

where the parameter b_7 measures the effect of financial stability on the output gap.

And the novel monetary policy rule equation (equation (6)) is:

$$i_t = g_1 i_{t-1} + (1 - g_1)\{i_t^n + g_2(E_t[\pi_{t+N}^4] - \pi_{t+N}^T) + g_3 \hat{y}_t + g_4 \widehat{fs}_t\} + \varepsilon_t \tag{31}$$

The trend equation is defined as:

$$\overline{fs}_t = \rho^{\overline{fs}} \overline{fs}_{t-1} + (1 - \rho^{fs}) \overline{fs}_{ss} + \varepsilon_t^{\overline{fs}} \tag{32}$$

where $\overline{fs}_{ss}$ denotes the steady state as the characterization of equilibrium of financial stability, and $\varepsilon_t^{\overline{fs}}$ is the financial trend shock.

4. Data, model calibration, and estimation processes

The coefficient of the structural equation of the model defines the model's properties. There are different ways to set these parameters: they can be set by calibration, estimated using Bayesian methods, or using both calibration and estimating. Before presenting the parametrization method used in this chapter, we present the data used for our study.

4.1. Data sources and preliminary analysis

We considered a sample of 11 countries in the euro area: Austria (AUS), Belgium (BEL), Finland (FIN), France (FRA), Germany (GER), Greece (GRE), Ireland (IRE), Italy (ITA), the Netherlands (NET), Spain (SPA), and Portugal (POR), in addition to data on the euro area (EUR) as a whole. First, we solicited the database of the Federal Reserve Bank of Saint Louis for monthly and quarterly data on the real gross domestic product (GDP), consumer price index (CPI), and nominal exchange rate of the euro to the US dollar (EUR/USD).

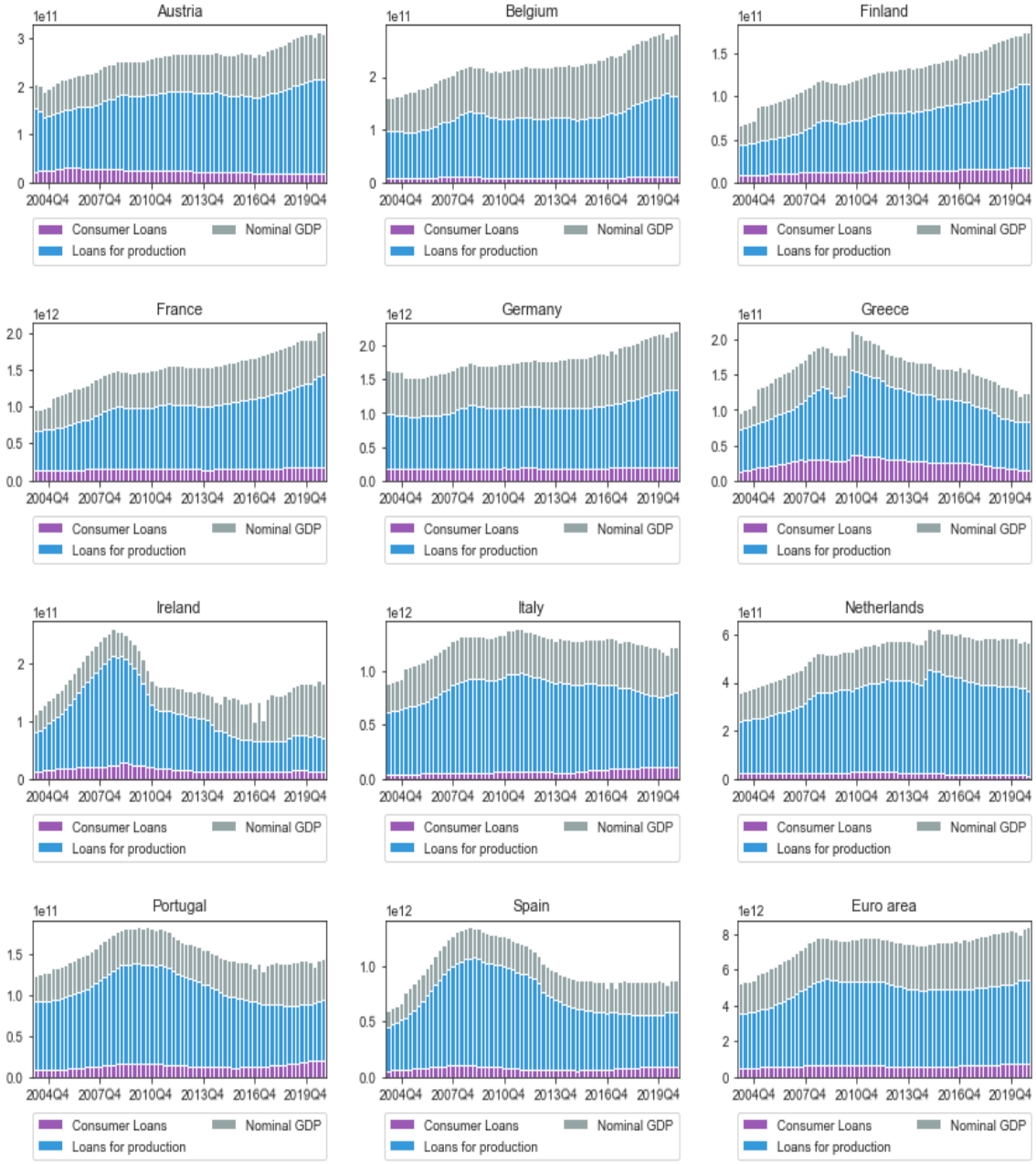
To these variables are added the foreign – considered US – variables (GDP, CPI, Fed fund rate, and the volatility index VIX). The monthly variables are then converted to quarterly ones for the purposes of the study. The second database is that of the Bank for International Settlements (BIS), where the policy rate of the euro area takes its source. The third database is the IMF (International Monetary Fund) database, where we download the return on assets (ROA), bank capital, total asset data, and nominal GDP. The last database that we consult is the euro area and national central bank statistics database[78] for data on the Euro area national commercial bank assets and the stock of outstanding credit for production.

Preliminary analysis

A focus on the share of outstanding bank credit to GDP in euro national countries shows that, while the credit to finance production varies in terms of evolution from one country to another over the period, it has a majority share compared with a smaller share of consumer credit (Figure 2).

[78] https://www.euro-area-statistics.org/?lg=en.

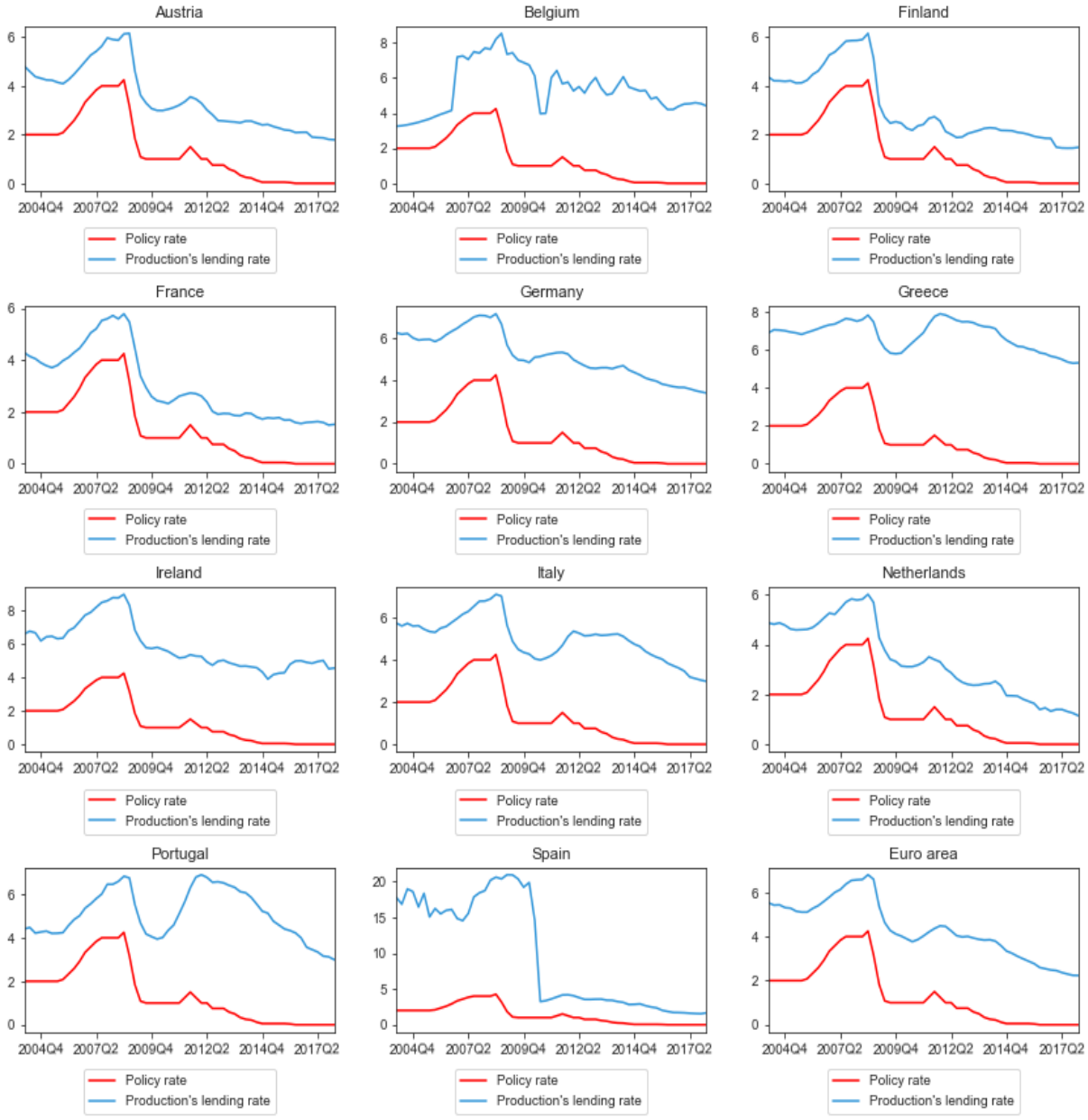
Figure 2: Outstanding loans and nominal GDP



Source: Author' computation.

On the other side, the dynamic of lending rate for loans to finance production is the same as the policy rate in Euro area countries. We can see a positive spread between the lending and policy rates over the period (Figure 3), which suggests that the lending rate has relatively short maturity.

Figure 3: Interest rates (in percent)

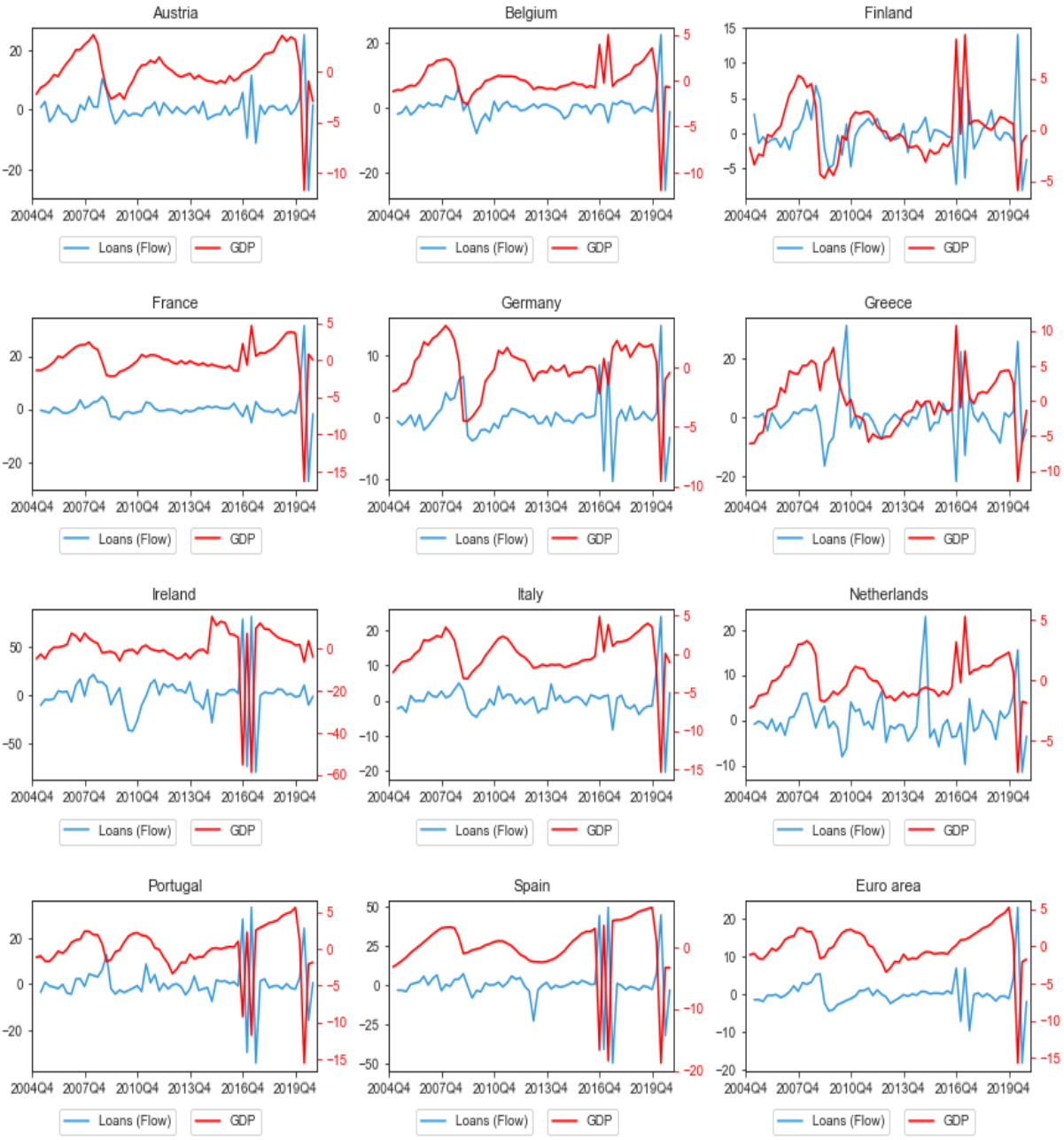


Source: Author' computation.

While many studies on the countercyclical capital buffer (CCyB) have used outstanding credit in stock to measure credit, in this study we use the flow of outstanding credit measured as the first difference of the stock. The reason for this is that the stock indicator can be misleading, since it divides a stock of outstanding credit by a flow variable of nominal GDP (Karam et al., 2021). Furthermore, there is a positive correlation between the flow of outstanding credit with the output gap (business cycle). The credit gap follows the output gap with a lag in euro aera countries over

the period studied, with the exception of Greece in 2015–20, the Netherlands in 2011–15, Italy in 2014–17, and the euro area in 2015–19 as a whole (see Figure 4).

Figure 4: **Gap in the flow of credit for production[a] and output gap[b]**



Source: Author' computation.
Notes: [a] percent of GDP, [b] in percent. Gaps are computed using HP filter.

Our analyses include regulatory requirements in the sense of concerning the leverage ratio. The capital requirements relate to banks' exposure to credit risk, and they strive to maintain good-quality credit oriented toward productive use to support the economy. Thus, we use the leverage ratio to represent the regulatory requirement to moderate credit creation. In our sample of

eurozone countries, except Finland, Spain, and the euro area as a whole, where the leverage ratio seems to be stable, around 5%, 6%, and 4.8%, respectively, it has increased steadily since 2007 for the other countries (see Figure 5).

Figure 5: **Leverage ratio (defined as bank capital-to-total assets ratio)**

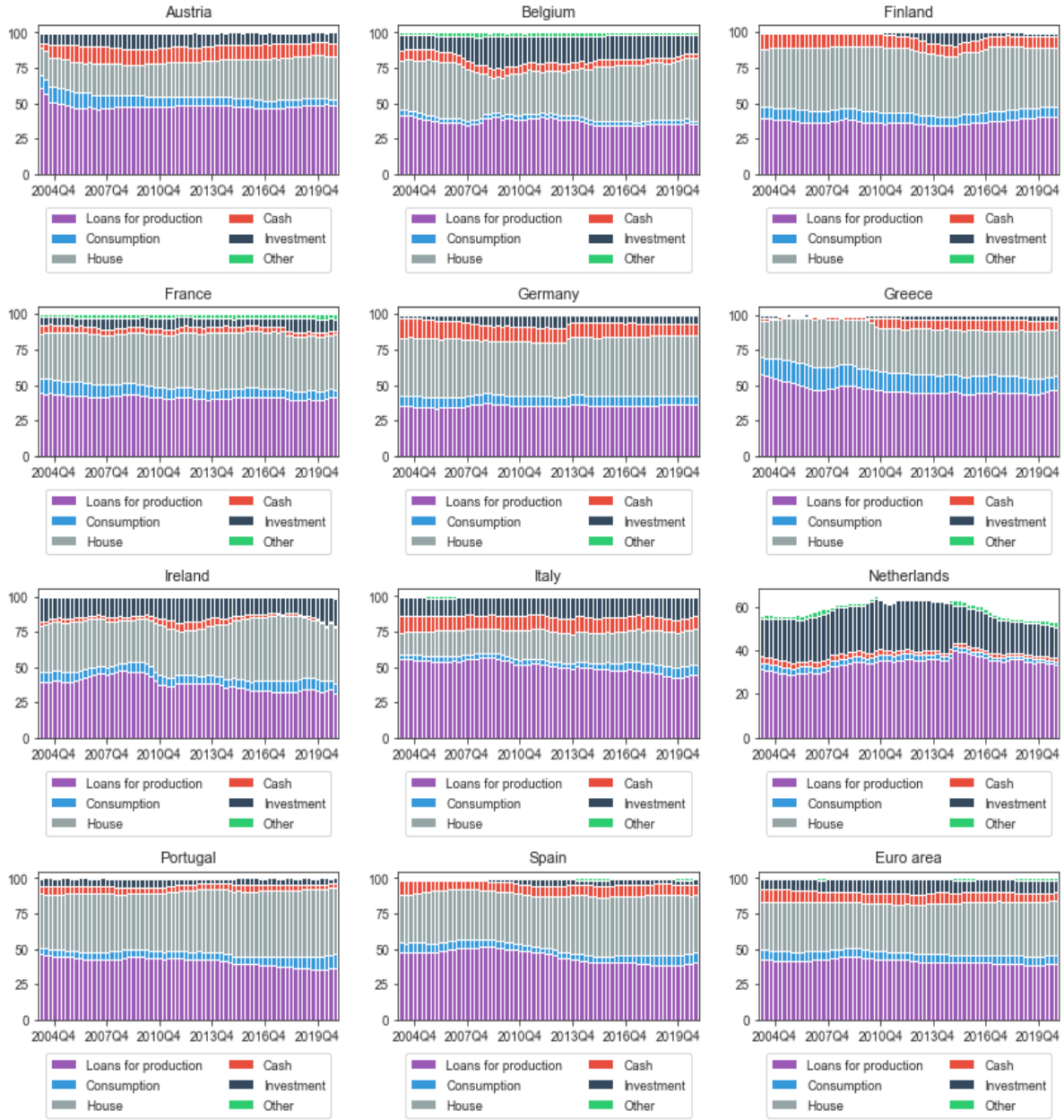


Source: Author' computation.

The regulatory requirements (leverage ratio) are defined here as bank capital-to-total assets. The decomposition of bank assets shows that its main component is credit to finance production, followed by house credit, for all countries in our sample except the Netherlands, where the data on house credit are missing (Figure 6). The credit to finance production for the Netherlands is

followed by investment credit. However, it is important to note that this part of the Netherlands bank asset has seen a slight decline since 2016. For Belgium, France, Ireland, Italy, and the euro area as a whole, the share of investment credit comes third, while for Austria, Finland, Germany, and Spain, it is the share of credit for cash that comes third. And, for Greece and Portugal, the share of consumer loans follows that of house credit. However, while this share of bank assets has gradually declined at the margin in Greece, in recent years it has risen slightly in Portugal.

Figure 6: Bank assets



Source: Author' computation.

4.2. Model calibration and estimation processes

The parametrization of the QPM model is a crucial exercise since it determines the model properties. Generally, studies using the QPM model typically prioritize calibration over estimation when determining their parameters. This approach has several advantages. First, the calibration process facilitates a deeper comprehension of the model's properties. Second, since no model can completely capture all of the essential characteristics of the data, attempting to estimate such aspects may lead to fitting the data in ways that the model was not intended to accommodate. For instance, it might try to "explain" a significant price surge caused by a weather-related shock (Mæhle et al., 2021). Furthermore, the availability of a sufficiently long data series for robust parameter estimation is limited, particularly in emerging market economies. Even when longer data series are accessible, economic and structural changes over time diminish the relevance of older data. This is particularly true for monetary policy regimes, which frequently undergo alterations, making older data less applicable or meaningful for estimation purposes.

However, in this study, instead of calibrating the model parameters, we combine the Bayesian estimation and calibration to set the parameter values, for two main reasons. First, this methodology aims to ensure that the model exhibits sensible properties that align with prior knowledge of the euro area economy and historical data. This enhances the interpretation of forecasts and policy implications derived from the model. Second, given our country sample, this methodology allows us to have different model properties from one country to another. This approach, combining calibration and Bayesian estimation, lies between fully micro-founded estimated DSGE models and pure time series models (Jakab et al., 2015).

Parameters are divided into two groups. The first group consists of calibrated parameters, which determine the steady state of the model and those in non-structural equations. The calibration of steady-state parameters is based on either target variable levels or historical data averages. We establish the parameters in non-structural equations, primarily those related to trends, in a manner that facilitates a gradual and smooth adjustment of model variables toward their steady states. Rather than estimating these parameters, we choose to calibrate them, since they govern the dynamics of unobserved variables. Similarly, in order to ensure reasonable dynamics of gaps and trends observed when applying the calibrated model to filter historical data, the standard deviations of shocks are typically calibrated unless specified as estimated. This careful calibration process aims to achieve a realistic representation of the dynamics, allowing for a proper analysis of the gaps and trends within the data. The values of this group of parameters are documented in Table B.1 in Appendix B.

The second set of parameters is estimated using both the model and the available data. This group includes parameters found in the structural equations within the new blocks or in the extended business cycle section of the model. Estimating these parameters poses a significant challenge because of the complexity of the system. We use the Andrle (2018) system prior method to estimate the group's parameters, including the elasticities in aggregate demand equation (b_1, b_2, b_3, b_4, b_5, b_6, and b_7), exchange rate equation (e_1), Phillips Curve equation (a_1, a_2, and a_3), credit cycle and lending rate equation ($\rho^{\widehat{ncr}}$, α_1, α_2, α_3, α_4, ρ^{rs1y}, and ρ^{premC}), financial stability equation (φ_1, φ_2, φ_3, and $\rho^{\overline{fs}}$), and countercyclical capital buffer equation ($\rho^{v}$and ϕ^{v}). The estimated parameter values of this group are shown in Table 1 (below). To ensure sensible dynamic properties of the model, the remainder of the parameters in the second group are meticulously calibrated.

For example, parameters in monetary policy equation (g_1, g_2, g_3, and g_4) are set identically for all countries, after being obtained through Bayesian estimation using euro area data. Finally, the setting rules for leverage targets are calibrated. Calibration of the steady-state level of leverage is done ad hoc, but since euro area banks typically have a buffer above regulatory requirements to avoid penalties and stigma, we set targets based on historical observations of leverage ratio. Therefore, the parameter bc_{SS}^{TAR} in the target leverage ratio equation is calibrated to be lower than the average leverage of historical data, while the target persistence ($\rho^{bc^{TAR}}$) and credit gap responsiveness are chosen for consistency with the observed data.

Table 1: Estimated country-level model parameters

	Parametrization method			AUS	BEL	FIN	FRA	GER	GRE	IRE	ITA	NET	POR	SPA	EUR
Parameters		Distr.	Prior	Posterior mode											
Real GDP															
b_1	B.E.	Beta	7.000	0.387	0.370	0.374	0.323	0.401	0.376	0.106	0.377	0.977	0.296	0.225	0.409
b_2	B.E.	Normal	0.500	0.216	0.219	0.224	0.242	0.198	0.471	0.395	0.210	0.520	0.256	0.423	0.189
b_3	B.E.	Normal	0.500	0.506	0.510	0.499	0.512	0.508	0.501	0.501	0.508	0.497	0.513	0.514	0.506
b_4	B.E.	Normal	0.400	0.343	0.344	0.340	0.335	0.352	0.161	0.250	0.347	0.368	0.328	0.216	0.356
b_5	B.E.	Normal	0.500	0.544	0.544	0.545	0.545	0.542	0.545	0.528	0.543	0.533	0.544	0.530	0.541
b_6	B.E.	Normal	0.250	0.163	0.162	0.180	0.129	0.175	0.148	-0.123	0.171	0.145	0.079	0.040	0.182
b_7	B.E.	Normal	0.600	0.319	0.326	0.323	0.318	0.320	0.326	0.551	0.329	0.011	0.359	0.388	0.317
Inflation															
a_1	B.E.	Beta	0.600	0.829	0.825	0.827	0.825	0.832	0.679	0.315	0.836	0.858	0.819	0.311	0.841
a_2	B.E.	Normal	0.200	0.572	0.558	0.576	0.563	0.546	0.672	0.487	0.556	0.434	0.562	0.620	0.549
a_3	B.E.	Beta	0.700	0.516	0.511	0.521	0.498	0.517	0.678	0.439	0.513	0.562	0.480	0.479	0.524
Exchange rate															
e_1	B.E.	Beta	0.450	0.410	0.412	0.412	0.414	0.409	0.467	0.556	0.408	0.399	0.416	0.541	0.405

Table 1 (continue): Estimated country-level model parameters

	Parametrization method			AUS	BEL	FIN	FRA	GER	GRE	IRE	ITA	NET	POR	SPA	EUR
Parameters		Distr.	Prior	Posterior mode											
Credit Cycle[a]															
$\rho^{\widehat{ncr}}$	B.E.	Normal	0.500	0.369	0.438	0.511	0.401	0.464	0.451	-0.423	0.488	0.443	-0.030	-0.365	0.498
α_1	B.E.	Normal	0.500	0.417	0.404	0.436	0.373	0.427	0.425	-0.279	0.427	0.432	0.234	0.112	0.439
α_2	B.E.	Normal	0.400	0.351	0.340	0.360	0.455	0.341	0.569	0.552	0.375	0.335	0.466	0.741	0.325
α_3	B.E.	Normal	0.200	0.155	0.156	0.159	0.159	0.157	0.184	0.162	0.159	0.128	0.158	0.161	0.158
α_4	B.E.	Normal	0.021	0.019	0.018	0.017	0.019	0.017	0.020	0.019	0.019	0.017	0.019	0.024	0.019
ρ^{prem^C}	B.E.	Normal	0.800	0.757	0.743	0.759	0.765	0.746	0.742	0.742	0.744	0.784	0.745	0.773	0.746
$\rho^{rs^{1y}}$	B.E.	Normal	0.600	0.572	0.576	0.577	0.573	0.573	0.604	0.593	0.583	0.580	0.579	0.616	0.584
Financial stab.[b]															
φ_1	B.E.	Beta	0.300	0.247	0.238	0.244	0.274	0.243	0.248	0.267	0.240	0.308	0.254	0.271	0.242
φ_2	B.E.	Beta	0.400	0.195	0.191	0.194	0.203	0.194	0.209	0.139	0.192	0.335	0.175	0.173	0.197
φ_3	B.E.	Beta	0.200	0.003	0.003	0.003	0.003	0.003	0.004	0.003	0.003	0.217	0.003	0.003	0.003
ϕ	B.E.	Normal	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
$\rho^{\overline{fs}}$	B.E.	Normal	0.35	0.337	0.333	0.345	0.345	0.339	0.328	0.293	0.340	0.349	0.318	0.317	0.341

Notes: Distr. is Distribution. B.E. is Bayesian estimation. [a] Credit cycle and Lending rate bloc. [b] Financial stability bloc.
See text for country codes. See Appendix A for description of the parameters.

5. Model evaluation, policy analysis and forecasting, and interpretation

Before using our QPM for forecasting and policy analysis, it is important to verify that its behavior is consistent with our understanding and empirical evidence of economic relationships in our country. First, we must check the properties of the calibration model to ensure its validity and reliability. The process of reviewing model properties includes assessing the response of the modeled economy to common shocks. This includes looking at how GDP and inflation might respond following fiscal stimulus, or the magnitude of changes in QPM macroeconomic variables following a rise in banks' leverage ratio. Answering these questions based on a single model equation is challenging because they relate to the overall behavior of the model and account for complex interactions between variables. Impulse response functions (IRF) are invaluable graphical tools for summarizing the responses of the model.

5.1 Model evaluation: IRF analysis

We select seven shocks divided into two categories to analyze the model.[79] The first one is common business cycle shocks, which refer to demand, exchange rate, and monetary policy shocks. The second category is shocks originating from the financial system (credit demand, solvability ratio shock, countercyclical capital buffer, and financial stability shocks). The addition of new credit, macroprudential and financial stability blocks in the native QPM did not significantly alter the impulse response to business cycle shocks. For this reason, we will pay more attention to the second group in what follows. It is worth noting that our model begins from a steady state. In the first simulation, an unexpected shock with 1% in magnitude occurs, which is transient and lasts only 1 quarter. However, because of the rigidity and friction of the model, it takes time for the economy to fully adjust to the shock.

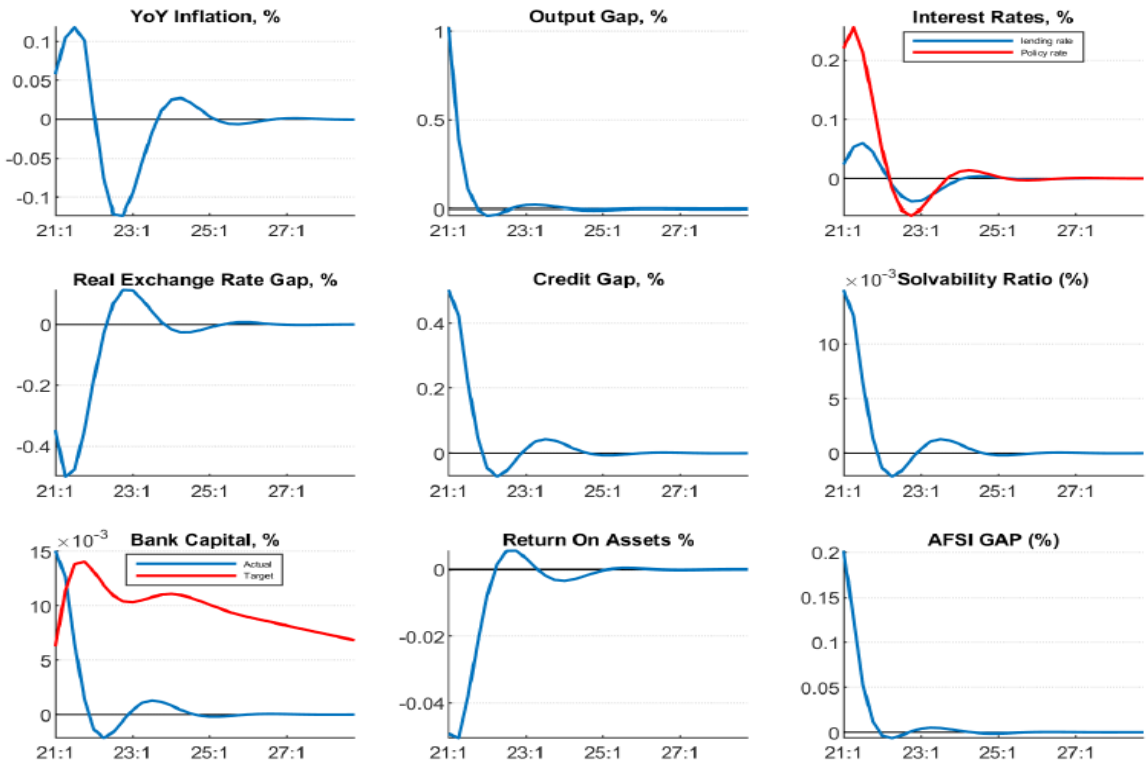
[79] To save space and for clarity, we only report in this chapter the results for seven shocks (aggregate demand, exchange rate, interest rate, credit demand, solvability ratio, countercyclical capital buffer and financial stability) from the QPM concerning the 11 eurozone countries and the euro area. We add supplementary online appendix and results for a comprehensive and complete overview of all model outcomes (i.e. all shocks) for all eurozone countries and the euro area (here).

5.1.1 Common business cycle shocks

Aggregate demand shock

Short-lived demand shocks, such as a one-off fiscal stimulus, directly impact output through the IS curve. As shown by the euro area as a whole, IRF (Figure 7), the output gap increases immediately and remains positive for several quarters because of the persistence impact of the current business cycle. The above-normal demand leads to higher input costs for domestic producers, mainly as a result of wage pressure from overtime and accelerated capital depreciation resulting from higher capacity utilization. These inflationary pressures are reflected in the Phillips curve through the real marginal cost term, which accounts for the output gap. As we can see in the figure, inflation goes up. On other hand, the higher demand increases consumer spending or investment, leading to a strong demand for credit. Since economic activity expands, business requires additional funds for expansion, while individuals may seek credit for purchasing goods and services. Thus, the credit demand (credit gap) increases after the shock and remains positive during several quarters. By supposing that banks are able to maintain sound lending practices and effectively manage credit risk, this increase of credit leads the quality of their loan portfolio to remain strong, supporting their solvability ratio (after the shock, the solvability ratio increases and remains positive as a credit gap).

Figure 7: Aggregate demand shock for euro area as all



Source: Author' computation.
Notes: (i) On the interest rates figure, the red line represents the response of the policy rate, while the blue line indicates the lending rate to the shock. (ii) On the bank capital figure, the red line represents the response of the bank capital target, while the blue line indicates the actual (bank capital) to the shock.

The central bank responds to an overheated economy characterized by strong output growth and rising inflation. In response to this situation, adjusting the monetary policy gradually increases the interest rate according to the policy response function. It is worth noting that in this case there is no compromise between the central bank's dual objectives. With both inflation and output high, the central bank sees a need to raise the policy rate. which leads commercial banks to raise their lending rate. This increase in interest rates has many consequences. First, it increases borrowing costs and dampens credit demand (as we see in the figure, the credit gap becomes negative before returning to its initial condition). Second, a higher interest rate leads to an increase in the cost of funding for banks and affects their net interest margin and, consequently, their return on assets. The banks' return on assets decreases after the shock and remains negative for several quarters before becoming positive. And, lastly, the higher interest rate on domestic assets leads to capital inflows from foreign investors seeking higher returns. This increase in capital inflows can result in an immediate appreciation of the nominal exchange rate. This phenomenon is consistent with the

uncovered interest rate parity (UIP) condition, which suggests that interest rate differentials between countries should be offset by changes in exchange rates.

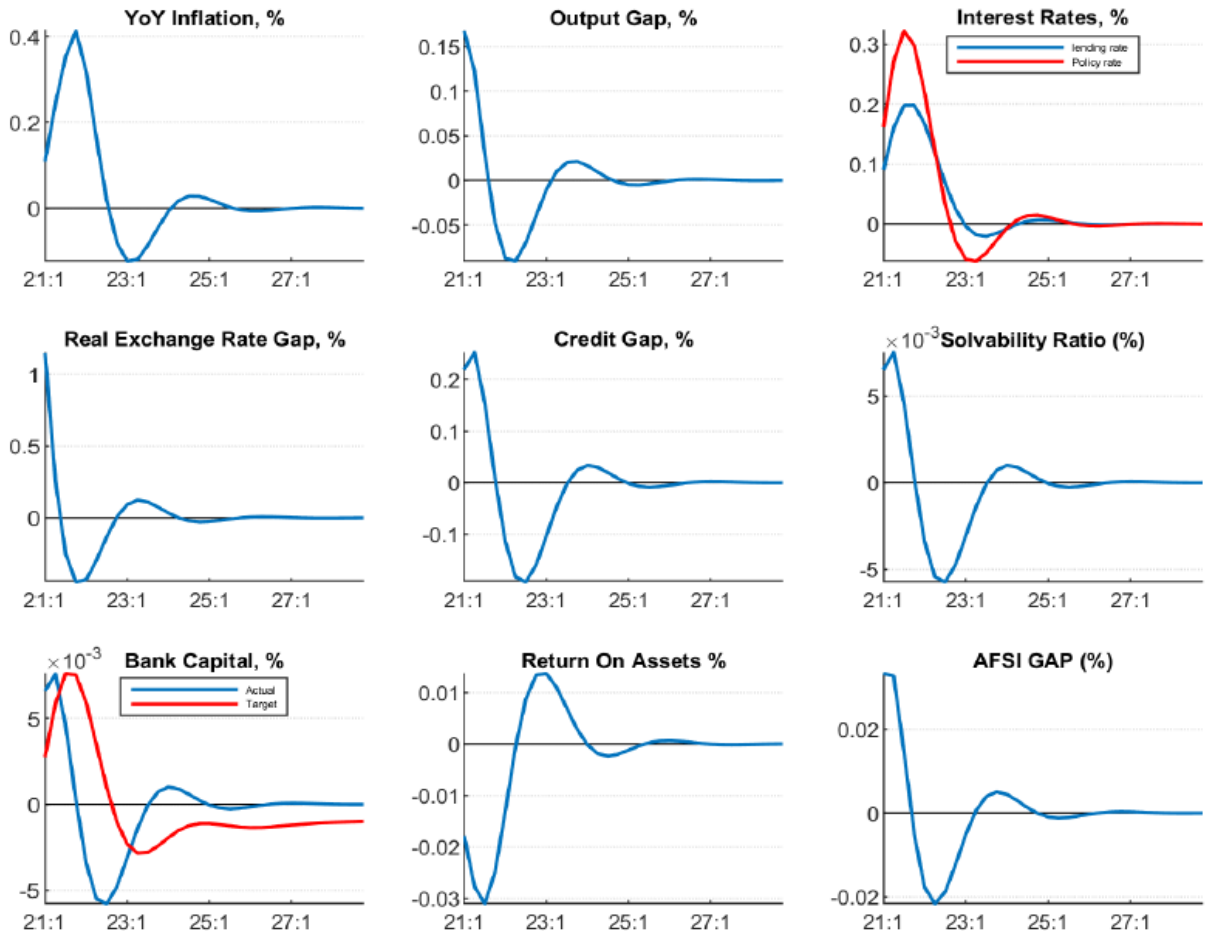
The monetary conditions unequivocally tighten as a result of specific factors. First, the policy interest rate experiences a greater increase compared to inflation, leading to a positive real interest rate gap. Additionally, the real exchange rate gap becomes negative because of nominal appreciation and elevated domestic inflation. Tight monetary conditions have a dampening effect on aggregate demand. The elevated real interest rate incentivizes saving rather than spending on consumption and investment. Moreover, the strengthened real exchange rate diminishes export competitiveness and promotes imports. These combined forces gradually cool down the economy and guide output back toward its long-term trend. The presence of a strong real exchange rate and the closing of the domestic output gap act as factors that restrain inflationary pressures in the economy. Once inflation reaches its target level and the positive output gap diminishes, the central bank responds by reducing the policy rate to its neutral level.

The result of the aggregate demand shock on these different variables of the Euro area as a whole is similar when we take each country individually, except Ireland, where credit demand decreases before increasing after the demand shock (see Figure C.1 in Appendix C). However, the extent and depth of the shock, and the speed with which these different variables return to the steady state, differ from country to country. The figure shows, on the one hand, that after the shock, while the output gap increases at 1% for other countries, it increases at 0.94% and 0.85% for Greece and the Netherlands, respectively. The output in converging returns to it steady state faster in Ireland than in other countries. On the other hand, the interest rate increases more in Germany (after the shock it reaches its peak at 4%), followed by Italy (3.5%), and France (3%). The bank's return on assets converges back to it steady state after the demand shock more quickly in France, Ireland, and Italy than in other countries.

Exchange rate shock

An exchange rate shock is a sudden and significant movement or volatility in the value of a country's currency relative to other currencies. Figure 8 (below) presents the response of variables of the Euro area as a whole to an exchange rate shock. The figure shows that the shock has a positive effect on year-on-year inflation, its effect on the output gap is positive, its impact on both policy rate and lending rate is positive, its effect on the credit gap is positive, its impact on bank capital is positive, its impact on the bank's return on assets is negative, and its effect on financial stability is positive.

Figure 8: Exchange rate shock for euro area as all



Source: Author' computation.
Notes: (i) On the interest rates figure, the red line represents the response of the policy rate, while the blue line indicates the lending rate to the shock. (ii) On the bank capital figure, the red line represents the response of the bank capital target, while the blue line indicates the actual (bank capital) to the shock.

The positive reaction of year-on-year inflation after the shock implies an increase in inflationary pressures. The domestic currency depreciation leads to higher import costs, which is passed on as higher consumer prices, leading to a rise in inflation. On the other hand, the output gap reacts positively to the exchange rate shock, which means an expansionary effect on the economy. A depreciation in the domestic currency makes export more competitive and boosts demand for domestic goods and services, leading to higher economic activity. Moreover, the positive effect on both policy and lending rates indicates a tighter monetary condition. The central bank, in response to the shock, raises its interest rate to control inflationary pressures and stabilize the currency, which, in turn, leads to an increase in bank lending rates, helping to mitigate the risks associated with the shock and promote stability in the financial sector.

Furthermore, the positive reaction of the credit gap to the shock suggests an increase in lending activity. A depreciation of domestic currency leads to a higher lending rate and makes borrowing more expensive, which can encourage banks to expand their lending activities to offset the higher cost of borrowing and support economic growth. In addition, the positive effect of the shock on the bank's capital indicates improved financial heath and resilience of banks. The domestic currency affects the value of banks' assets and liabilities denominated in foreign currencies. If the portion of banks' assets in foreign currency is significant or banks have hedging mechanisms in place, the depreciation can result in valuation gains and strengthen their capital positions. Finally, the negative reaction of banks' return on assets means a decrease in profitability. Exchange rate shocks can introduce volatility and uncertainties in financial markets, affecting banks' earnings and overall profitability. Factors such as increased currency hedging costs or higher loan default risks due to exchange rate fluctuations can contribute to a decrease in banks' return on assets.

We also observe these results when we take the Euro area countries of our sample separately (see Figure C.2 in Appendix C). The shock's magnitude, extent and depth, and the speed with which the different variables return to a steady state, differ from country to country. And this is because the effect of the exchange rate shock depends on various factors, such as specific circumstances, the resilience of the economy, the flexibility of exchange rate regimes, and the effectiveness of policy responses.

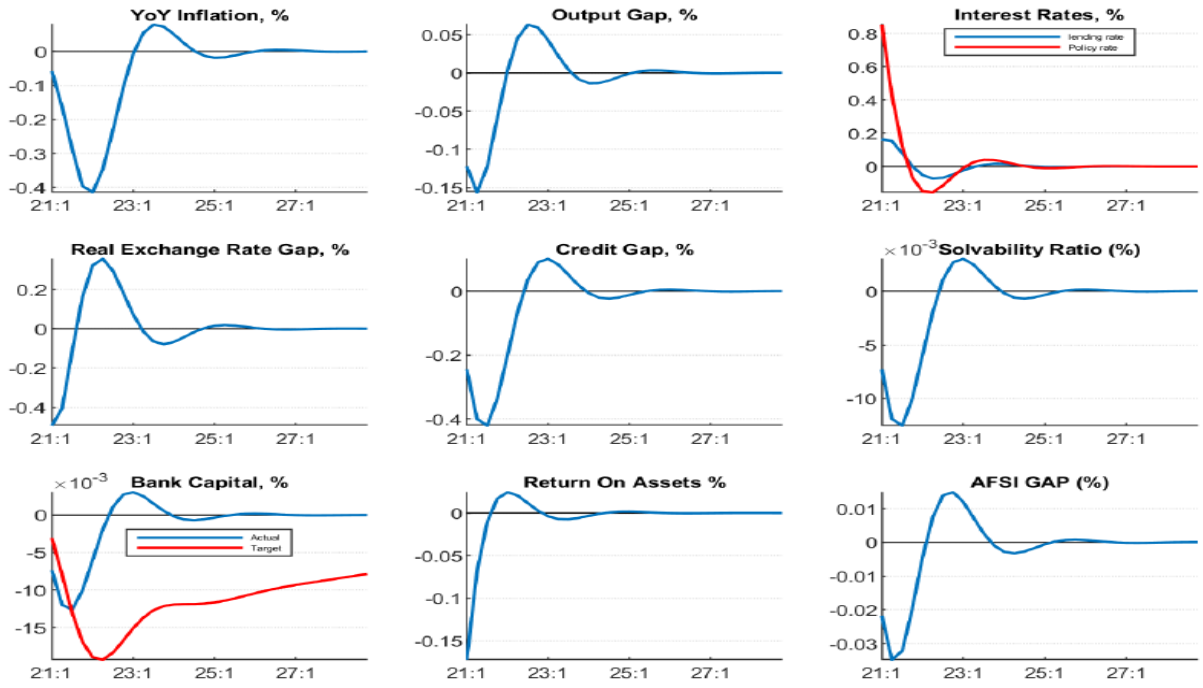
Interest rate shock

An interest rate shock can be defined as a sudden and significant change in interest rates, and it can have various impacts on different aspects of the economy. Figure 9 presents the response of the variables of the Euro area as a whole to a positive interest rate shock. We can see in the figure that the interest rate shock has a negative impact on all variables except policy and lending rate.

The negative effect indicates that a rise in the interest rate leads to a decrease in inflationary pressures in the economy, resulting in a lower interest rate. Also, the negative reaction of the output gap after the shock implies a contractionary effect on the economy. The increase in interest rate leads to reduced borrowing and investment, and subsequently lower production in the economy (lower output) and a negative output gap. Moreover, the negative effect of the credit gap indicates a decrease in credit growth or a contraction in lending activities. The higher interest rate discourages borrowing and investment, leading to reduced credit demand. This situation leads to a potential decline in the financial health and capital positions of banks (bank capital reacts negatively after the shock). As the interest rate is higher, the borrowing costs of banks increase, affecting their profitability and potentially weakening their capital adequacy. Furthermore, the shock's negative

effect on banks' return on assets evidences a decrease in profitability for banks. The higher borrowing costs resulting from the shock impact banks' net interest margins and overall profitability and affect their return on assets. As a result, the interest rate shock poses risks and challenges to the stability of the financial system (the aggregate financial stability reacts negatively to the shock).

Figure 9: Interest rate shock for euro area as all



Source: Author' computation.
Notes: (i) On the interest rates figure, the red line represents the response of the policy rate, while the blue line indicates the lending rate to the shock. (ii) On the bank capital figure, the red line represents the response of the bank capital target, while the blue line indicates the actual (bank capital) to the shock.

5.1.2 Shocks originating from the financial system

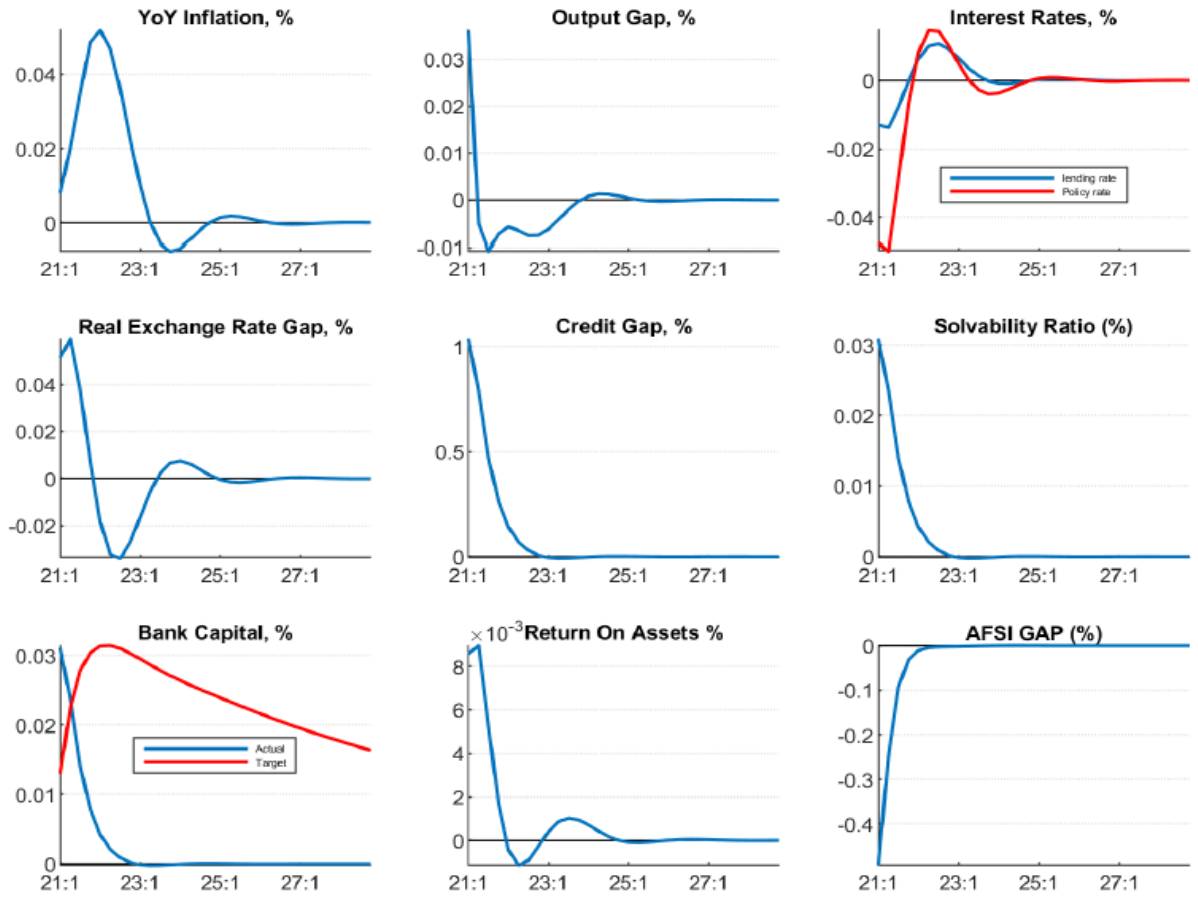
Credit demand shock

Assessed as a shock to the credit gap, a positive shock to credit demand captures growth in the credit demand above the trend given business cycle credit conditions and costs. Figure 10 (below) shows that the credit demand shock has a positive effect on both inflation (inflation stays positive for many quarters after the shock) and the output gap (the output gap is positive after the shock), while simultaneously it has a negative impact on interest rates (the policy and lending rate are negative after the shock before going up). This implies an interesting dynamic in the model, and such a scenario may indicate the following. (i) The positive impact on inflation suggests that increased demand for credit will put upward pressure on prices. This may be due to the increased

availability of credit driving higher spending and economic activity. The expansionary effect of credit demand on aggregate demand can be greater than the economy's capacity to produce goods and services, leading to inflationary pressures. (ii) The positive effect on the output gap suggests that credit demand shocks are stimulating growth and pushing output levels above their potential. This suggests that the increase in credit supply is effectively boosting investment, consumption, and overall economic activity. The positive output gap indicates that the economy is above its sustainable long-term trend during the first quarter after the shock. Or (iii) the negative impact on interest rates suggests that the central bank or monetary authority are responding to a credit demand shock by lowering interest rates. Lower interest rates help to stimulate borrowing and investment, which supports economic growth. Its purpose may be to encourage businesses and households to take advantage of credit and further stimulate economic activity. Lower interest rates can also act as a countermeasure to potentially mitigate inflationary pressure resulting from the positive shock to credit demand.

The figure also shows that excessive credit growth may threaten financial stability (the AFSI gap becomes negative after the shock before returning to its steady state). Faced with this situation, the macroprudential authority enhances the stability and resilience of banks by raising the required leverage ratio. This measure aims to moderate the growth of credit and ensure that banks maintain a healthy financial position. For their part, banks engage in capital accumulation efforts to meet the elevated leverage ratio requirement (bank capital increases after the shock). By increasing their capital levels, banks aim to maintain a strong financial position and ensure compliance with regulatory standards. These measures may include retaining earnings, reducing dividend payouts, raising additional capital through equity issuances, or reallocating resources to less risky assets. The accumulation of capital enhances the resilience and stability of banks, providing them with a buffer against potential losses and reinforcing the overall soundness of the banking system. We can also see that the increase in demand for credit leads to higher bank profitability, resulting in improved returns on their assets after the shock. Some quarters after the shock, given a specific level of bank capital, the leverage ratio falls below the desired target. This implies that there is insufficient capital available to support the desired level of leverage mandated by regulatory requirements. In this situation, banks may need to take appropriate measures to increase their capital base or adjust their leverage ratio to align with the target.

Figure 10: Credit demand shock for euro area as all



Source: Author' computation.
Notes: (i) On the interest rates figure, the red line represents the response of the policy rate, while the blue line indicates the lending rate to the shock. (ii) On the bank capital figure, the red line represents the response of the bank capital target, while the blue line indicates the actual (bank capital) to the shock.

The results showing the demand for credit shock on the different variables of the Euro area as a whole are the same when we take each country individually, except Ireland, Portugal and Spain, where credit demand shock negatively affects the output gap (see Figure C.4 in Appendix C). However, it is important to note that, again, the extent and depth of the shock, and the speed with which these different variables return to the steady state, differ from country to country. The negative impact of demand for credit shock on output for these countries indicates a contractionary effect on economic activity. This means that the shock reduces the demand for credit, leading to a decrease in borrowing and spending by businesses and households. As a result, investment and consumption decline, leading to a decrease in overall output. Policymakers in this situation may need to consider appropriate measures to stimulate demand and support economic growth, such as implementing expansionary fiscal or monetary policies to boost spending and investment.

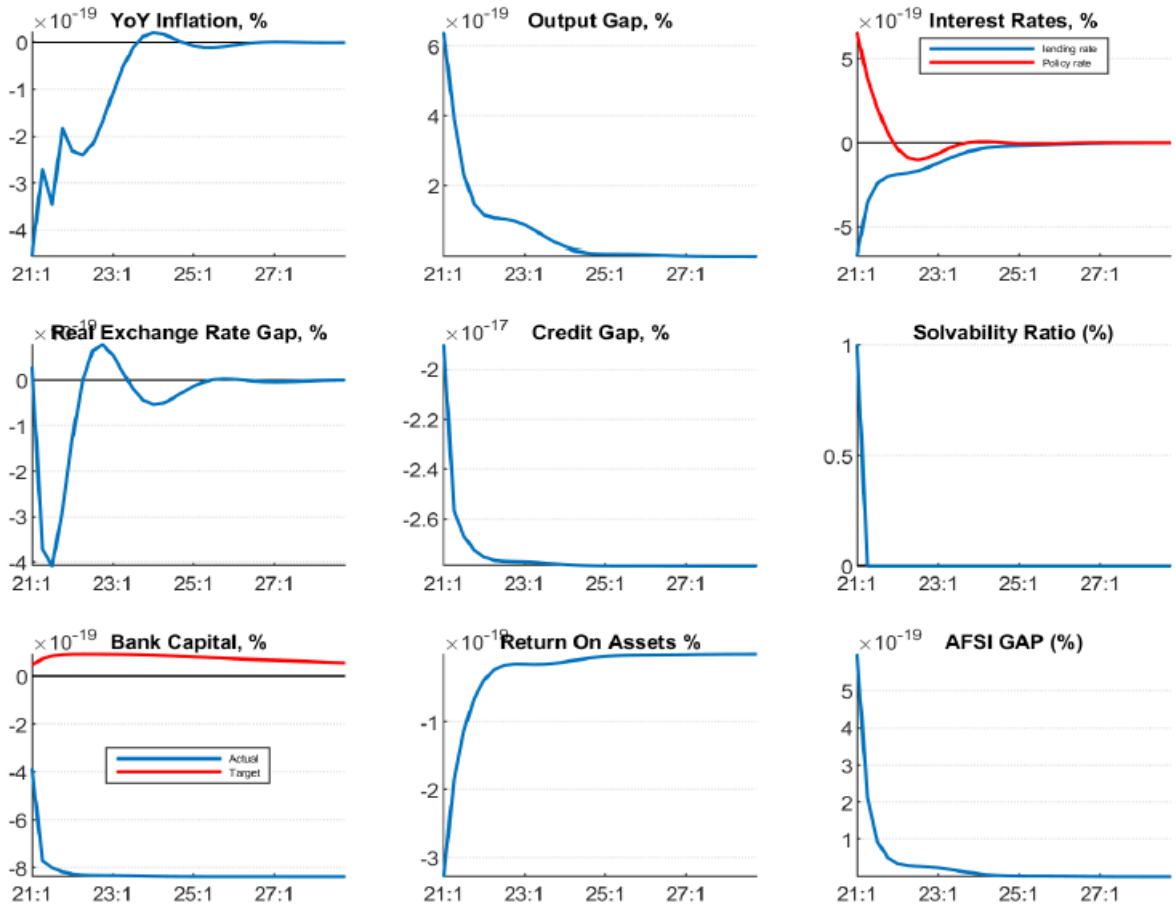
Solvability ratio shock

Figure 11 presents the reaction of the variables of the Euro area as a whole to banks' positive solvability ratio shocks. The figure shows that the year-on-year inflation reacts negatively to the shock (inflation becomes negative many quarters after the shock), the shock effect on the output gap is positive, its impact on the policy rate is negative, its effect on the lending rate is positive, its effect on the bank capital ratio is negative, and its impact on the bank's return on assets is negative.

This suggests that rising solvability ratios are dampening inflationary pressures in the economy, which may be due to factors such as reduced lending capacity and tighter credit conditions. In addition, the positive impact of the solvability ratio on the output gap indicates that an increase in the solvability ratio leads to a rise in the output gap. This suggests that a higher solvability ratio improves the stability and resilience of banks, thereby increasing lending and investment, boosting economic activity, and narrowing the output gap. Moreover, we can see in the figure that the policy rate reacts negatively to the solvability ratio shock. This means that the central bank responds to the positive impact on output and the negative impact on inflation by lowering the policy rate. This action has the purpose of further supporting economic expansion and counteracting any disinflationary pressures resulting from the shock.

Furthermore, the positive reaction of lending after the shock suggests that banks increase their lending rates in response to a higher solvability ratio. This may be due to factors such as perceived reduced credit risk and the need to maintain profitability and adequate returns on loans. Additionally, the effect of the solvability ratio shock on the bank's capital ratio is negative. This might be due to factors such as increased risk-taking or a decrease in capital due to other financial factors. A lower bank capital ratio can impact the stability and solvency of banks. Finally, the negative impact of the solvability ratio shock on the bank's return on assets suggests that the shock leads to a decline in banks' profitability. This could be due to factors such as the increased costs associated with maintaining a higher solvability ratio or reduced lending capacity.

Figure 11: Solvability ratio shock for euro area as all



Source: Author' computation.
Notes: (i) On the interest rates figure, the red line represents the response of the policy rate, while the blue line indicates the lending rate to the shock. (ii) On the bank capital figure, the red line represents the response of the bank capital target, while the blue line indicates the actual (bank capital) to the shock.

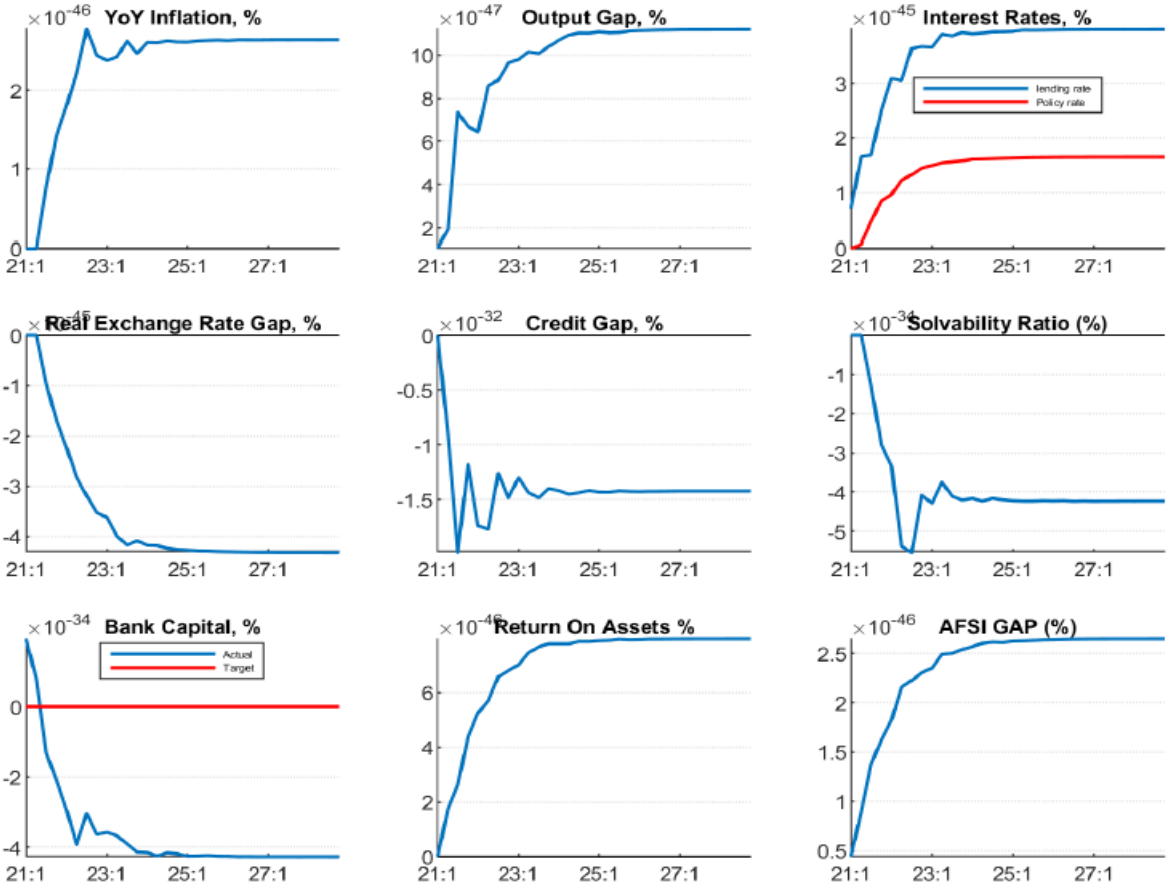
These results are different when we take each country individually (see Figure C.5 in Appendix C). For example, while the inflation rate reacts negatively to the solvability shock for Austria, Germany, Greece and Spain, it reacts positively for countries such as Belgium, France, Finland, and so on. This means that an increase in the solvability ratio leads to upward pressure on inflation (because of several factors, such as increased lending capacity, easing credit conditions, or improved economic outlook). Likewise, the output gap, interest rates, and reaction of other variables vary from country to country, depending on their specificity.

Countercyclical capital buffer (CCyB) shock

A countercyclical buffer shock is a change in the CCyB requirement imposed on banks by the regulatory authorities. The CCyB is a regulatory tool designed to enhance the resilience of the banking sector during periods of excessive credit growth and economic expansion, and to release

it during periods of financial stress. When a CCyB shock occurs, the objective is usually to adjust the capital buffer requirement upward or downward to reflect the current economic conditions.

Figure 12: Countercyclical capital buffer shock for euro area as all



Source: Author' computation.
Notes: (i) On the interest rates figure, the red line represents the response of the policy rate, while the blue line indicates the lending rate to the shock. (ii) On the bank capital figure, the red line represents the response of the bank capital target, while the blue line indicates the actual (bank capital) to the shock.

Figure 12 (above) presents the reaction of the variables of the Euro area as a whole to a positive shock in the CCyB. The figure shows that the year-on-year inflation reacts positively to the CCyB shock, which means that activating the CCyB leads to upward pressure on inflation, for several reasons. (i) Activation of the CCyB implies an increase in bank capital requirements (we can see in the figure that bank capital reacts positively after the shock) during economic upturns. This action has a restrictive effect on banks' ability to extend credit and reduce the overall availability of loans in the economy. With reduced credit supply (the credit gap decreases after the shock and stays negative for several quarters after the shock), aggregate demand may be dampened, leading to lower inflationary pressures. (ii) The increase in capital requirement associated with CCyB leads to higher borrowing costs for banks. The higher capital requirements associated with the CCyB can lead to

increased borrowing costs for banks. Since banks pass on these higher costs to borrowers, interest rates for loans may rise (both policy and lending rates rise after the shock and stay positive for many quarters). Thus, higher interest rates can reduce investment and consumption, leading to decreased aggregate demand and potentially lower inflation. (iii) The positive impact on financial stability suggests that activation of the CCyB helps to strengthen the resilience of banks and the overall financial system. This might contribute to greater stability and confidence in the financial sector, which could have positive spillover effects on the broader economy, including inflation. Finally, (iv) activation of the CCyB, by enhancing the capital position of banks, can improve their profitability and return on assets. This may be due to reduced risk and increased confidence from investors and depositors.

However, it is crucial to note that the specific impact of a CCyB shock on different variables, including inflation, output gap, policy rate, lending rate, credit growth, bank capital, and bank return on assets, depends on the specific design and implementation of the CCyB, as well as the prevailing economic conditions. For example, we will see a different result if we take euro area countries individually (see Figure C.6 in Appendix C).

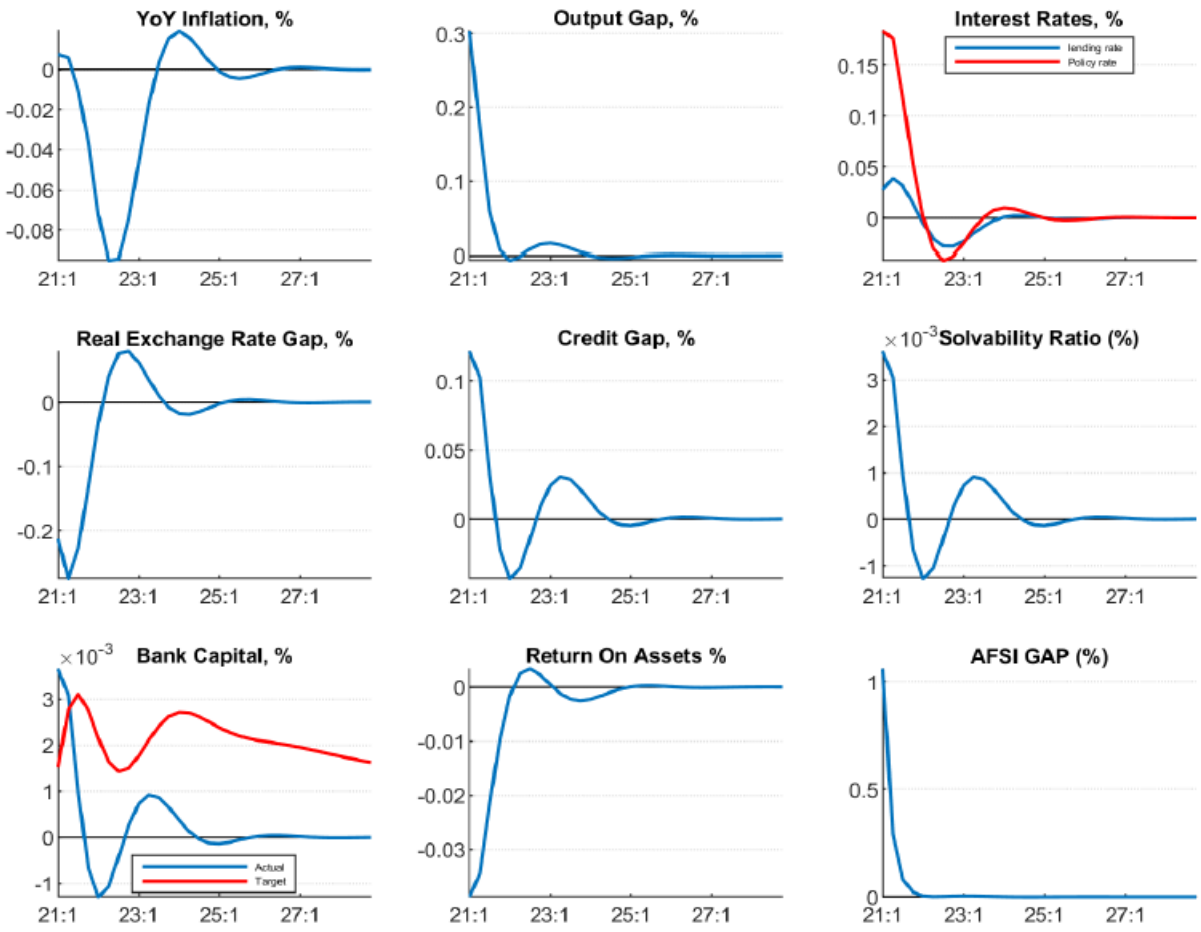
Financial stability shock

Financial stability shock can be defined as an unexpected event or development that disrupts the stability of the financial system. The impact of a financial stability shock on various macroeconomic variables can vary depending on the nature and magnitude of the shock. Figure 13 (below) shows that the impact of financial stability shock on year-on-year inflation is positive in the first quarters, and then negative, its effect on the output gap is positive, its impact on both the policy rate and lending rate is positive, its effect on the credit gap is positive, its impact on bank capital is positive, its impact on banks' return on assets is negative, and its effect on financial stability is positive.

The positive impact of the financial stability shock on inflation in the first quarter, followed by a decrease, suggests an initial increase in inflationary pressures due to disruptions in the financial system. Over time, however, the negative effect indicates a moderation or decline in inflation when stability returns. This may be a result of policy measures aimed at addressing the root causes of the shock or restoring confidence in the financial sector. Furthermore, the positive effect on the output gap indicates an expansionary impact on the economy. This positive reaction of the economy could be attributed to measures taken to stabilize the financial system, such as liquidity injections or government interventions, which can stimulate economic activity. In addition, both policy and lending rates have a positive reaction after the shock, meaning that the central bank is responding to the financial instability by tightening monetary conditions. This measure is aimed at controlling

inflationary pressures or dealing with risks in the financial sector. Higher interest rates also serve as a deterrent against excessive borrowing and to promote financial stability.

Figure 13: Financial stability shock for euro area as all



Source: Author' computation.
Notes: (i) On the interest rates figure, the red line represents the response of the policy rate, while the blue line indicates the lending rate to the shock. (ii) On the bank capital figure, the red line represents the response of the bank capital target, while the blue line indicates the actual (bank capital) to the shock.

Moreover, the positive effect of the credit gap (credit growth) points to an increase in lending activity. This could be a result of measures taken to restore confidence in the financial system, such as providing liquidity support to banks or implementing policies to encourage lending. These measures, in addition to macroprudential measures such as regulatory measures or capital injections, lead to an improvement in the financial health and resilience of banks (banks' capital reacts positively to the shock). However, the shock decreases banks' profit, since it has a negative impact on their return on assets. This could be due to factors such as higher regulatory compliance costs, higher funding costs, or reduced lending due to financial instability. However, the positive

impact on bank capital suggests that the shock contributes to strengthening the overall financial position of banks.

The analysis of Figure C.7 in Appendix C shows that the financial stability of a positive shock has the same impact on each Euro area country of our sample. However, it is important to note that, again, the extent and depth of the shock, and the speed with which these different variables return to the steady state, differ from country to country.

5.2 Model evaluation: forecasting

Having analyzed the impulse response functions, we move on to the next section, where we perform an additional exercise to evaluate the performance of the parametric model in forecasting and policy analysis. The purpose of these exercises is to highlight the strengths and weaknesses of the model while validating the chosen parameterization.

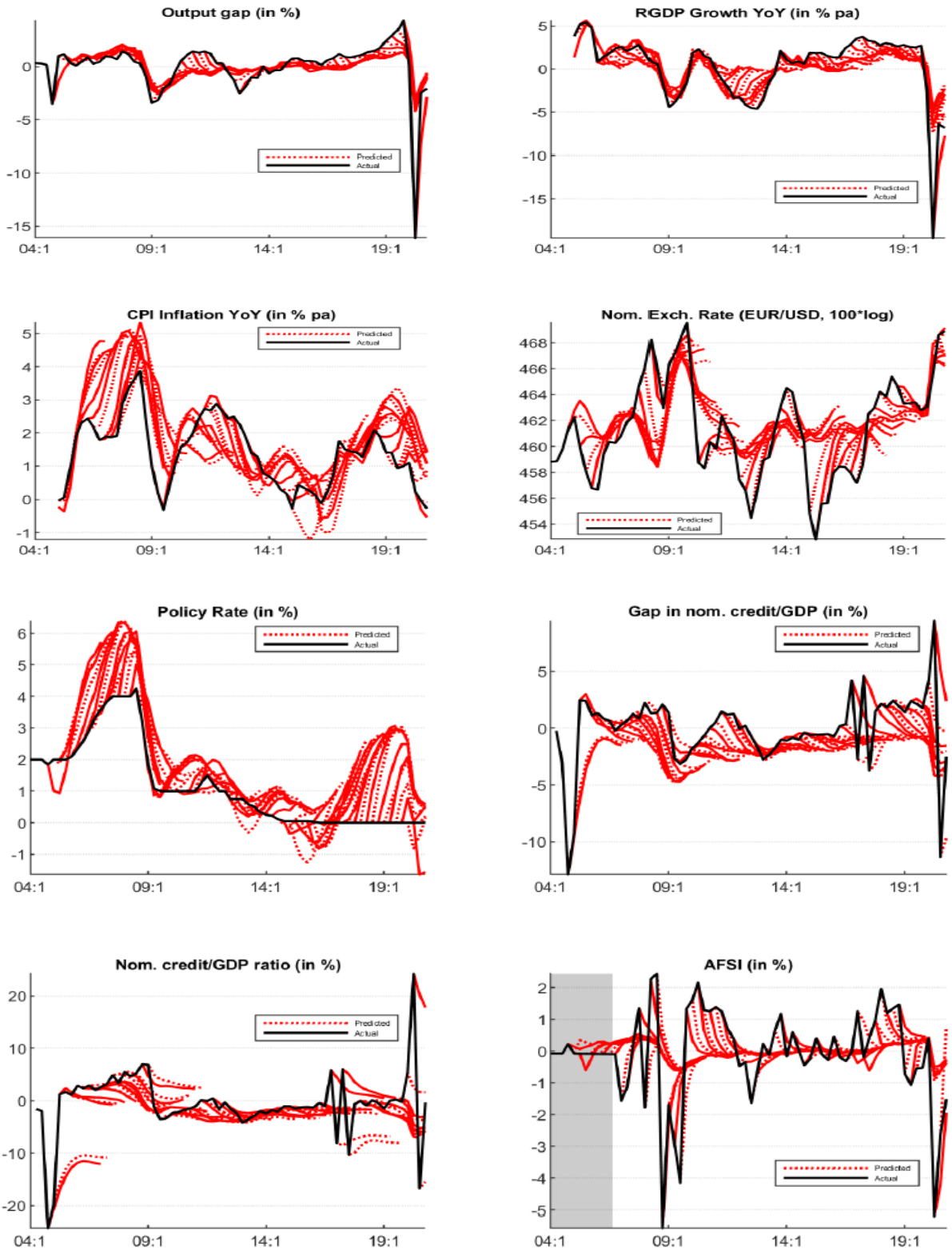
5.2.1 In-sample forecasting

We begin by conducting in-sample[80] forecasting to assess the performance of the forecast over the 2005Q1–2019Q4 period. We start the simulation by considering the first quarter of the sample period (2005Q1). From this, we generate a purely model-based forecast for the next 8 quarters. Then, we move forward and repeat the process quarterly until we reach the final period of the simulation: 2019Q4. These projections are based on the assumption that we can access the following information: first, estimates of unobserved variables for the current quarter, derived from data for the entire sample period; and, second, all external variables associated with the forecast horizon.

It should be noted that the historical samples that we use do not include the implementation of macroprudential policies, especially the setting of a leverage ratio by the macroprudential authorities. Therefore, for the purposes of these forecasts, we assume that leverage and return on assets (ROA) are observed and known. Furthermore, since no macroprudential measures were applied in the historical sample, we will not evaluate forecast performance for the macroprudential policy block. Only the business cycle block, credit block, and financial stability block will be assessed.

[80] In-sample forecasts are forecasts made within the time horizon of available data that provide insights into how the model fits and captures patterns in the observed data.

Figure 14: In-sample forecast for euro area as all



Source: Author' computation.
Note: The grey area covers the periods for which the actual data on aggregate financial stability index are not available.

Figure 14 (above) presents the forecast of the variables of the Euro area as a whole. And we can see that the forecasts of output gap and real year-on-year GDP growth are quite close to the actual data, even if the figures show that the forecasts overshoot for the real GDP growth rate during the 2013–14 period. We can also see that the inflation growth rate forecasts overshoot over the 2007–9 period, corresponding to the global financial crisis of 2008, and over 2019–20, during the COVID-19 crisis; meanwhile, they undershoot during the 2010–13 period. Arguably, this overshooting and undershooting of the inflation growth rate by the different measures, such as monetary injection, were undertaken by the authorities to solve the different crises. Concerning the nominal exchange rate in-sample forecast, the figure shows that forecasts are less volatile than the actual rates over the 2011–20 period. Also, it is very clear that forecasts undershoot over the 2008–9 period, and they are much closer to the actual data at the end of the forecast window (2020Q1–2020Q4).

The policy rate in-sample forecast is more volatile than the actual data. Based on the policy rule outlined in Section 3, specifically equation (31), the onset of the global financial crisis necessitated a lower interest rate response. Over this period, the forecasts are closer to the actual data. However, we also see that the forecasts overshoot during the 2007–9 period and the 2018–20 period.

Concerning both nominal credit to GDP ratio and its gap, the in-sample forecasts are less volatile than the actual data. Forecasts are closest to the actual data over the 2005–17 period for the nominal credit to nominal GDP ratio. They undershoot over the forecast period. The aggregate financial stability index in-sample forecast shows that the forecasts are more stable than the actual data.

We repeat the exercise for each country in our sample countries and present the results in Appendix D. The results vary from country to country, depending on the country model properties (estimated model parameters).

5.2.2 Out-of-sample forecasting

We purchase our model performance evaluation by doing an out-of-sample forecast, which uses a model trained on historical data to make predictions for future periods not included in the training data. The purpose of out-of-sample forecasting is to use unseen data to evaluate model performance and predictive accuracy. By comparing out-of-sample forecasts with actual values for future periods, we assess how well our model generalizes and predicts future behavior. This helps to assess the model's ability to capture underlying patterns, trends, and relationships beyond the observed data.

Table 2: Model-based forecast versus random walk Root Mean Square Errors (RMSE)

	Output gap[a]	Real GDP[b]	CPI[c]	NER[d]	Policy rate	Credit gap[e]	Credit[f]	AFSI[g]
Austria	5.2	7.5	-0.2	-	-	7.0	12.4	2.1
Belgium	5.3	6.4	1.6	-	-	6.4	11.9	0.8
Finland	1.9	2.1	0.6	-	-	5.1	8.8	3.2
France	6.2	7.8	1.3	-	-	7.0	14.5	10.7
Germany	4.3	4.2	1.0	-	-	2.9	6.3	1.1
Greece	2.8	6.8	0.9	-	-	3.6	7.7	0.5
Ireland	2.5	2.9	-0.1	-	-	3.1	5.9	0.0
Italy	5.6	7.4	0.8	-	-	6.5	11.1	2.2
Netherlands	3.0	3.3	0.1	-	-	3.7	6.8	0.1
Portugal	6.6	8.8	0.2	-	-	5.2	9.3	0.4
Spain	8.2	10.5	0.8	-	-	11.7	17.7	0.7
Euro area	**6.6**	**9.0**	**1.1**	**1.3**	**-0.4**	**5.6**	**10.1**	**3.5**

Notes: [a] in %, [b] in % YoY (Year over Year), [c] consumer price index in % YoY, [d] EUR/USD nominal exchange rate, [e] nominal credit gap (credit/nominal GDP), [f] nominal credit (credit/nominal GDP), [g] Aggregate financial stability index.
The table values correspond to the difference between the RMSE of random walk, and the model forecast RMSE. A positive value means the model forecast RMSE is lower than the RMSE of random walk, and the opposite for a negative value. A value of 0, means that the RMSEs of the model and random walk are the same.
Source: Author' computations.

We train the model over the 2005Q1–2019Q4 period and then run the forecast for the subsequent 8 quarters; lastly, we compute the root mean square error (RMSE) of the forecast and compare it to the random walk one. Table 2 (above) compares the RMSE model-based forecasts81 with those for a benchmark random walk model for Euro area countries. The table indicates that the model outperforms the random walk forecasts for the business cycle variable (with the exception of policy rate and CPI inflation rate for Austria), credit block variable, and financial stability index. These results suggest that our model fails to predict the policy rate evolution but matches well the output gap, real GDP year-on-year, CPI inflation year-on-year, nominal exchange rate, flow nominal credit to nominal GDP ratio and its gap, and the aggregate financial stability index.

5.3 Historical interpretation of data

In this section we will assess the predictive power of the model by examining its ability to explain past economic development in the Euro area. Specifically, we perform a historical shock decomposition analysis using a Kalman filter to assess the effectiveness of the model in capturing and interpreting observed historical data. This analysis helps us to determine the usefulness of the model in understanding the dynamics of the Euro area as a whole economy and provides insights into its predictive power. The usefulness of a model to policymakers depends on its ability to illuminate the imbalances and shocks that have shaped recent economic events. Assessing a model's ability to capture and account for these factors is a key test for assessing its applicability and value. Policymakers rely on models to provide insights into the underlying causes of economic development to make informed decisions and implement effective policies to correct imbalances. This mitigates the impact of shocks on the economy.

The Kalman filter is used to identify trends and determine optimal values of structural shocks that are consistent with the observed data. The data-filtering process serves two main purposes: first, it generates estimates of unobservable variables such as trends and shocks; and, second, it allows historical developments to be explained by estimated structural shocks. By comparing these estimated shocks with expert judgment, we validate the model and ensure its accuracy in explaining past economic events. This validation process increases our confidence in the model's ability to provide meaningful insights into historical data.

The filtering process is based on three sets of observed variables, with the first set belonging to the business cycle block of the model. These variables capture key economic indicators that reflect the

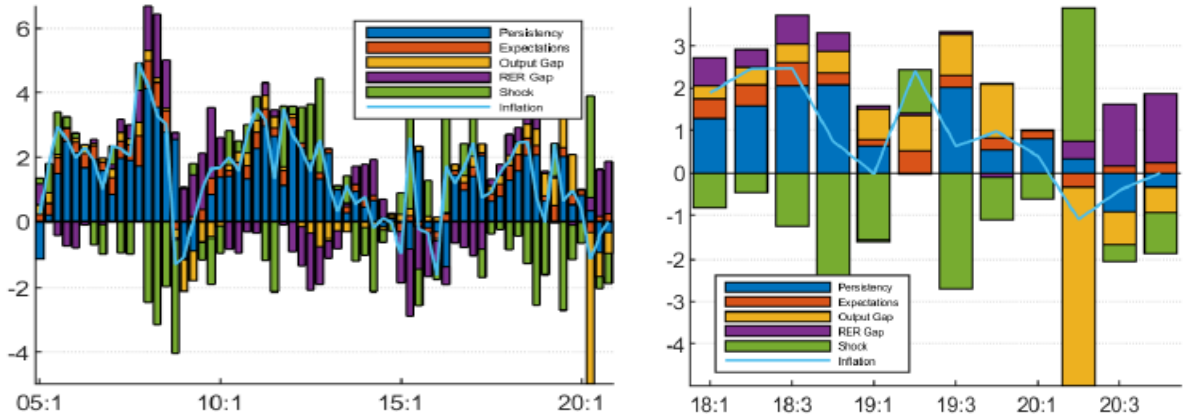
[81] A forecast is considered a pure model-based forecast if there are no expert judgments and no changes in the model's parameters and structure (Karam et al., 2021).

cyclical nature of the business, and they include CPI inflation, real GDP, the nominal exchange rate, and the policy rate. To these variables we add the US GDP, CPI inflation, and interest rate as foreign variables. The second set concerns the credit cycle block and the flow of bank credit to GDP, the lending rate, and the VIX. The last set is related on the macroprudential policy block and includes total assets of banks, ROA, and total bank capital. To these variables, we add the aggregate financial stability index.

Inflation decomposition

Figure 15 presents the inflation decomposition based on equation (3), which aims to analyze the fundamental drivers of inflation. The lefthand figure takes into account all of the sample period (2005Q1–2020Q4), while the right one focuses on the recent development of inflation (2018Q1–2020Q4). The contribution of the real exchange rate (purple bar) and inflation persistence (blue bar) are significant factors in influencing the inflation rate. The contribution of the inflation shock (green bar) is also pronounced. Overall, the contribution of inflation expectation (orange bar) and the output gap appear lower than the other variables, except in the recent period, where the contribution of the output gap is important (especially in 2020Q2, during the COVID-19 crisis).

Figure 15: Inflation decomposition



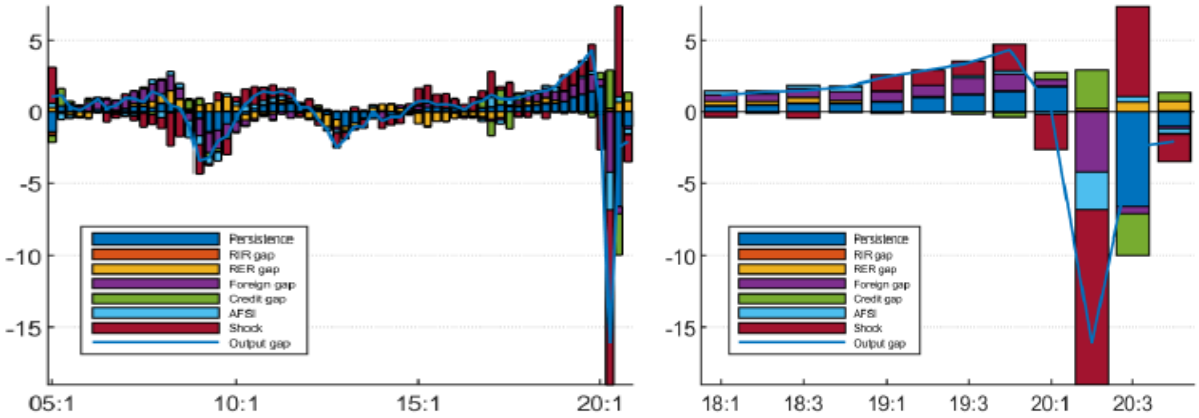
Source: Author' computation.
Note: Bars in each period sum up to the sky-blue line, which is the inflation.

Output gap decomposition

Based on equation (20), the output gap is represented in Figure 16 (below). Assessing the impact of the financial sector on the output gap, which represents business cycle fluctuations, shows that credit and the aggregate financial stability index feedback have historically not had a significant impact on the gap (shown respectively in the green and sky-blue bars). This means that financial sector shocks, especially those related to credit dynamics, do not play a significant role in the change

in the output gap. However, it is worth noting that this conclusion is based on historical data and may not be true in all economic contexts or in different situations. The most important contributions are the shock from the output gap (in the burgundy-red bar), the foreign output gap (in the purple bar), the real exchange rate, and output gap persistence.

Figure 16: Output gap decomposition

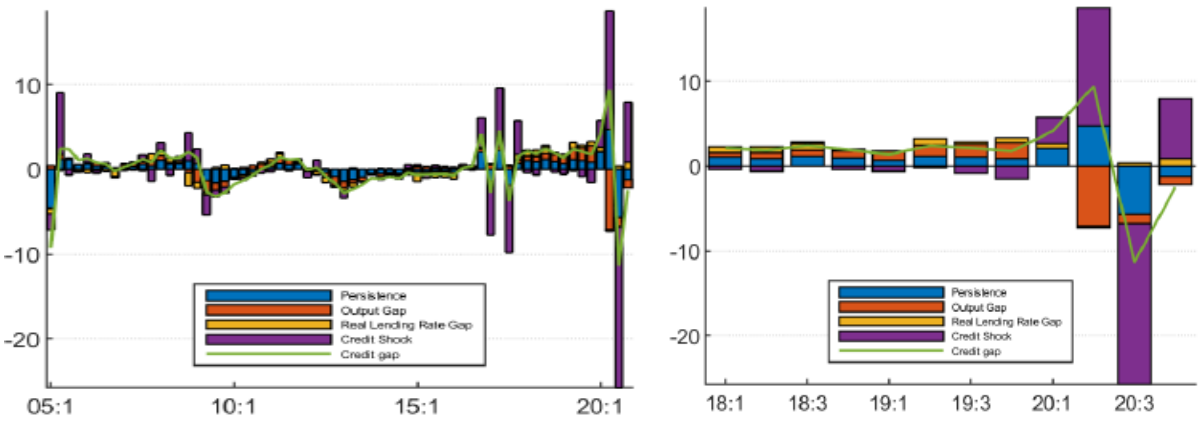


Source: Author' computation.
Note: Bars in each period sum up to the blue line, which is the output gap.

Credit gap decomposition

Figure 17 presents a credit gap decomposition based on equation (10), which takes into account the underlying determinants of credit demand. The analysis reveals that the real lending rate emerges as a less significant factor influencing the demand for credit, as represented by the credit gap (depicted by the yellow bars), while the output gap (orange bars) appears to be a significant factor influencing the demand for credit, especially in recent years.

Figure 17: Credit gap decomposition



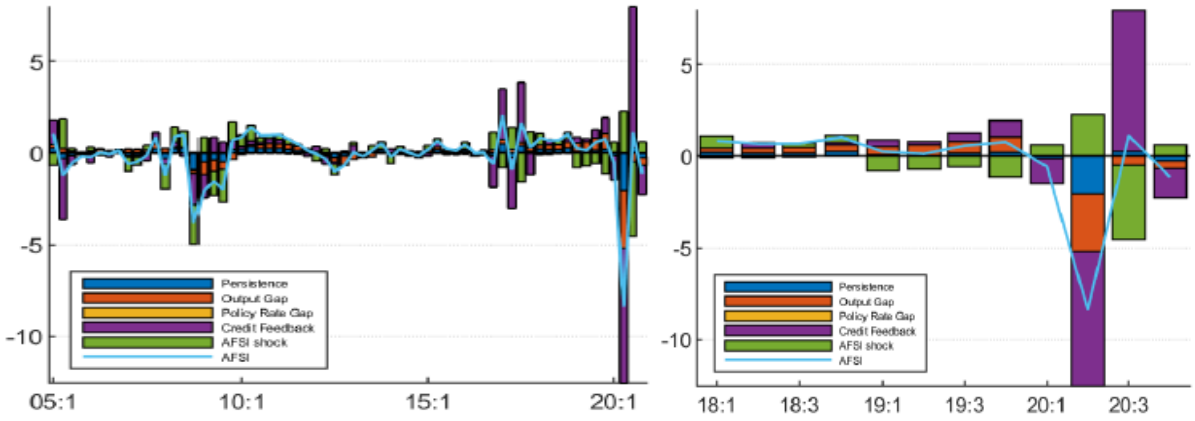
Source: Author' computation.
Note: Bars in each period sum up to the green line, which is the credit gap.

The decomposition highlights the role of the output gap and the real lending rate in shaping credit dynamics, indicating that changes in output gap and the real lending rate have a substantial and lower impact, respectively, on the demand for credit. The figure reveals that credit shocks, represented by the purple bars, make a significant contribution to the credit gap. These credit shocks capture financial shocks and other determinants of credit that are not explicitly modeled. Interestingly, the impact of these credit shocks appears to counterbalance the effect of the output gap and the real lending rate gap. While both the output gap and the real lending rate have been important determinants of credit demand, the presence of credit shocks suggests that other factors not explicitly considered in the model also play a substantial role in shaping credit dynamics. This result highlights the importance of incorporating these credit shocks into the analysis to capture the full range of factors influencing the credit gap.

Aggregate financial stability index decomposition

Figure 18 illustrates a decomposition of the financial stability index based on equation (29), which takes into account the underlying determinants of financial stability. The analysis reveals that several factors have been significant determinants for financial stability, as represented by the financial stability index (AFSI).

Figure 18: AFSI decomposition



Source: Author' computation.
Note: Bars in each period sum up to the sky-blue line, which is the output gap.

The output gap, credit feedback, and aggregate financial stability shock have all played important roles in shaping financial stability. The output gap captures the cyclical fluctuations in the economy and its impact on financial stability. The credit feedback reflects the feedback loop between credit dynamics and financial stability, indicating that changes in credit conditions can influence the

overall stability of the financial system. Additionally, the aggregate financial stability shock represents other factors, not explicitly modeled, that affect financial stability.

Decomposition of the financial stability index sheds light on the various determinants driving financial stability and provides insights into the factors that contribute to the overall stability of the financial system. By considering these underlying factors, policymakers and analysts can better understand the dynamics of financial stability and develop appropriate measures to safeguard the stability of the financial system.

6. Conclusion

This chapter makes a valuable contribution to the ongoing effort to improve systemic risk monitoring and implement Basel III requirements. This is achieved by extending the existing new Keynesian (NK) quarterly projection model (QPM) to incorporate macroprudential policy and financial stability considerations that are specific to the Euro area. By incorporating these two blocks into the QPM framework, we have sought to improve the understanding and analysis of the interplay between monetary policy, macroeconomic variables, and financial stability in the Euro area context.

Our model parametrization is based on both calibration and Bayesian estimation, especially the Andrle (2018) system prior method. Our analysis focuses on examining the model's properties and conducting an extensive evaluation exercise to identify its strengths and weaknesses. From this evaluation, we found that the impulse response functions of the model gave satisfactory results. They improve the understanding of model dynamics and effectively demonstrate the impact of macroprudential policies on promoting financial stability. Furthermore, the decomposition of historical shocks allows us to quantify the contribution of various exogenous shocks to the dynamics of important macroeconomic and financial variables such as inflation rate, output gap, credit gap, and aggregate financial stability. These decompositions reveal factors that influence the behavior of these variables over time and provide valuable insights for policy formulation and analysis.

The main objective of this chapter has been to present and demonstrate the practical value of the QPM as a tool for quantifying the impact of financial shocks on the Euro area banking system and macroeconomic environment. Furthermore, we assess the macroeconomic impact of capital banking instruments. Utilization of the QPM framework leads to a comprehensive analysis of the overall impact of financial shocks and assesses how the introduction of capital banking instruments

affects macroeconomic conditions. The results of the analyzed shocks reveal important insights into the dynamics of the Euro area economies and the interplay between various variables.

First, the impact of aggregate demand shocks on key macroeconomic indicators, such as the output gap, inflation, and interest rates, reflects the impact of changes in aggregate demand on the broader economic situation. The analysis highlights how these variables respond to changes in aggregate demand, with output gaps reflecting changes in economic activity, inflation reflecting price pressures, and interest rates adjusting to balance supply and demand. Our findings align with prior studies. For example, Kandil (1991) and Halka and Kotłowski (2016) observed similar dynamics, where an increase in aggregate demand leads to a positive output gap, potential inflationary pressures, and adjustments in interest rates to manage the demand–supply balance. The consistency of these results across studies reinforces our confidence in the validity of the model and its ability to capture the dynamics of the economy.

Second, credit demand shocks play a significant role in shaping the behavior of credit growth, bank solvability ratios, and lending rates. The analysis indicates that increased credit demand can lead to higher lending rates, potentially affecting borrowing costs for individuals and businesses. Additionally, the impact on bank solvability ratios emphasizes the importance of maintaining adequate capital buffers to ensure the stability and resilience of the banking system. Our analysis corroborates the findings of previous studies. For instance, Barnett and Ryland (2014) and Islam (2022) highlighted the relationship between credit demand, lending rates, and bank solvability. By comparing our results with these studies, we validate the model's ability to capture these dynamics and contribute to the broader understanding of credit market dynamics. This comparison with existing literature helps to validate the model's ability to capture these dynamics and contributes to a broader understanding of credit market dynamics and their impact on the banking sector.

Furthermore, the analysis of shocks related to financial stability reveals the interconnectedness between financial conditions and macroeconomic outcomes. The results indicate that shocks to financial stability indicators can have both positive and negative effects on inflation, output gap, interest rates, and bank performance. These findings underscore the importance of monitoring and addressing the risks to financial stability to safeguard the overall health of the economy. Our findings are consistent with research conducted by Bauducco et al. (2011) and Tunay and Tunay (2021). These studies also examined the impact of financial stability shocks on macroeconomic indicators and the banking system.

Macroprudential authorities and analysts are strongly encouraged to utilize the quarterly projection model for their analyses, as it offers valuable insights into the impact of financial shocks and the

effectiveness of specific policies in promoting financial stability and economic growth. By employing the QPM framework, policymakers and analysts can enhance their understanding of the intricate dynamics of the economy and make more informed decisions. The QPM enables a comprehensive assessment of the effects of financial shocks on various macroeconomic variables, providing a deeper understanding of the channels through which shocks propagate. It allows for the evaluation of different policy measures and their potential impact on financial stability, offering insights into the effectiveness of these policies in mitigating risks and promoting sustainable growth. Furthermore, the QPM facilitates scenario analysis, enabling policymakers to assess the potential outcomes of different shocks and policy interventions. This helps in designing appropriate measures to address emerging challenges and risks in the financial system. To sum up, the QPM serves as a powerful tool for policymakers and analysts to better understand the impact of financial shocks, to evaluate the effectiveness of policy measures, and to make more informed decisions. Its comprehensive framework and scenario analysis capabilities offer valuable insights into the dynamics of the economy, contributing to the promotion of financial stability and sustainable economic growth.

Overall, the model offers a flexible and adaptable framework for analyzing macroprudential, financial risks and policy implications. Its structure allows for easy modifications and extensions to capture sector-specific risks that may concern policymakers. Adding a fiscal policy block, for example, helps policymakers to understand how fiscal policy can affect financial stability. This comprehensive analysis allows them to make more informed decisions that consider the broader implications for both the economy and the stability of the financial system.

Appendix A. Model variables

Table A1: Model description

Variable	Description
y_t	Real GDP (100*log)
$\bar{y}_t$	Trend in Real GDP (100*log)
$\hat{y}_t$	Output Gap (in %)
Δy_t	Quarterly Growth in Real GDP (in % pa)
$\Delta^4 y_t$	Real GDP Growth YoY (in % pa)
$\Delta \bar{y}_t$	Real GDP Growth YoY (in % pa)
mci_t	Real Monetary Condition Index (in % pa)
cpi_t	CPI (level, 100*log)
π_t	CPI Inflation QoQ annualized (in % pa)
$E_t\pi_{t+1}$	Expected CPI Inflation QoQ annualized (in % pa)
$E_t\pi_{t+4}$	Expected CPI Inflation YoQ (in % pa)
π_t^4	CPI Inflation YoY (in % pa)
$\bar{\pi}_t^4$	Inflation Target (in % pa)
rmc_t	Real Marginal Cost (in %)
s_t	Nominal Exchange Rate (LCY/FCY, 100*log)
Δs_t	Nominal Exch. Rate Depreciation QoQ annualized (in % pa)
$\Delta^4 s_t$	Nominal Exch. Rate Depreciation YoY (in % pa)
$prem_t$	Country Risk Premium (in % pa)
i_t	Nominal Policy Interest Rate (in % pa)
r_t	Real Interest Rate (in % pa)
$\bar{r}_t$	Trend Real Interest Rate (in % pa)
$\hat{r}_t$	Real Interest Rate Gap (in %)
$i^{neutral}$	Nominal Policy Neutral Interest Rate (in % pa)
z_t	Trend Real Exchange Rate (level, 100*log)
$\bar{z}_t$	Trend Real Exchange Rate (level, 100*log)
$\hat{z}_t$	Real Exchange Rate Gap (in %)
Δz_t	Real Exchange Rate Depreciation QoQ annualized (in % pa)
$\Delta \bar{z}_t$	Trend Real Exchange Rate Depreciation QoQ annualized (in % pa)
$\hat{y}_t^*$	Foreign Output Gap (in %)

Table A1 (continue): Model description

Variable	Description
i_t^*	Foreign Nominal Interest Rate (in % pa)
r_t^*	Foreign Real Interest Rate (in % pa)
$\bar{r}_t^*$	Foreign Real Interest Rate Trend (in % pa)
$\hat{r}_t^*$	Foreign Real Interest Rate Gap (in %)
cpi_t^*	Foreign CPI (level, 100*log)
$\bar{\pi}_t^*$	Foreign Inflation QoQ annualized (in % pa)
vix_t	Chicago Board Options Exchange Volatility Index
ncr_t	Ratio of nominal credit to nominal GDP, percent
$\widehat{ncr}_t$	Gap in the ratio of nominal credit to nominal GDP (in %)
$\overline{ncr}_t$	Equilibrium ratio of nominal credit to nominal GDP (in %)
$\Delta\overline{ncr}_t$	Growth in trend of demand of credit (in %)
rs_t^{1y}	1-year benchmark interest rate (in%)
rs_t^L	Lending interest rate (in %)
r_t^L	Real lending interest rate (in %)
$\bar{r}_t^L$	Equilibrium real lending interest rate (in %)
$\hat{r}_t^L$	Real Lending Interest Rate Gap, (in %)
$prem_t^C$	Credit premium (in %)
ta_t	Total banks' assets to GDP ratio (in %)
bc_t	Bank capital ratio (in %)
bc_t^{TAR}	Target leverage ratio (in %)
roa_t	Banks' returns on assets ratio (in %)
sr_t	Solvency ratio (in %)
rwa_t	Risk weighted assets (in %)
em_t	Exposition measure (in %)
v_t	Countercyclical capital buffer (in %)
fs_t	Aggregate Financial Stability Index (in %)
$\widehat{fs}_t$	Aggregate Financial Stability Index GAP
$\overline{fs}_t$	Aggregate Financial Stability Index Trend (in %)
$\varepsilon_t^{\hat{y}}$	Shock to Output gap (demand)
ε_t^{π}	Shock to CPI inflation (cost-push)

Table A1 (continue): Model description

Variable	Description
ε_t^s	Shock to Exchange rate (UIP)
ε_t^i	Shock to Interest rate (monetary policy)
$\varepsilon_t^{\bar{\pi}_t^4}$	Shock to Inflation target
$\varepsilon_t^{\bar{r}_t}$	Shock to Real interest rate
$\varepsilon_t^{\Delta z_t}$	Shock to Real exchange rate depreciation
$\varepsilon_t^{\Delta y_t}$	Shock to Potential GDP growth
$\varepsilon_t^{\hat{y}_t^*}$	Shock to Foreign output gap
$\varepsilon_t^{i_t^*}$	Shock to Foreign nominal interest rate
$\varepsilon_t^{\pi_t^*}$	Shock to Foreign inflation
$\varepsilon_t^{\bar{r}_t^*}$	Shock to Foreign real interest rate
$\varepsilon_t^{\widehat{ncr}}$	Credit demand shock, percent
$\varepsilon_t^{\overline{ncr}}$	Permanent level shifting shock to the trend in credit flow-to-GPD (%)
$\varepsilon_t^{\Delta\overline{ncr}}$	Shock to the equilibrium rate of growth in credit flow-to-GPD, (%)
$\varepsilon_t^{prem^C}$	Shock to the credit premium, percent
$\varepsilon_t^{rs^{1y}}$	Shock to the benchmark 1-year rate, percent
ε_t^{ta}	Shock to the asset side of the banks' balance sheet
ε_t^{vix}	Shock to VIX, percent
ε_t^{bc}	Shock to capital accumulation (leverage ratio), percent
$\varepsilon_t^{bc^{TAR}}$	Shock to the target level of the leverage ratio, percent
ε_t^{sr}	Shock to Solvency ratio, percent
ε_t^{rwa}	Shock to Risk weighted assets, percent
ε_t^{roa}	Shock to the return-on-assets ratio, percent
ε_t^{v}	Shock to Countercyclical capital buffer, percent
$\varepsilon_t^{\overline{fs}}$	Shock to Aggregate Financial Stability Index Trend, percent
$\varepsilon_t^{\widehat{fs}}$	Shock to Aggregate Financial Stability Index, percent

Notes: YoY is year-on-year.pa is per annum. CPI is the consumer price index. QoQ is quarter-on-quarter. LCY (respectively FCY) is local currency (respectively foreign currency). Trend is calculated by using Hodrick-Prescott filter.

Appendix B. External sector equations

$$\pi_t^* = \rho_{\pi^*}\pi_{t-1}^* + (1+\rho_{\pi^*})\bar{\pi}_{SS}^* + \varepsilon_t^{\pi^*} \tag{B.1}$$

$$y_t^* = \rho_{y^*}y_{t-1}^* + \varepsilon_t^{y^*} \tag{B.2}$$

$$r_t^* = i_t^* - E_t\pi_{t+1}^* \tag{B.3}$$

$$i_t^* = \rho_{i^*}i_{t-1}^* + (1-\rho_{i^*})(\bar{r}_t^* + \pi_t^{4*}) \tag{B.4}$$

$$\hat{r}_t^* = r_t^* - \bar{r}_t^* \tag{B.5}$$

$$\bar{r}_t^* = \rho_{\bar{r}^*}\bar{r}_{t-1}^* + (1-\rho_{\bar{r}^*})\bar{r}_{SS}^* + \varepsilon_t^{\bar{r}^*} \tag{B.6}$$

$$vix_t = \rho^{vix}vix_{t-1} + \varepsilon_t^{vix} \tag{B.7}$$

Appendix C. Impulse Response Functions (IRF) to different shocks

Figure C.1: Aggregate demand shock

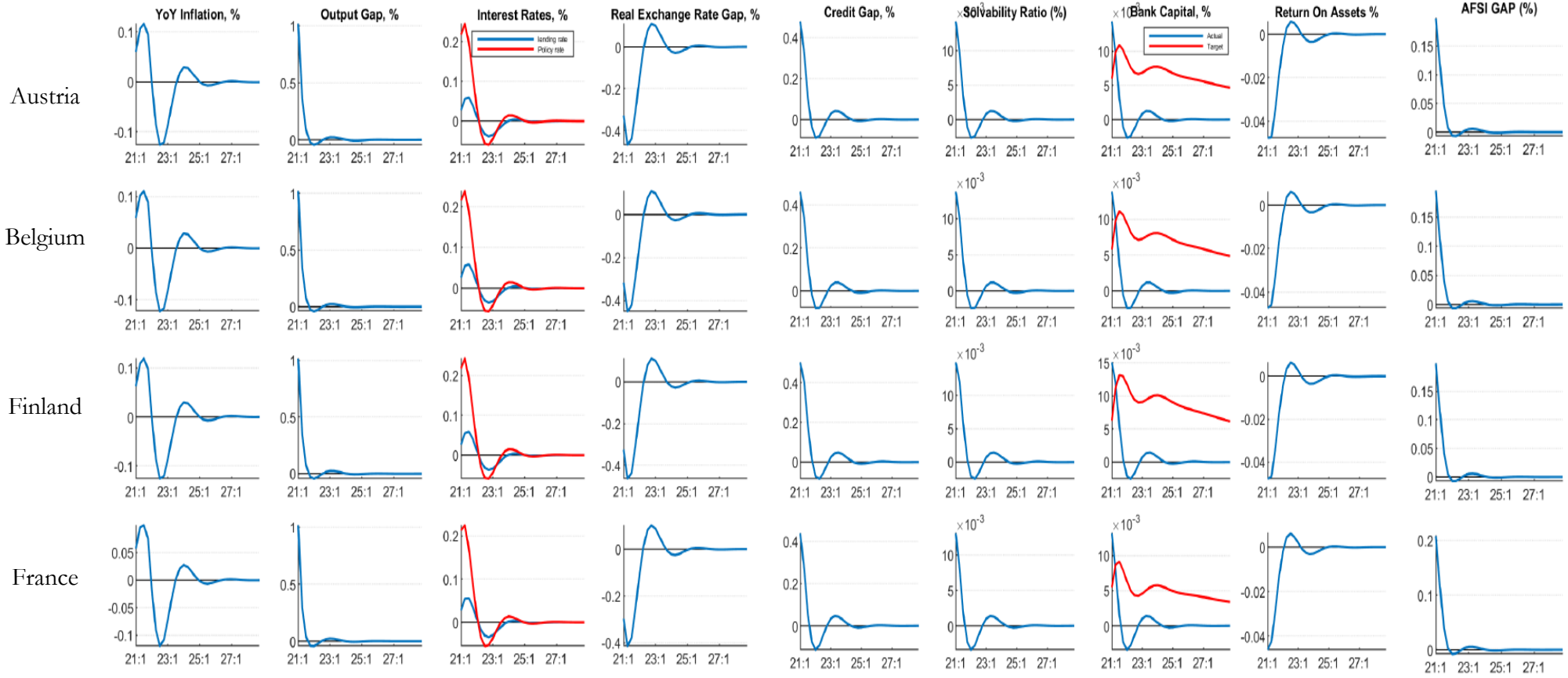


Figure C.1 (continue): Aggregate demand shock

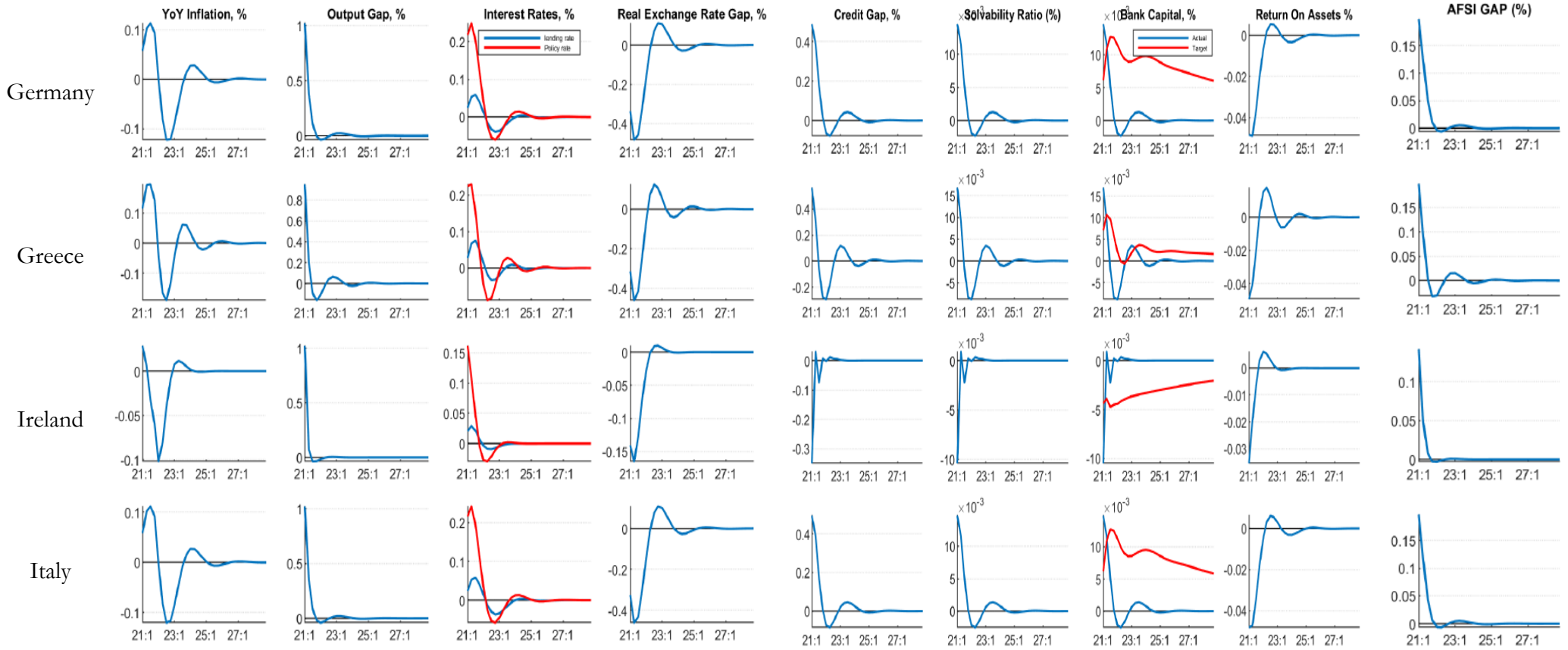


Figure C.1 (continue): Aggregate demand shock

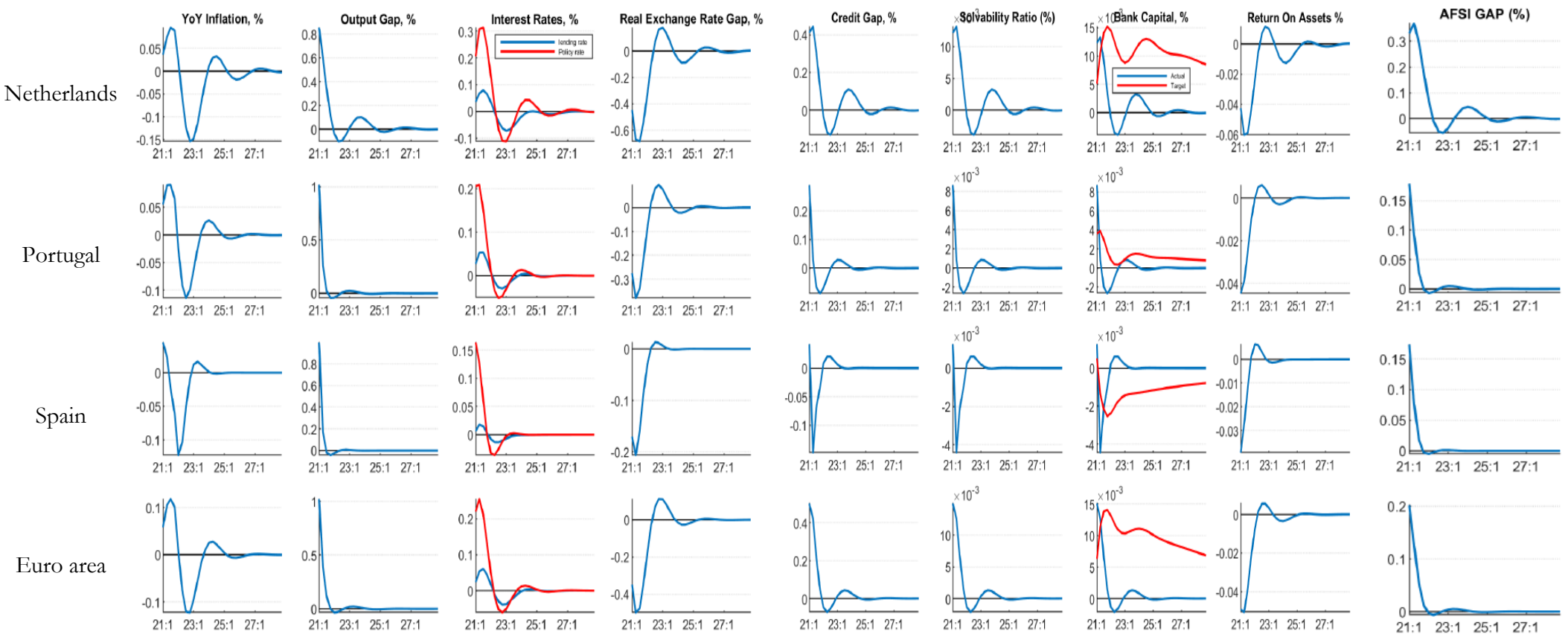


Figure C.2: Exchange rate shock

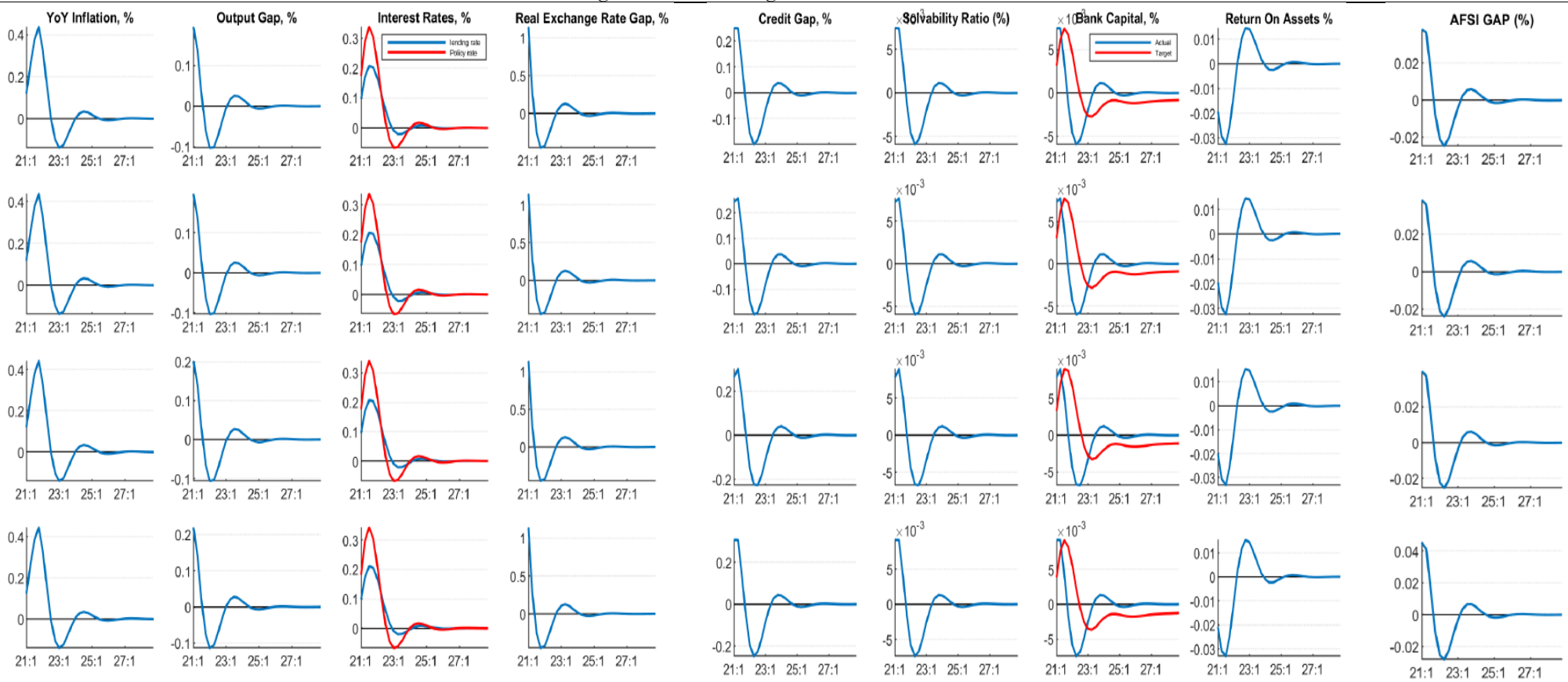


Figure C.2 (continue): Exchange rate shock

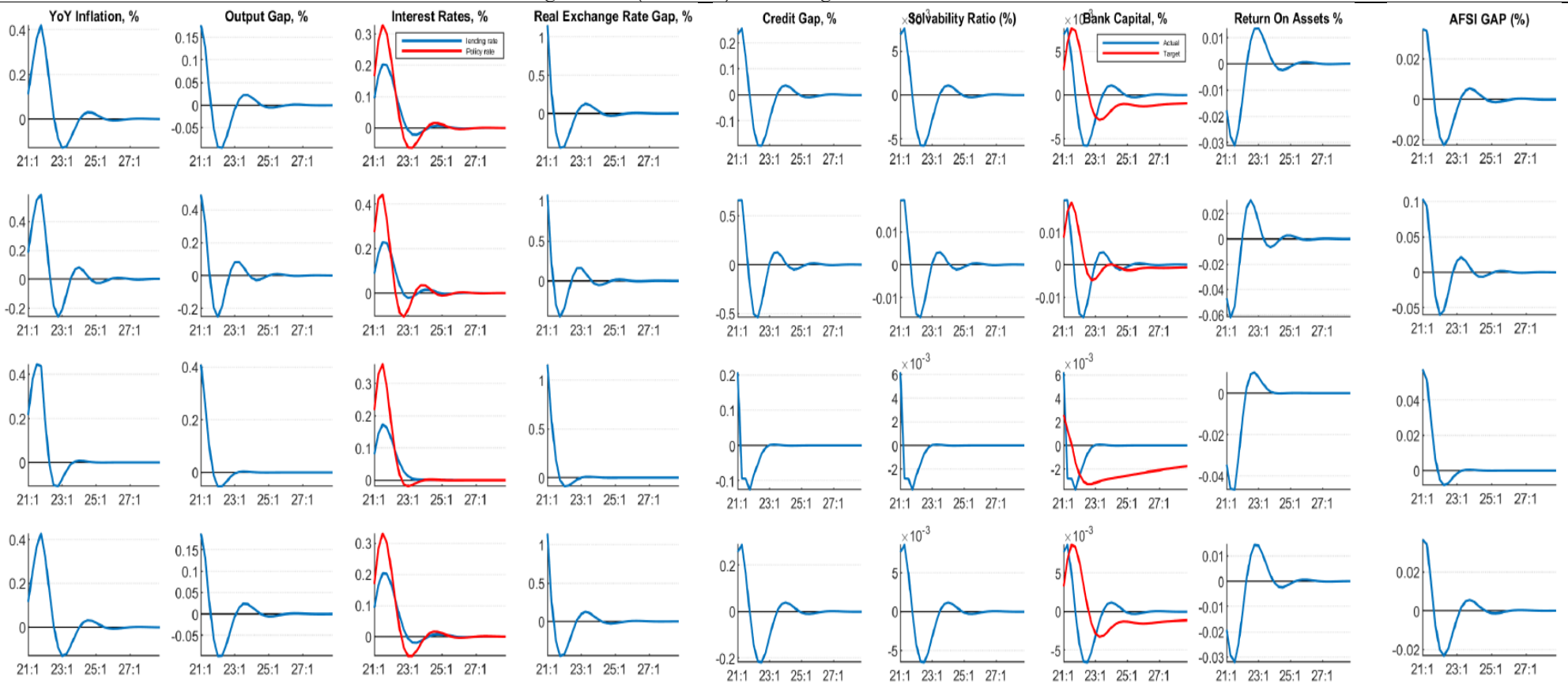


Figure C.2 (continue): Exchange rate shock

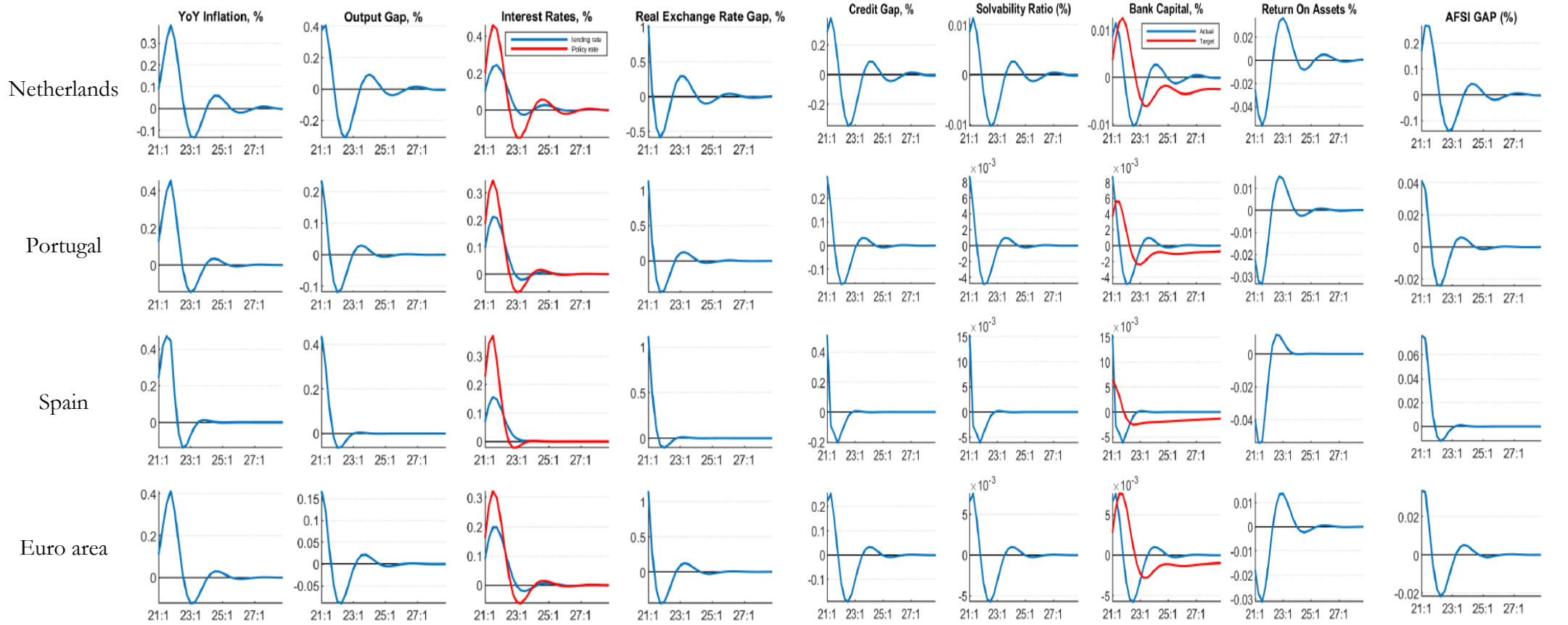


Figure C.3: Interest rate shock

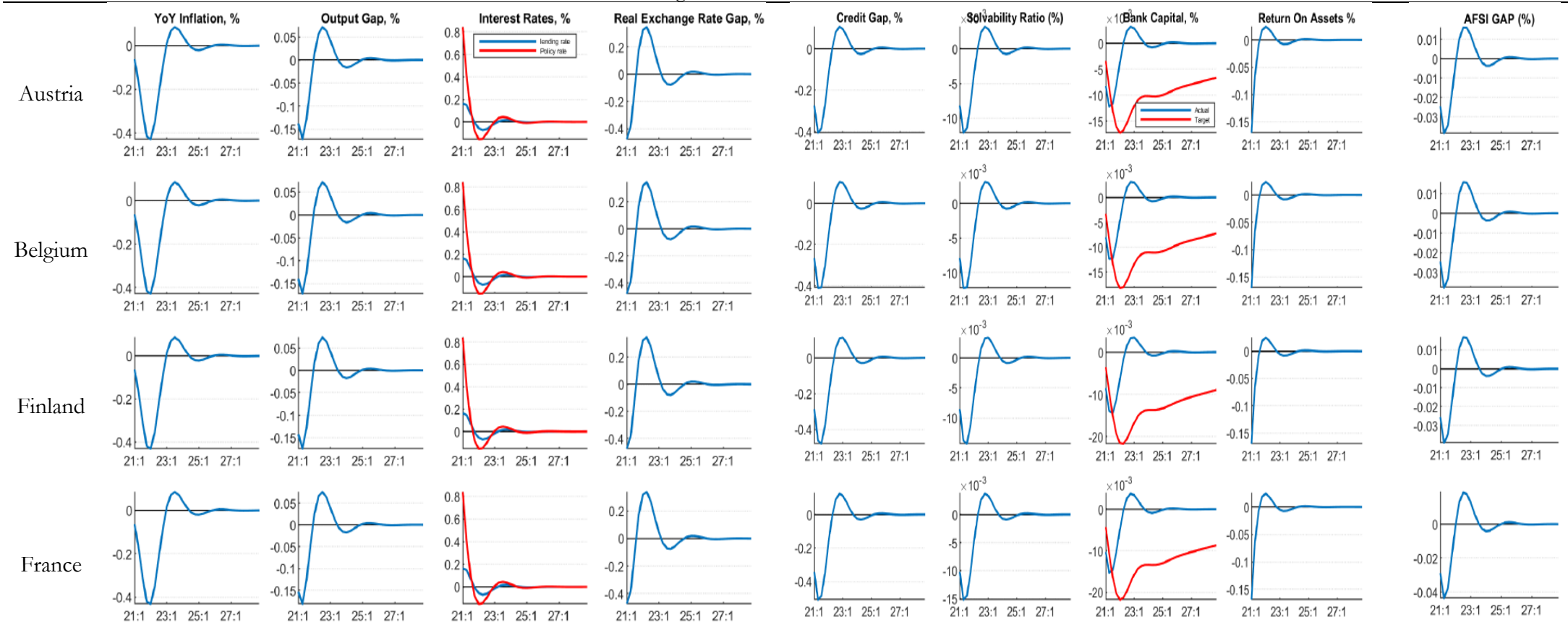


Figure C.3 (continue): Interest rate shock

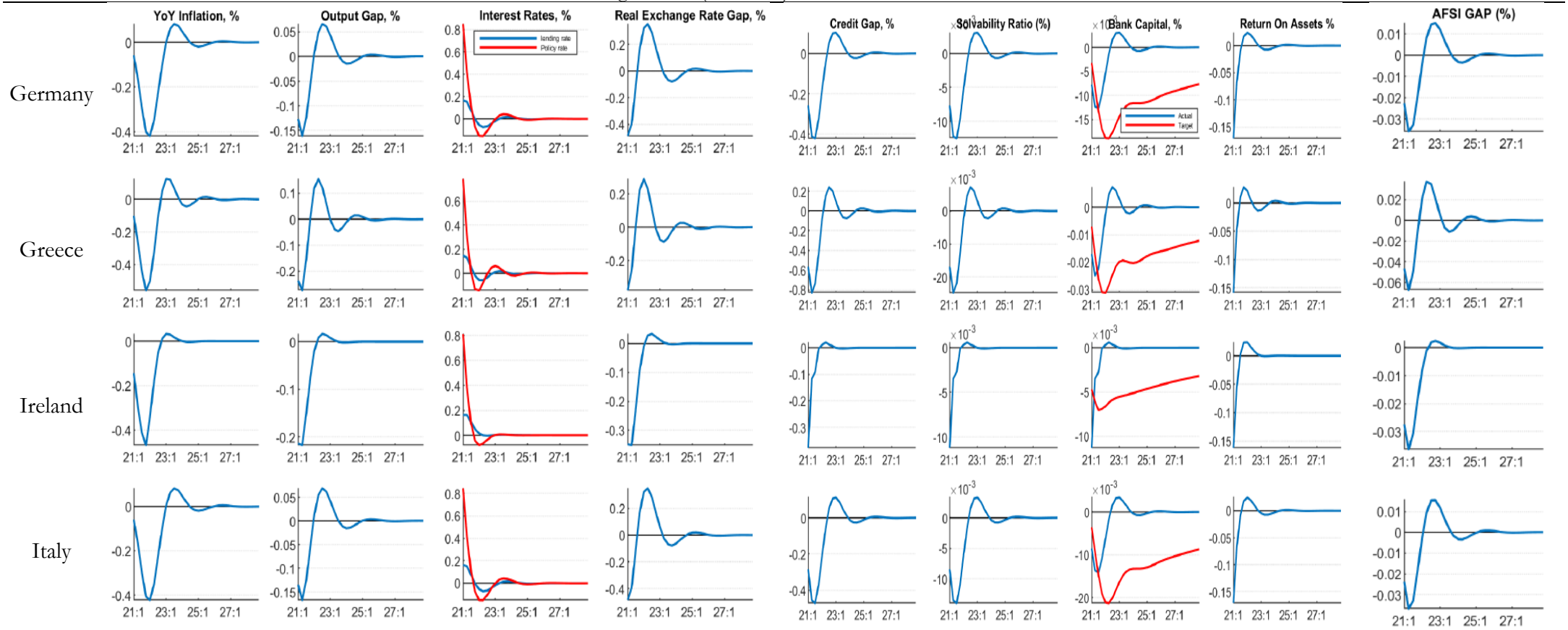


Figure C.3 (continue): Interest rate shock

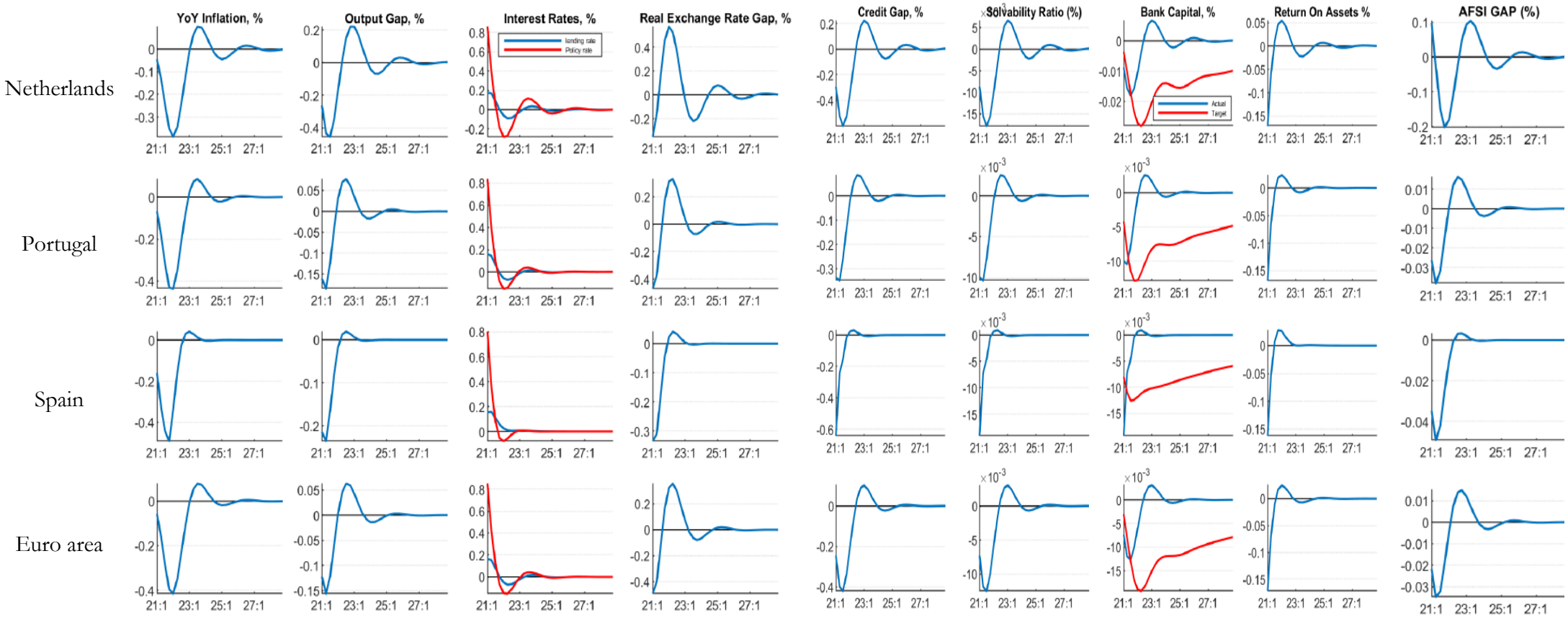


Figure C.4: Credit demand shock

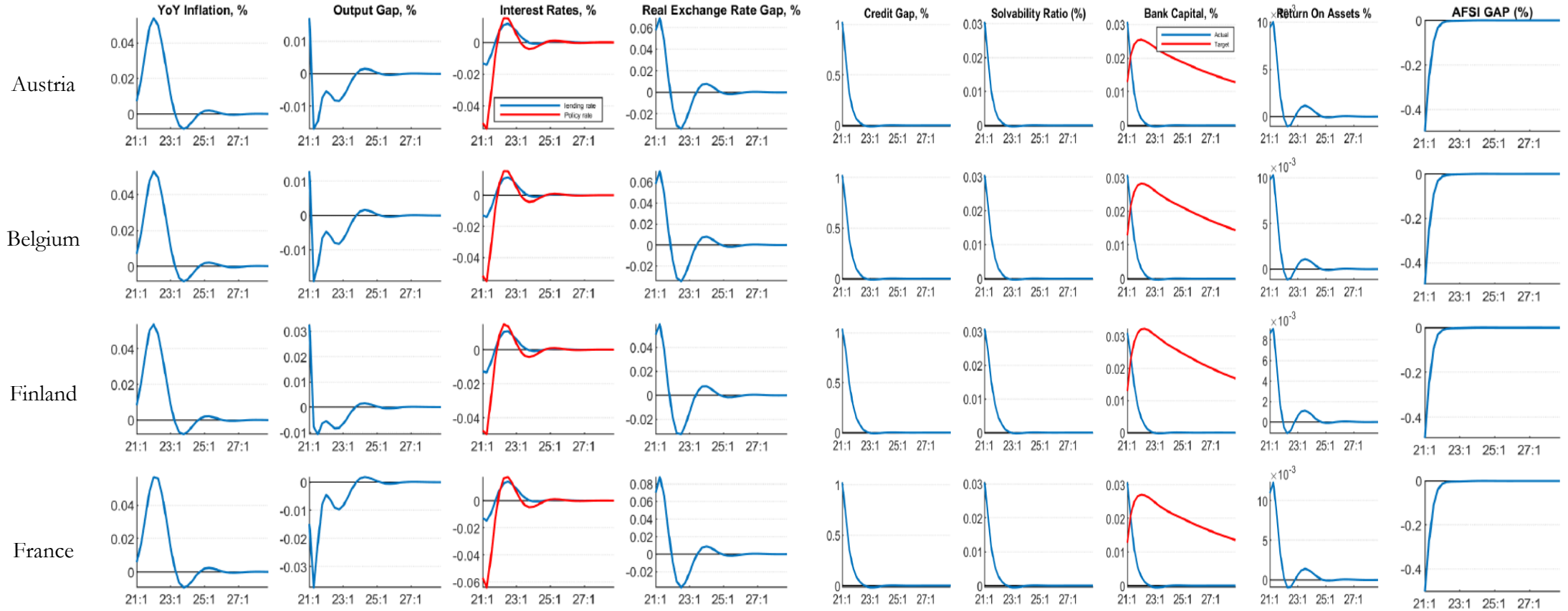


Figure C.4 (continue): Credit demand shock

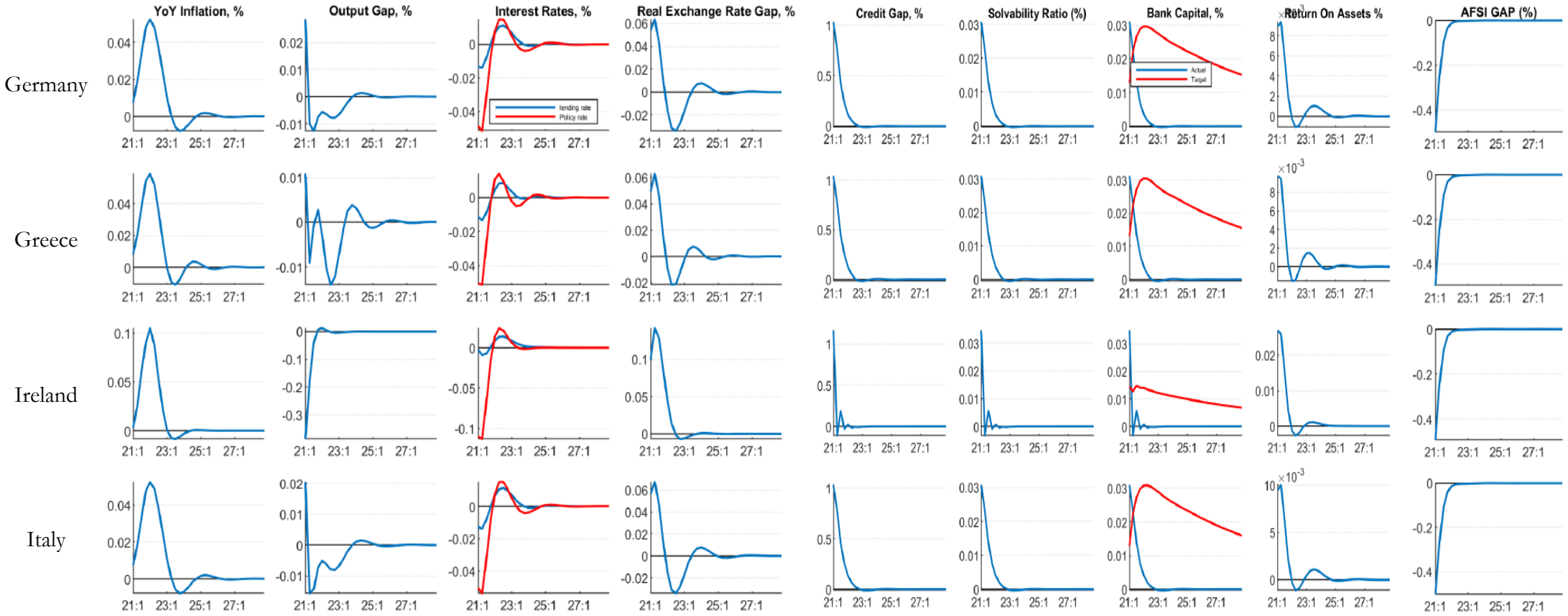


Figure C.4 (continue): Credit demand shock

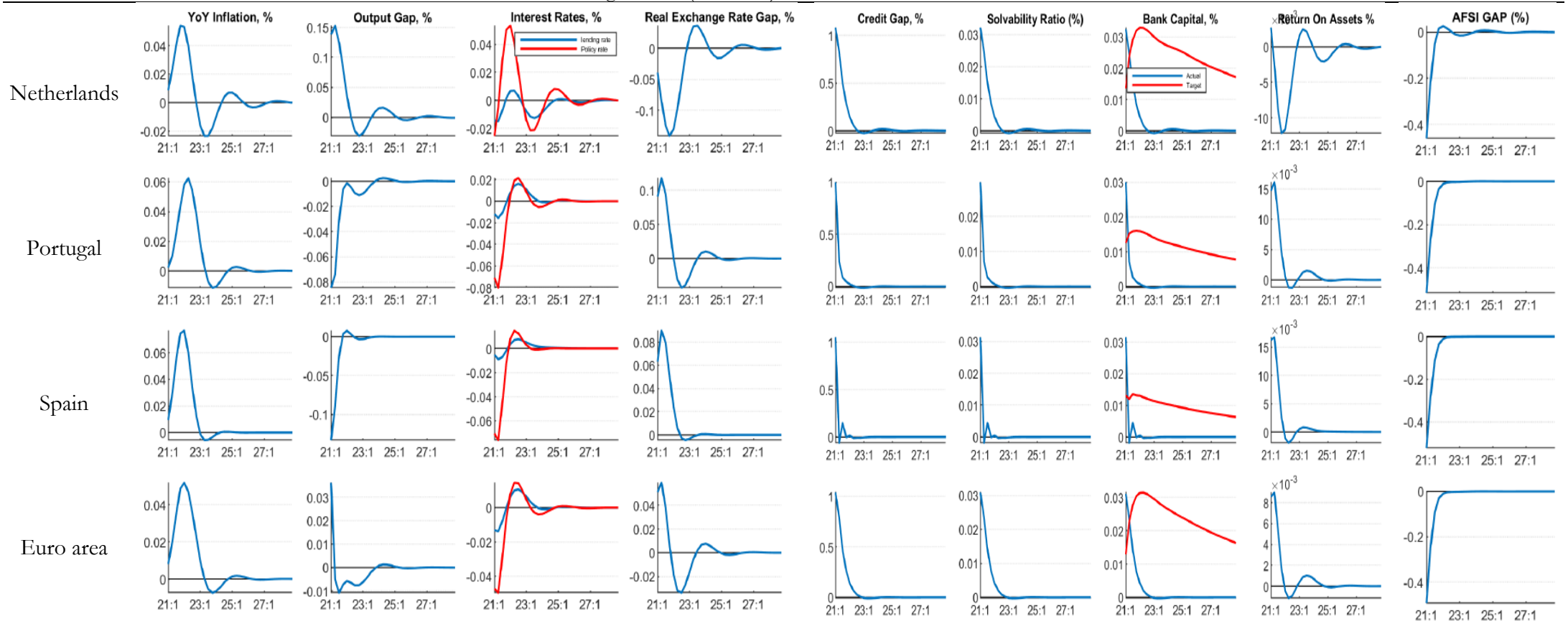


Figure C.5: Solvability ratio shock

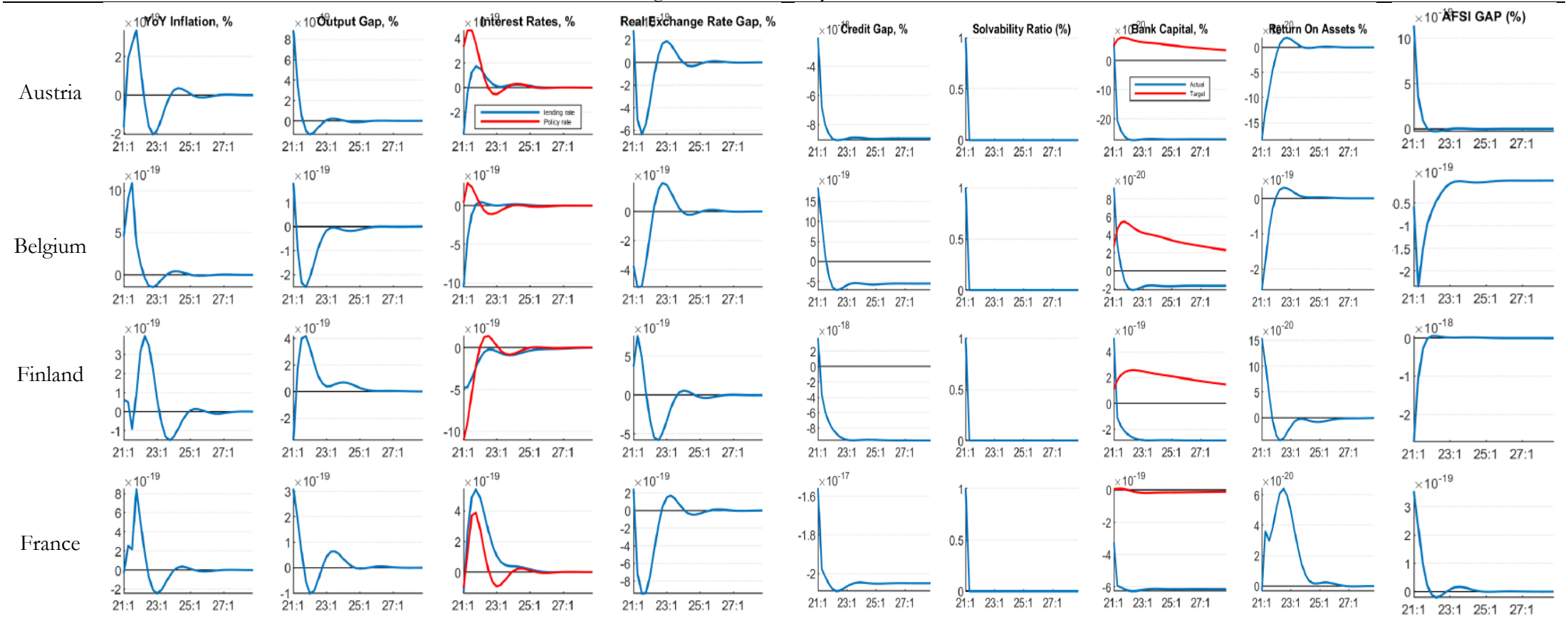


Figure C.5 (continue): Solvability ratio shock

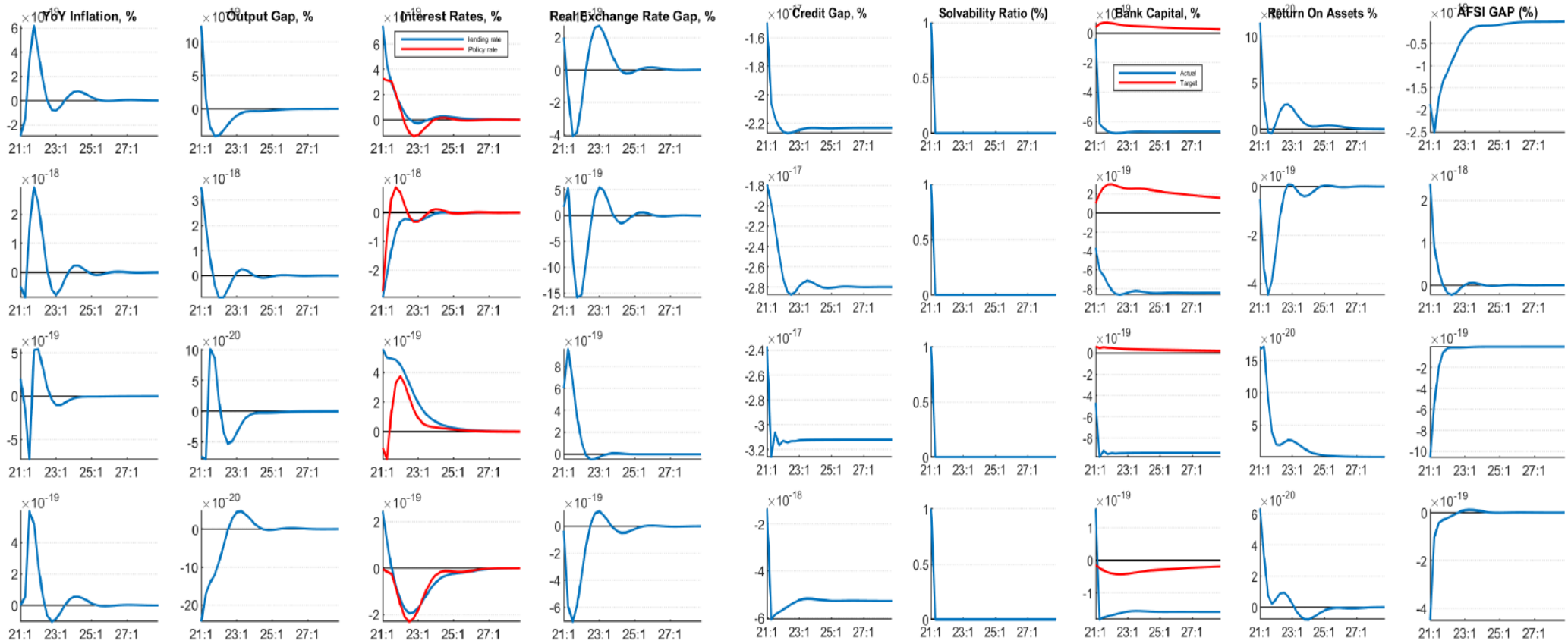


Figure C.5 (continue): Solvability ratio shock

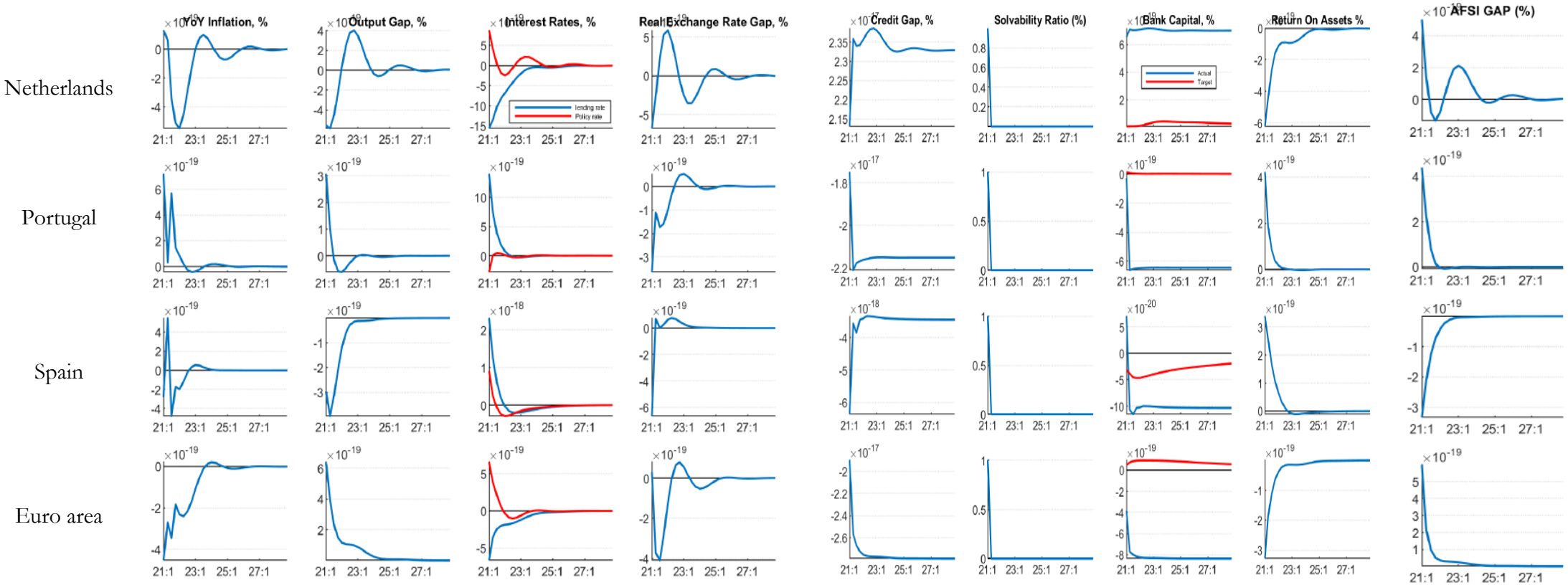


Figure C.6: Countercyclical capital buffet shock

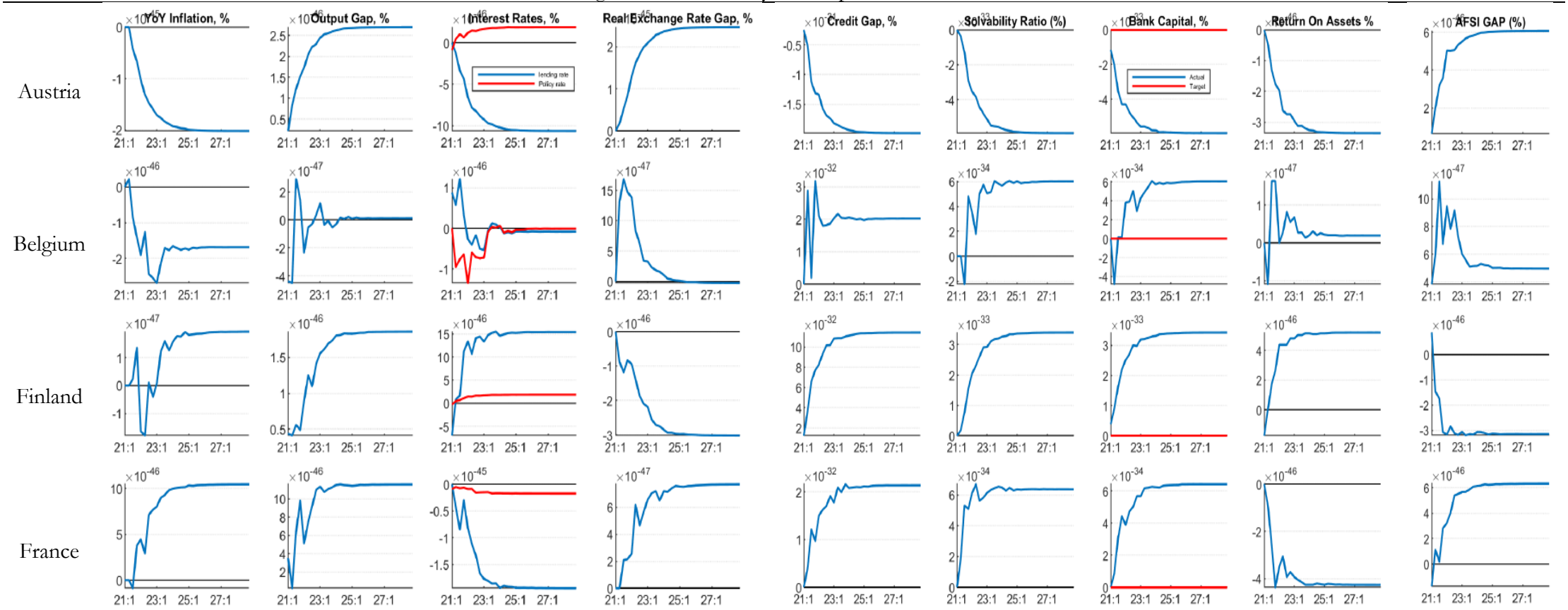


Figure C.6 (continue): Countercyclical capital buffet shock

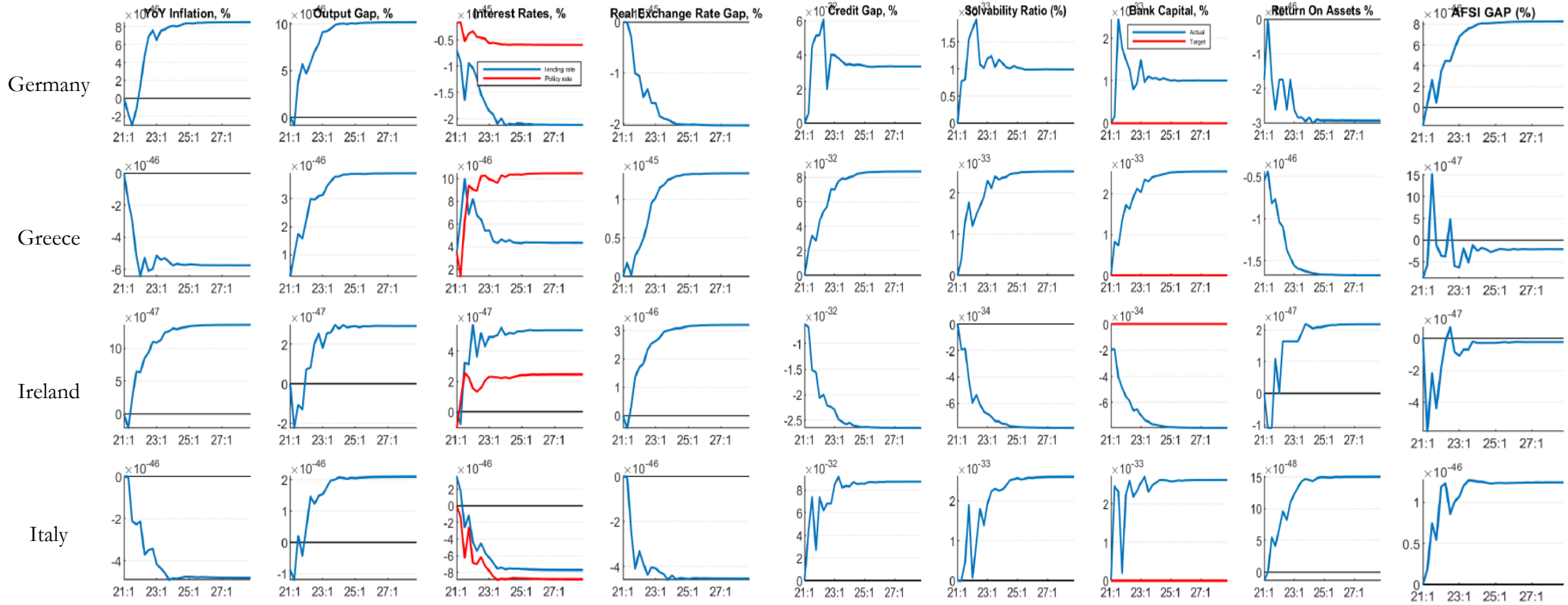


Figure C.6 (continue): Countercyclical capital buffet shock

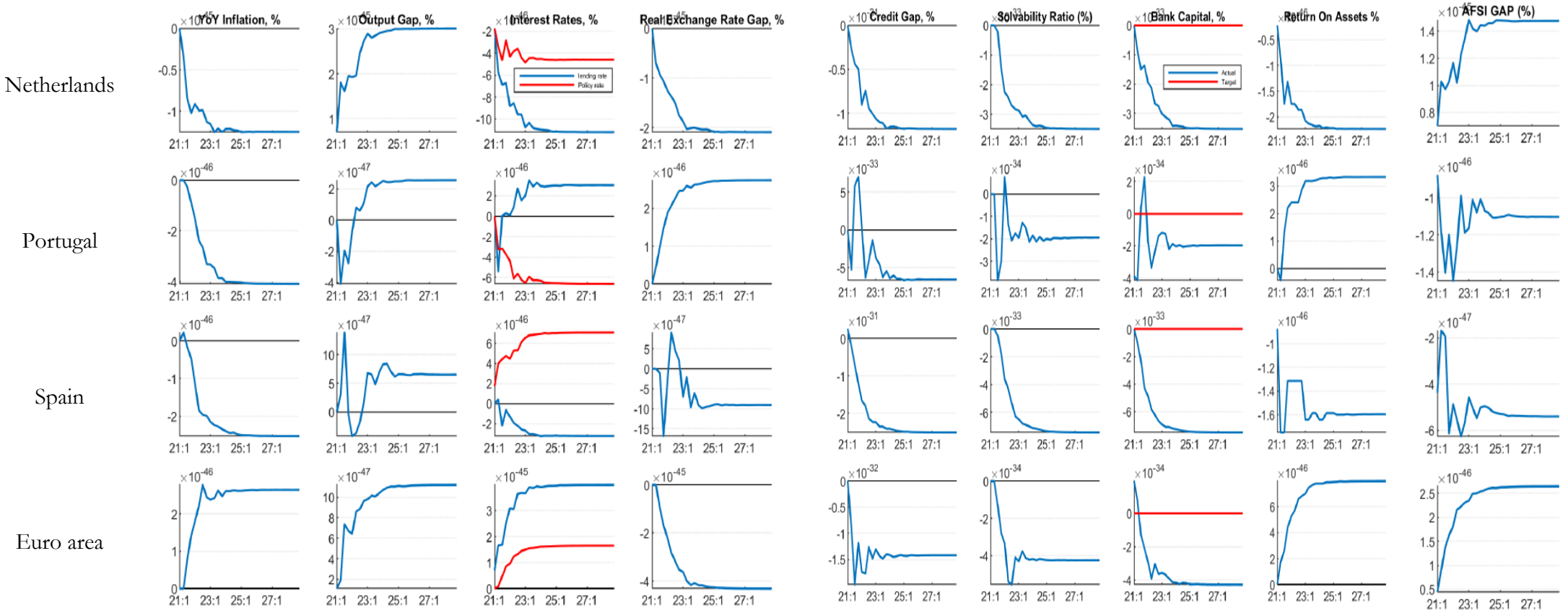


Figure C.7: Financial stability shock

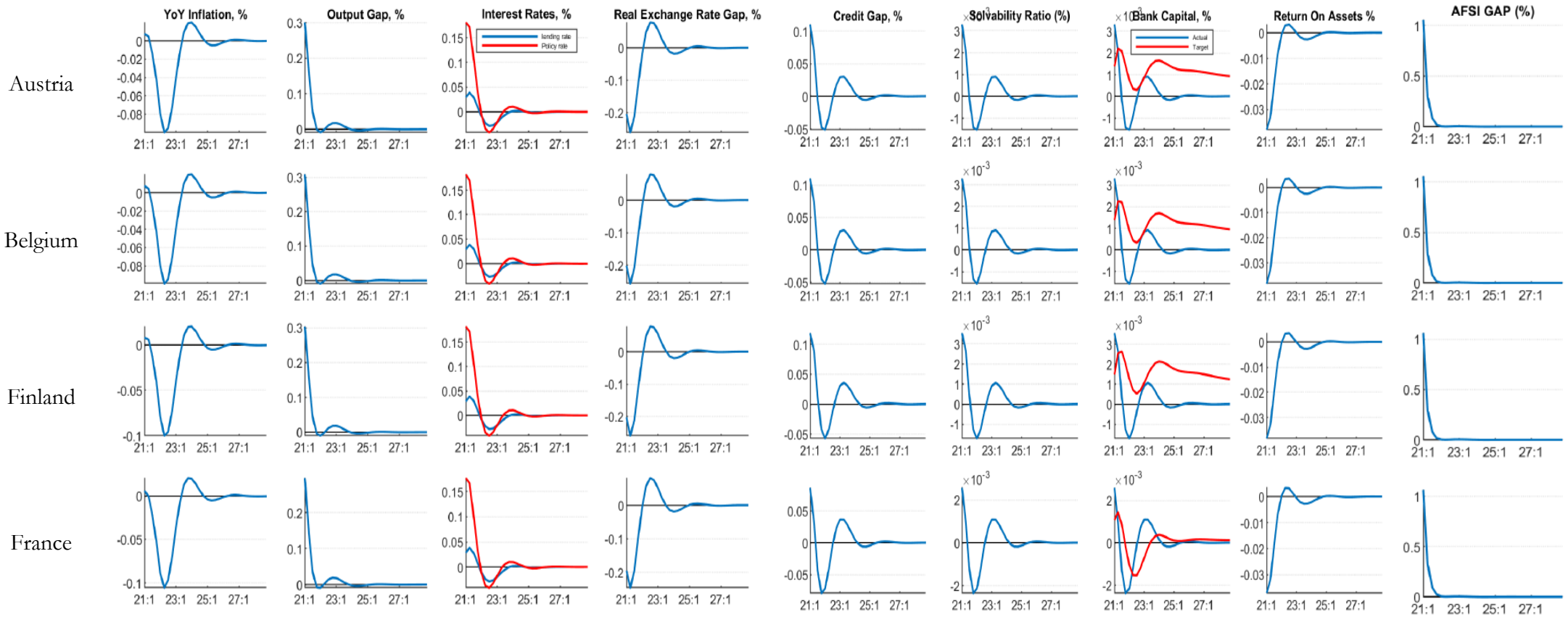


Figure C.7 (continue): Financial stability shock

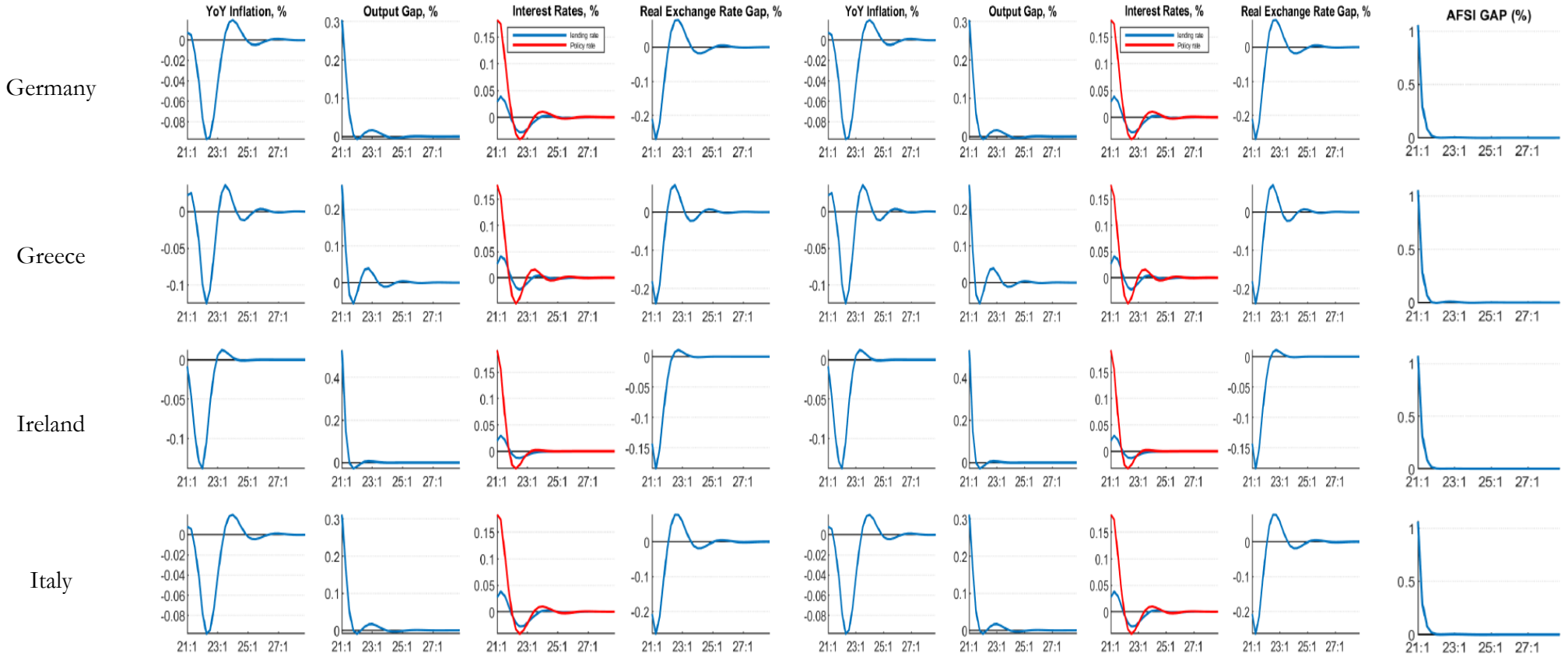
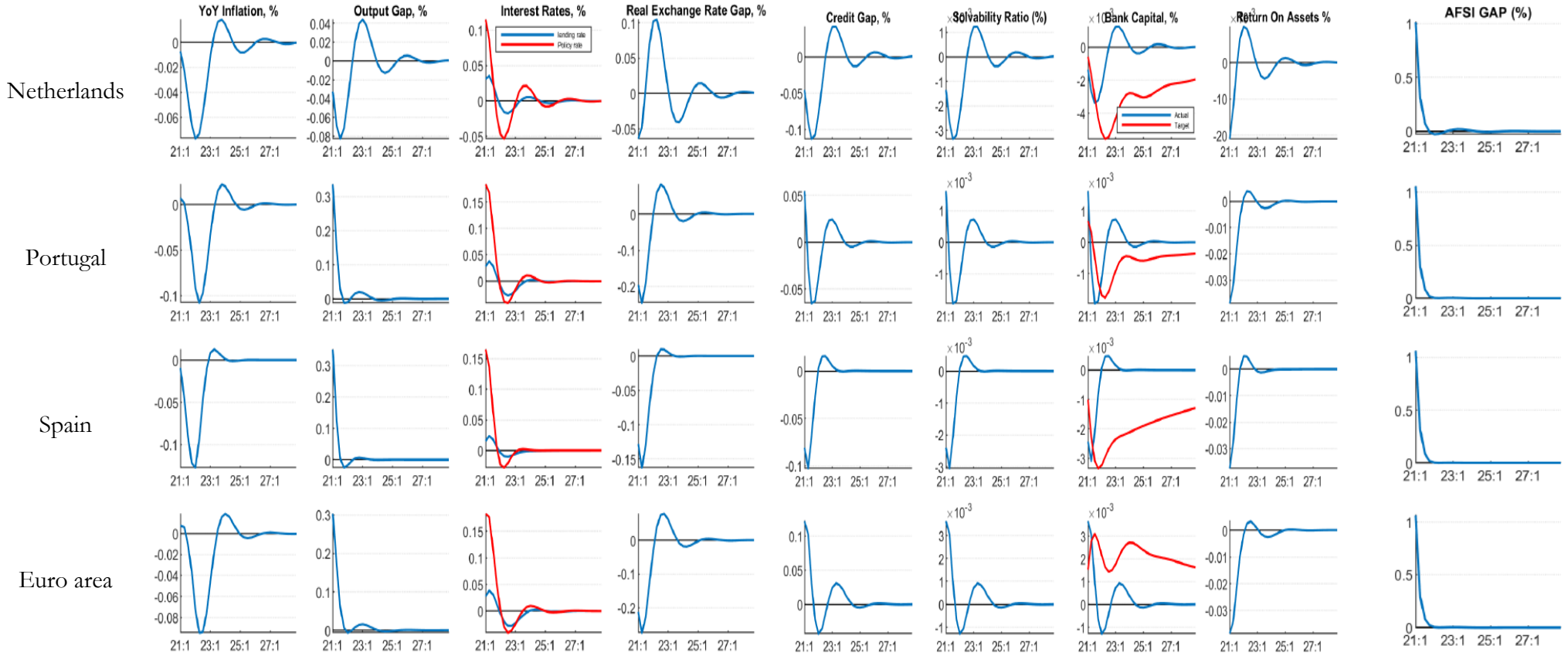


Figure C.7 (continue): Financial stability shock



Chapter 3

The effects of fiscal shocks on financial stability in euro area

Chapter 3

The effects of fiscal shocks on financial stability in euro area

Abstract: The objective of this chapter is to enhance comprehension of the impact of fiscal shocks on the financial stability and financial cycles of the euro area, focusing especially on public debt levels. To do this, we use i) the methodology developed by Hansen (2000) and ii) the non-linear panel local projection impulse response function approach developed by Jordà (2005). Our results are numerous. First, we identify a threshold of 71% for the public debt to GDP ratio, surpassing the Maastricht criterion of 60%. Second, in instances where public debt is high, shocks in government spending have a negative influence on the financial cycle; yet they bolster financial stability, indicating intricate interactions. Conversely, in situations where public debt is low, these shocks initially stimulate both the financial cycle and stability, but their effects diminish over time. Third, revenue shocks in high debt regimes moderately stimulate the financial cycle, but they have a detrimental impact on financial stability. These findings highlight the importance of coordinating fiscal and macroprudential policies and contemplating the implementation of a fiscal union within the euro area to ensure enduring financial stability and resilience.

Keywords: Fiscal Shocks, Fiscal Policy, Financial Stability, Public Debt, Nonlinear Panel Local Projection, Macroprudential Policy, Euro Area.

JEL Classification: E62, E63, G18, G28, H12, H63.

1. Introduction

Understanding how fiscal shocks influence the likelihood of ending a period of expansion or contraction has become imperative, especially in light of the recent global financial turmoil (Afonso and Sousa, 2011). This is justified by the fact that fiscal stimulus measures have become one of the most crucial responses to these financial disturbances (see, for example, Arestis, 2012). Indeed, these measures pose major challenges. On the one hand, they represent a crucial test of the long-term sustainability of public finances, as evidenced by the evolution of government bond markets (Schuknecht et al., 2009). On the other hand, they can lead to business cycle desynchronization (Rafiq and Mallick, 2008; Mallick and Mohsin, 2007, 2010) or have a negative impact on the correlation between monetary and financial stability (Granville and Mallick, 2009; Sousa, 2010).

In the Economic and Monetary Union (EMU),[82] for instance, the effects of budgetary shocks on financial stability stand out as a central enigma among the many complex questions that have emerged over the years. This question is crucial, as eurozone countries are sovereign entities, each with the freedom to decide its own budgetary policies while sharing a common currency, the euro. This means that EMU member states have given up their ability to formulate independent monetary policies, and exchange rates are no longer used as an adjustment tool. This situation may lead to specific imbalances that may be addressed through national measures. Until now, fiscal policy has been the main tool for correcting these imbalances (e.g., Blanchard and Giavazzi, 2002; Giavazzi and Pagano, 1990).[83] The resort to fiscal policy highlights the importance of coordinated efforts within the euro area to maintain economic stability (see, for example, Debrun et al., 2008).

The global financial crisis (GFC) of 2008–9 marked a turning point in understanding global economic interdependence, simply because it was a result of the interconnectedness of financial markets and showcasing how a crisis in one part of the world can quickly spread through the world. The shocks that began in US financial markets spread worldwide, exposing the fragility of global markets (see, for instance, Reinhart and Rogoff, 2009; Rajan, 2010). The eurozone was no exception, and the impact of the crisis was felt very quickly by member countries (Lane and Milesi-Ferretti, 2011; Baldwin and Giavazzi, 2016). This experience highlighted the central role of fiscal

[82] The EMU has faced huge challenges since its inception. The sovereign debt crisis of 2010–12 exposed the structural weaknesses of the euro area, particularly the lack of fiscal integration. Structural and institutional deficiencies, economic disparities between member states, and persistent unemployment are ongoing obstacles. Banking crises such as the 2008–9 global financial crisis and a complex political environment further complicate the problem. The unprecedented challenges posed by Brexit and the COVID-19 pandemic have complicated things further. Addressing these issues requires continued efforts to deepen economic and political integration, fiscal coordination, and reforms to enhance the resilience of the euro area.

[83] These papers show evidence of countries facing economic challenges taking fiscal measures to stimulate economic activity or manage public debt.

policy, as well as the intricate connections it shares with financial stability. Eichengreen and Wyplosz (2016) exemplify the different dynamics between budget decisions and financial stability in the euro area, which underscores that manifold relations exist between these two spheres. The sovereign debt crisis that emerged within the EMU during the early part of this decade also marked another turning point in history. It revealed fundamental differences in national budgetary policies and highlighted the structural vulnerabilities of the monetary union (De Grauwe and Ji, 2012; Lane, 2012).[84] National budgetary policies came under considerable pressure, leading to painful budget adjustments and repercussions for financial markets.

The academic literature on this issue is vast and diverse. Many studies have explored the mechanisms through which budgetary shocks affect the real economy and the financial market (see, for example, Blanchard and Perotti, 1999; Badinger, 2006; Akitoby and Stratmann, 2008; Afonso and Sousa, 2011). Researchers have examined the channels through which national budgetary policies, whether expansionary or restrictive, influence regional economic stability. Implications for monetary policy, exchange rates, and investor confidence have been meticulously scrutinized.

However, despite advances in research, many questions remain unanswered. *How do the specific characteristics of budgetary shocks, whether expenditure-related or revenue-related, impact financial stability? To what extent have reforms in the economic governance of the EMU succeeded in mitigating systemic risks? What lessons can we draw from past crises to guide future budgetary policies?* These are the questions that we will try to answer in this chapter. Specifically, we will seek to quantify the impact of fiscal shock on financial stability and the financial cycle, depending on the public debt condition in the EMU.

As highlighted by the ECB (2010), our analysis is motivated by the insight that governments and their fiscal policies are directly linked to the financial system. Variables such as the amount and maturity of government debt held by financial institutions, the amount of government debt backed by the credit default swap market, and the proportion of intrabank loans backed by government securities as collateral can significantly affect the correlation between fiscal policy and financial stability. In the past, however, the goal of promoting financial stability has received little attention as a standard objective of fiscal policy. As a result, few studies have examined the relationship between fiscal policy and financial stability. Furthermore, to our knowledge, no empirical study has specifically investigated the impact of fiscal shocks on financial stability while considering the level

[84] De Grauwe and Ji (2012) and Lane (2012) provide valuable insights into the challenges faced by the EMU during this critical period.

of public debt. Therefore, the aim of our study is to fill this gap and contribute to the understanding of how fiscal policy affects financial stability.

The main objective of this chapter is to gain insights into the impact of fiscal shocks on the financial stability and cycles of the euro area, while also considering the level of debt. Its significance lies in the interconnectedness of fiscal and financial sectors, offering insights into the repercussions of fiscal shocks for the financial market and investor sentiment. Also, it has policy implications and guides effective response in the euro area, which is characterized by a common currency but different fiscal policies. Understanding market dynamics is important for managing risk – it forms part of the broader goal of achieving macroeconomic stability. This particular study allows us to consider a specific situation that has formed in the euro area and to identify measures that can ensure economic resilience and stability by managing the related risks. The main goal is to shed light on this complex relationship, which can influence market behavior, investor confidence, and interest rates. Policymakers can use this deeper understanding to formulate targeted policies to promote stability and resilience. Coordination of fiscal policies among euro area member states is crucial to addressing the challenge of reconciling national budgetary sovereignty with regional financial stability. The study mission extends to unraveling the multifaceted channels through which fiscal decisions affect financial markets and institutions. The study can provide a call for coordinated fiscal policies and macroprudential measures if it clearly shows that fiscal shocks are important for financial stability. Then it may also imply the need for adaptive strategies that ensure both the stability and prosperity of the eurozone's economic environment.

The remainder of this chapter is structured as follows. Section 2 reviews previous relevant literature. Section 3 presents the econometric framework used. Section 4 describes the data and its statistical properties. Section 5 provides a commentary on the results and the specification tests. Section 6 assesses the long-term fiscal and budgetary evolution of the eurozone from the perspective of institutional economics and political economy. And Section 7 concludes.

2. Related literature

The empirical research on the impacts of fiscal shocks on financial stability is notably limited, in contrast to the abundance of work on real economic activity, which gives rise to much debate (see for instance, Blanchard and Perotti, 1999; Fatás and Mihov, 2001; Perotti, 2002; Badinger, 2006; Mountford and Uhlig, 2009; Reinhart, 2010; Corsetti et al., 2012; Auerbach and Gorodnichenko,

2012; Caggiano et al., 2015).[85] However, considering the relationship between the effects of macroeconomic shocks and financial stability, as analyzed by N'Goran (2022), it is plausible to assert that the second body of literature partially encompasses the first. The premises for the correlation between fiscal policy and real economic activity were laid down by the pioneering work of Blanchard and Perotti (1999) and developed by Perotti's (2002) research. These studies explore the impact of fiscal shocks on various economic indicators. Corsetti et al. (2012) evaluate government consumption's macroeconomic impacts across 19 OECD countries, identifying variations in responses based on exchange rate frameworks. Caggiano et al. (2015) estimate non-linear VAR models and find that government spending multipliers exceed 1 during recessions, contrary to previous studies. These findings are validated by Auerbach and Gorodnichenko (2013a), who use a regime-switching structural vector autoregression (SVAR) methodology and dataset of OECD countries. Ramey and Zubairy (2018) investigate US government spending multipliers, suggesting low multipliers that question the stimulative effects of public purchasing increases. Blot et al. (2014a) treat fiscal austerity and consolidation as equivalent to fiscal stimulus, suggesting that reductions in public purchasing might not significantly harm the private sector.

Several studies have investigated the impact of fiscal multipliers on the fiscal position, a critical factor for financial stability. Corsetti et al. (2012), Blot et al. (2014b), Bi et al. (2016), and Aussilloux et al. (2018) are among these analyses. Blot et al. (2014b) use a macroeconomic model to simulate public debt and output dynamics for 11 EMU countries, considering time-varying fiscal multipliers, to assess their ability to meet the revised EMU Stability and Growth Pact targets. Bi et al. (2016) employ a real business cycle framework, finding that fiscal multipliers are generally smaller in states with high debt, especially with income tax adjustments, but uncertainties about timing, reaction magnitude, and debt target play a crucial role. Aussilloux et al. (2018) conduct a simulation exercise for public expenditure reduction in France, aiming for a best-case scenario of reducing the public debt to GDP ratio from 100% to 75% by 2040. Poghosyan (2017) explores factors influencing sovereign debt cycles in 57 advanced and emerging economies from 1960 to 2014, revealing an asymmetric relationship between financial and debt cycles, with debt expansions following credit overheating being more prolonged, and duration dependence in both expansion and contraction phases.

[85] Reinhart (2010) notes the rise in the use of fiscal measures during the 2007–9 global financial crisis, sparking discussions about fiscal multipliers. For example, Blanchard and Perotti (1999) use a SVAR model to analyze the impacts of public expenditure and tax revenue shocks on the American economy. Badinger (2006) contradicts neoclassical predictions by finding that public spending shocks initially increase production and consumption in Austria. See, for example, Baum and Koester (2011) or Cimadomo (2011) for a large literature review.

Despite the various identification schemes of fiscal policy shocks employed to assess the macroeconomic effects of fiscal policy, the potential role of fiscal policy in financial stability has received less attention. Exploring the impact of fiscal shocks on financial stability begins with a historical background, emphasizing that financial crises are not new and have occurred repeatedly in history. The work of Reinhart and Rogoff (2010) provides insights into patterns and similarities in financial crises across centuries, shedding light on the potential relevance of fiscal policy in mitigating or exacerbating these crises. Building on this, the discourse on the subject has primarily centered on the effects of fiscal policy on long-term interest rates (Gale and Orszag, 2003; Brook, 2003; Laubach, 2009) and macroeconomic variables such as GDP, consumption, and its components, as well as investment and its components.

Cecchetti et al. (2011) guide us to the heart of the matter – the real effects of debt. In this analysis the authors assess how excessive debt levels can impact economic activities and contribute to financial instability, offering a contemporary perspective. Using empirical specification derived from the neoclassical growth model and 18 OECD countries from 1980 to 2010, they find that when a country's national debt reaches around 85% of its gross domestic product (GDP), additional increases in debt can begin to have a significant impact on economic growth. In particular, a subsequent 10-percentage-point increase is associated with a decline in trend growth of more than one-tenth of a percentage point.

On the other hand, Bernanke et al. (1999) introduce the concept of the financial accelerator in a quantitative business cycle framework, elucidating how disruptions in financial markets can amplify the impact of fiscal shocks on the real economy.[86] Furthermore, Mendoza and Terrones (2008) provide an anatomy of credit booms, offering insights into how macro aggregates and micro data can inform our understanding of the credit cycle. Mian and Sufi (2009) contribute significantly by examining the consequences of mortgage credit expansion, specifically delving into the US mortgage default crisis. Their work underscores the critical linkages between fiscal policy, credit markets, and the broader economy. Gorton (2012) challenges conventional wisdom by exploring why financial crises are often misunderstood, urging a reconsideration of how fiscal policy interacts with the financial sector. Rajan (2005) offers a stimulating analysis of whether financial development has made the world riskier, prompting researchers to take a close look at how fiscal policy might mitigate systemic risks. Thus, Jordà et al. (2016) take a historical approach and explore

[86] Disruptions in financial markets can act as an amplifier for the effects of fiscal shocks by constraining credit, raising interest rates, inducing asset price volatility, affecting wealth, causing a liquidity squeeze, and facilitating global contagion. These dynamics underscore the importance of stable and well-functioning financial markets for mitigating the adverse consequences of fiscal shocks on the real economy. See, for example, Caldara and Kamps (2008).

macro financial and new business cycle facts, highlighting the importance of understanding long-term trends in fiscal and financial dynamics.

The dynamics of credit markets play an important role in the transition of fiscal shocks to the broader economy. Dell'Ariccia et al. (2008) examine the intricate relationship between credit booms and lending standards, focusing on the subprime mortgage market. Favara and Imbs (2015) and Justiniano et al. (2015) examine in-depth the key impact of credit supply on housing markets. Using an equilibrium model, these studies highlight the importance of understanding how fiscal policy can affect credit conditions and, consequently, asset prices. Jappelli and Pistaferri (2007) emphasize how the impact of fiscal measures, particularly through subsidies and tax policies, can influence the dynamics of housing markets. One explanation provided is that capital taxes on housing gains, reduced value-added tax (VAT) on home purchases, tax deductibility of interest payments, or taxation of the imputed rental value of the house are just a few examples of how fiscal policy can play an important role. Similarly, tax subsidies for the purchase of new homes can drive up demand and prices, especially in the context of an inelastic housing supply. Furthermore, when the sovereign financing needs are lower and the budgetary situation is healthier, a country's interest rates may be lower, and mortgage loans may come with more favorable financing terms.

Looking at the behavior of the financial markets around episodes of significant fiscal change, in his early work Darrat (1988) demonstrates that the Canadian stock market exhibits a positive response to escalating public deficit. However, this reaction turns negative when we consider lagged values of the public deficit. Divergent results are presented by van Aarle et al. (2003), Ardagna (2009), and Agnello and Sousa (2011). For instance, van Aarle et al. (2003), using a SVAR model and quarterly data for 12 EMU countries, find divergent results. Their results indicate that following an increase in the public deficit, stock markets rise in the EMU-12 but fall in the USA and Japan.

Meanwhile, Arin et al. (2009) use quarterly data observation for G3 countries (the USA, Japan, and Germany)[87] and VAR models to examine the response of macro and financial variables to fiscal policy innovations. The authors examine various aspects of tax policy and find that not all taxes have a depressive effect on stock returns. Specifically, indirect taxes and labor taxes both show a significant negative impact on market excess returns, while corporate taxes have no significant response. The magnitude of the impact of indirect taxes on stock returns is larger than the effect of labor taxes. In terms of changes in corporate taxation, companies will be less affected, as they can choose their capital structure (choosing between debt and equity financing). Faced with rising

[87] Their data ranges are, respectively, 1973Q2 to 2005Q4 for the USA, 1978Q4 to 2005Q4 for Japan, and 1967Q1 to 1991Q3 for Germany.

corporate income tax liabilities, companies can mitigate the impact on their returns on equity by turning to debt financing, as evidenced by a concurrent rise in interest rates. Likewise, using a panel VAR consisting of 10 industrialized countries, Agnello and Sousa (2011) show a negative stock market reaction to an escalation in primary fiscal deficits, although this reaction appears to be temporary.

Although the results differ, a more consistent pattern emerges when the effects of government spending and revenue on the stock market are examined separately. Afonso and Sousa (2011), using a VAR counter-factual analysis and quarterly data for four countries (the USA, the UK, Germany, and Italy),[88] find that government spending shocks have a negative impact on stock prices, while government revenue shocks have a small but positive impact. Their VAR analysis shows that fiscal shocks play a limited role in US and German asset markets but have a large impact on stock price volatility in the UK, leading to heightened volatility in Italy because of government revenue shocks.

Ardagna (2009) stands out for his essential contribution to the literature. The author adds nuance to the understanding of how fiscal policy impacts different segments of financial markets. The author, employing a panel of OECD countries covering the period from 1960 to 2002, analyzes the effect of fiscal policy shocks on financial variables. The analysis departs from most of the literature, which typically focuses on government bond rates, by broadening the scope of the investigation to include consumer and business interest rates and stock market prices. He shows that, for OECD countries, fiscal adjustments signaling a healthier fiscal behavior (such as a reduction in public spending or fiscal consolidation in the form of a permanent and substantial decrease in public debt) are typically associated with increases in stock prices. However, these responses of stock prices to major changes in fiscal policy depend on the initial fiscal situation of each country and the characteristics of fiscal austerity.

Foresti and Napolitano (2016) use panel dynamic ordinary least square (DOLS) analysis to examine the impacts of fiscal policies on stock market indexes in 11 countries of the eurozone. They find that fiscal policies have an impact on the stock market. Specifically, after a rise (fall) in the public deficit, stock market indexes experience a decline (increase). However, additional analysis reveals that the direction of the observed stock market responses is not consistent over time, varying depending on the broader macroeconomic context. Taguchi and Enkhbaatar (2019) investigate the link between stock market and macroeconomic policies (fiscal and monetary policies) in Mongolia using a VAR model and quarterly data from 2000Q1 to 2017Q4. They base their analysis on the

[88] The data cover the following periods: 1970Q3–2007Q4 for the USA, 1971Q2–2007Q4 for the UK, 1979Q2–2006Q4 for Germany, and 1986Q2–2004Q4 for Italy.

assumption that recent fiscal and monetary policy biases are distorting stock price formation. Their analysis reveals that the cumulative public debt and high policy rate have stagnated stock prices.

André et al. (2023) examine the influence of fiscal policy on the stock markets of the euro area, focusing on the effects of a government spending shock at the effective lower bound (ELB). The authors employ a factor-augmented interacted panel vector-autoregressive (FAIPVAR) model to assess the effects of this shock. Their research demonstrates that the effect of the government spending shock varies significantly between the periods of the ELB and non-ELB, with a notably stronger positive impact on stock market returns during the ELB period. In contrast, the disparities are not statistically noteworthy for the USA when employing a factor-augmented interactive vector-autoregressive (FAIVAR) model based on time series data.

Others studies contend that fiscal policy can have a direct impact (through bond markets and interest rates) and an indirect impact (via stock market returns) on financial markets. As an illustration, Tavares and Valkanov (2003), using US data spanning 1960 to 2000, show that an increase in government spending has a positive effect on expected returns. However, the impact is statistically significant only for bonds, particularly in the short term. Their analysis reveals that fiscal policy shocks contribute to 3–4% of the variation in unexpected excess stock returns and 8–10% of the variation in unexpected excess bond returns. Using panel estimation of advanced and developing countries[89] over the period 1985–2012, Johnson and Kriz (2005) highlight that revenue constraints have a direct impact on state government borrowing, while the impact of spending, budget balancing, and debt rules work indirectly through improvements in credit ratings. Their results show that the impact of fiscal rules on bond spreads is small, ranging from 2.4 to 3.3 basis points.

In the context of the euro area, Hallerberg and Wolff (2008) employ a panel data analysis to assess the effect of fiscal institution such as the strength of the finance minister in the budget process and deficits on interest rate spreads of eurozone countries. The authors demonstrate that fiscal institutions wield considerable impact on government bond yields. They find that the quality of fiscal governance, particularly in the budgeting process, is a significant determinant of sovereign spreads. Iara and Wolff (2011)[90] observe in their study that fiscal rules have no significant overall impact on risk premia. However, they find significant effects when indicators of fiscal rules interact with overall market risk aversion. Therefore, fiscal rules have a negative impact on bond spreads,

[89] Where 44 countries adopted a numerical rule on the fiscal balance and/or the stock of public debt.
[90] Iara and Wolff (2011) develop a model of sovereign spreads determined by the probability of default in their interaction with the level of risk aversion. Their empirical analysis is based on a dataset covering 11 euro area countries from 1999 to 2009.

especially in market environments with higher risk sensitivity. The authors conclude that state fiscal rules have proven beneficial for markets in assessing the government's ability and commitment to repay debt in a timely manner.

Many works, including Bernoth and Erdogan (2012), Caggiano and Greco (2012), and Maltritz (2012), have identified the impact of international and country-specific risk factors on bond spreads. These factors encompass government debt levels and various market dynamics, including liquidity issues and fiscal policy, which combine to shape the dynamics of bond spreads. For instance, in their study of government bond yield spreads in 10 EMU countries from 1999Q1 to 2010Q1, Bernoth and Erdogan (2012) used a semi-parametric time-varying coefficient model to identify factors that influence changes in yield spreads. Their results show that initial government debt levels and investors' overall risk aversion had significant effects on spreads. As time went on, the importance of a country's fiscal stability became less of a worry for financial markets, causing Germany's reputation as a safe haven to lose significance (Habib et al., 2020). The authors emphasize that even before the collapse of Lehman Brothers in 2008, the increasing aversion to risk among investors started to affect sovereign risk premia and revive Germany's reputation as a financial refuge. A year later, when financial markets started to become unsettled, the market's reaction to fiscal easing became much more pronounced.

Born et al. (2020) study the effect of austerity on sovereign default premia. The authors create a new dataset covering 38 emerging and developed economies, including quarterly time series data covering government default premiums, government consumption, and production over the period 1991Q–2014Q4. They estimate a local projection and find that the effectiveness of austerity measures depends on (i) initial conditions and (ii) the time horizon of the review. Spending cuts increase default premiums during periods of fiscal stress but reduce them during better economic times. However, they argue that these results hold for the short term. These results are confirmed by David et al. (2022). Using the same methodology on a panel of 21 emerging market economies during 2000–18, their study reveals a substantial decrease in sovereign bond spreads following the announcement of legislative approval for austerity measures. This trend is particularly evident during periods of elevated sovereign bond spreads or in countries operating under an IMF program. Furthermore, their analysis indicates that the impact of consolidation announcements on economic output is less severe when sovereign spreads decrease. In such instances, the reduction in output is only half of what would be expected in a scenario where spreads do not respond to the announcements. This provides compelling evidence that confidence effects, as manifested through lower sovereign spreads, play a crucial role in transmitting fiscal shocks.

Some empirical studies have focused on the effect of fiscal shock on sovereign credit risk, which reflects the likelihood of a government defaulting on its debt. This part of the literature interest us, since sovereign credit risk has profound implications for financial stability.[91] These studies include Cantor and Packer (1996) and Afonso et al. (2007), who underscore the importance of a country's macroeconomic and fiscal variables as key determinants of sovereign credit ratings. Akitoby and Stratmann (2008) use country-annual data observed from 1994 to 2004 and a panel model framework to investigate the impact of fiscal policy on sovereign credit spreads in emerging markets. They demonstrate that adjustments based on revenue have a greater effect in reducing spreads than those based on expenditure. Furthermore, while debt-financed expenditure increases sovereign risk, realigning public spending funded by taxes lowers spreads, indicating a preference for this approach among investors. Robinson (2015) confirms the significance of fiscal policy decision-making and fiscal balance as key issues in determining sovereign risks for South Africa.

Bi (2012) develops a closed economy model to study the interactions among sovereign risk premia, fiscal limits, and fiscal policy, finding that a non-linear relationship between sovereign risk premia and the level of government debt emerges. Additionally, by doing non-linear simulations, the author shows that short-term austerity measures aimed at achieving immediate fiscal balance are not effective in reducing default risk premiums, even if government purchases are significantly reduced. On the contrary, a comprehensive and long-term financial reform plan can effectively change market expectations for future financial policies, potentially mitigating rising risk premiums.

Hantzsche (2022) investigates the influence of fiscal uncertainty on sovereign credit risk, focusing on how periods of economic crisis and significant fiscal intervention contribute to increased uncertainty regarding the future fiscal position of governments. The study considers expert assessments, particularly in relation to evaluating sovereign credit ratings. Through an empirical framework, the authors estimate the factors that determine sovereign credit risk. The findings reveal that fiscal uncertainty enhances the ability of sovereign credit rating models to predict outcomes, shedding light on why such ratings undergo more frequent changes during crises. Additionally, heightened uncertainty leads to heightened scrutiny of sovereign credit ratings, potentially intensifying the challenges faced by governments in managing their financial obligations.

Given the aforementioned observations, it is evident that the empirical research on fiscal shocks and financial stability is growing, and the discourse surrounding this topic has predominantly

[91] Sovereign credit risk may lead to currency devaluation (Reinhart and Rogoff, 2011). This could lead to investors selling the local currency based on concerns about the government's fiscal health, leading to a weaker exchange rate. Currency depreciation may increase the cost of servicing foreign currency debt and exacerbate inflationary pressures that affect financial stability.

focused on market stability. While financial markets undeniably play a pivotal role in the financial disruptions impacting our economies, it is imperative to adopt a more comprehensive perspective of financial stability, extending beyond market dynamics to encompass other sectors of the economy. This study endeavors to contribute to this debate. We empirically examine the influence of fiscal policies on financial stability, employing a methodology that we will elaborate on in the next section.

3. Econometric framework: A nonlinear panel local projection

We apply Jordà's (2005) local projection model to our panel data of 11 euro area countries in order to analyze whether the effect of fiscal policy shock on financial cycles and financial stability depends on the public debt condition. The methodology developed by Jordà (2005) involves estimating a series of regressions for each variable at different horizons, *h*. The linear model takes the following form when a shock is identified:

$$y_{t+h} = \alpha_h + \phi_h(L)x_{t-1} + \beta_h shock_t + u_{t+h} \quad (1)$$

with $h = 0,1,\dots,H-1$. Where y is the variable of interest, α_h denotes the regression constant, x is a vector of control variables, $\phi_h(L)$ is a polynomial in the lag operator, and $shock_t$ is the identified shock variable. The coefficient β_h corresponds to the response of y at time $t+h$ to the variable $shock$ at time t. The impulse responses are the sequence of all estimated β_h. The error term u_{t+h} is an *i.i.d.* vector of disturbances $(u_{t+h} \sim N(0, \sigma^2))$.

Following Auerbach and Gorodnichenko (2013b), Owyang et al. (2013), and Jordà et al. (2015), the model can be applied to panel data to estimate impulse responses. In this case the specification of the model is as follows:

$$y_{i,t+h} = \alpha_{i,h} + \phi_h(L)x_{i,t-1} + \beta_h shock_{i,t} + u_{i,t+h} \quad (2)$$

with $h = 0,1,\dots,H-1$. Where $y_{i,t+h}$ is the variable of interest (financial cycle or financial stability proxy in our case) for the country i at time $t+h$, $\alpha_{i,h}$ denotes (cross-section) individual effect, $x_{i,t-1}$ is a vector of control variables, and $shock_{i,t}$ is the identified shock. The shock is identified as fiscal shock and pertains to an unforeseen alteration in fiscal policy elements, such as government expenditure or taxation, that has the potential to generate noteworthy repercussions for the economy.[92] The vector of baseline control variables, $x_{i,t-1}$, includes logs of tax/GDP and

[92] These shocks can emerge from a multitude of origins, including alterations in governmental priorities, shifts in political dynamics, or responses to economic circumstances. Fiscal shocks can either be expansionary, characterized

government spending/GDP, and the public debt growth. $\phi_h(L)$ refers to a polynomial of order 4.[93] β_h gives the response of $y_{i,t+h}$ at time $t+h$ to shock. Therefore, the impulse responses are generated as a sequence of the estimated β_h in a series of single regressions for each horizon. The error term $u_{i,t+h}$ is an *i.i.d.* vector of disturbances. This approach is different to the standard method, where parameters of the VAR are typically estimated for horizon 0 and then iterated forward to construct the impulse response functions.

One of the most significant advantages of local projection is the seamless extension to non-linear frameworks. One straightforward method to partition data into two regimes involves using a binary (dummy) variable. However, a drawback of this approach is that it reduces the degrees of freedom available for analysis. Thus, following Ramey and Zubairy (2018), equation (2), in the state-dependance model (which corresponds to the model we estimate in this paper), becomes:

$$y_{i,t+h} = F(s_{t-1})\left[\alpha_{i,h}^{A} + \phi_h^{A}(L)x_{i,t-1} + \beta_h^{A} shock_{i,t}\right] + \left(1 - F(s_{t-1})\right)\left[\alpha_{i,h}^{B} + \phi_h^{B}(L)x_{i,t-1} + \beta_h^{B} shock_{i,t}\right] + u_{i,t+h} \quad (3)$$

with $F(s_t) = \frac{e^{-\gamma \hat{s}_t}}{1+ e^{-\gamma \hat{s}_t}}$, $\gamma > 0$, $\text{var}(s_t) = 1$, $E(s_t) = \mu = 0$ and $\hat{s}_t = \frac{s_t - \mu}{\sigma_s}$.

Where F is the logistic function that transforms the underlying series (the growth of debt) into a continuous variable between 0 and 1, indicating the state of the economy when the shock happens. The parameter γ governs the "smoothness" of the transition between states. Lower (absolute) values suggest infrequent extreme regime switches, with the economy often lingering in intermediate states. As γ increases, transitions become more abrupt, leading to clearer distinctions between periods of boom and bust.

The challenge posed by the local projections model is the serial correlation in the error terms caused by the consecutive leading of the dependent variable. To deal with this, the Newey–West correction is applied for our standard errors (Newey and West, 1987). However, in addition to separating the data into two regimes, the model offers the advantage of not imposing constraints on the shape of the impulse response function. Therefore, it is less susceptible to errors resulting from the misspecification of the SVAR. Another advantage of the model is that it does not necessitate the inclusion of all variables in all equations, allowing for a more parsimonious specification.

by augmented government spending or reduced taxes, or contractionary, characterized by diminished government spending or increased taxes. The ramifications of fiscal shocks can reverberate throughout the economy, influencing consumption, investment, employment, inflation, and other macroeconomic indicators. See, for instance, Blanchard and Perotti (2002), Romer and Romer (2010), and Auerbach and Gorodnichenko (2012).

[93] Selected based on the Akaike information criterion.

Additionally, the left-hand-side variables are not required to be in the same form as the right-hand-side variables, providing flexibility in modeling.

As drawbacks, in terms of impulse response calculation, the local projection method does not outperform the standard SVAR one, for the following reasons. First, it doesn't impose any constraints that connect the impulse responses at h and $h+1$, and the estimates can often be erratic because of decreased efficiency. Second, as the horizon expands, observations from the end of the sample are lost. Third, the impulse responses may exhibit oscillations at longer horizons (see, for instance, Romer and Romer, 2010).

4. Data

4.1 Sample of countries and fundamental variables

In order to estimate the model described in Section 3, we use quarterly data over the period 1999Q1 to 2021Q1 for 11 euro area countries (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain). The selected variables are traditional fiscal variables (government revenue and expenditure as a percentage of GDP and annualized quarter-over-quarter (QoQ) growth of government debt ratio),[94] financial cycle, and financial stability index.[95]

The annualized QoQ growth of debt ratio is used in the model as the switching variable, for the following reasons. The first is the question that we seek to answer in this chapter: What is the financial stability response to a fiscal shock, depending on the level of public debt? The other reasons are that the debt ratio serves as a comprehensive fiscal indicator that encapsulates both revenue and expenditure dynamics within a government's financial framework. Unlike fiscal deficits, which are often the primary focus of government policy announcements, the debt ratio provides a broader perspective on fiscal health. It not only reflects the balance between government revenue and expenditure but also incorporates extraordinary government actions, such as the purchase of financial assets, recapitalization of the banking sector, or adjustments related to previously issued government guarantees. As a result, the debt ratio offers a more comprehensive view of government actions and their impact on overall fiscal stability. Moreover, the dynamics of the debt ratio play a pivotal role in determining fiscal sustainability, serving as a critical gauge of a government's ability to manage its debt burden effectively over time. Therefore, policymakers

[94] From the IMF database.
[95] See N'Goran (2022) for the computation of both financial cycle and financial stability index (AFSI).

closely monitor the evolution of the debt ratio as part of their efforts to ensure sound fiscal management and promote long-term fiscal sustainability.

4.2 Fiscal and financial developments in eurozone

In this section we present some empirical evidence, namely stylized facts, about fiscal policies, financial cycles, and the financial stability index in the euro area over the period 1999–2021, based on annual notional accounts data from the IMF, the Federal Reserve of St Louis databases, and N'Goran's (2022) aggregate financial stability index (AFSI) data. The main fiscal and financial variables are presented in Figures 1 to 3. As we can see on these figures, some data, notably those in Figure 1, may be subject to seasonality, which we remove using the Census-X12 methodology prior to our estimation exercise.

Figure 1: General government revenues and expenditures (in % of GDP)

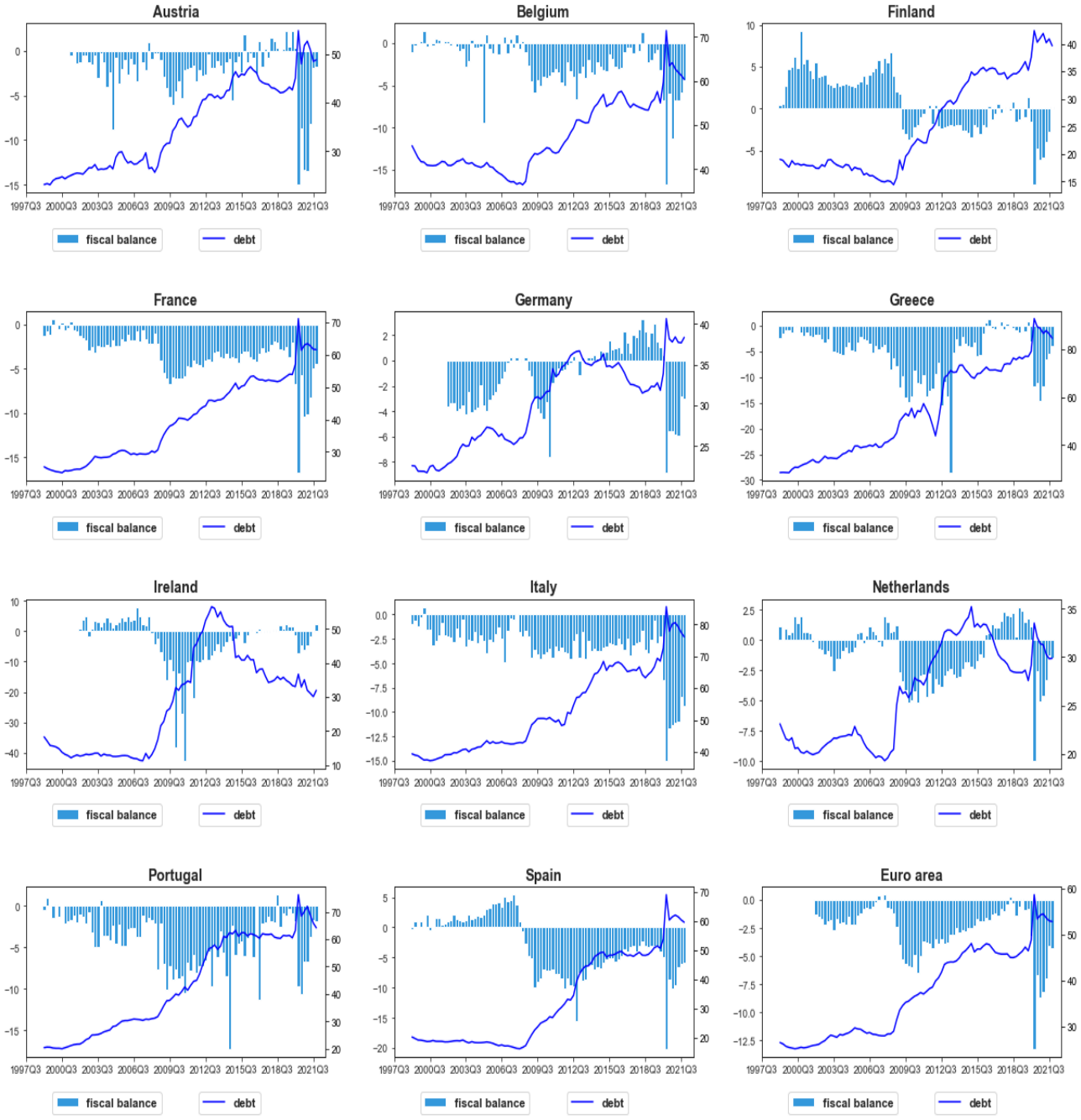


Source: Author'own computation.

Figure 1 displays the path of government revenue to GDP (black dashed dotted line) and expenditure to GDP (red dotted line) ratios. At first glance, the figure shows that, on the one hand, government revenue and expenditure to GDP ratios of countries in our sample follow an upward trend (with public spending generally exceeding income) over the period 1998Q1–2022Q4, with the exception of Ireland. We see in Figure 1 that in Ireland the evolution of the ratios of public

expenditure and revenue in relation to GDP is marked by two phases. The first phase runs from 2022Q1 to 2007Q, characterized by a slow increase in the expenditure/GDP and income/GDP ratios, with income exceeding expenditure. The second phase goes from 2008Q1 to 2022Q4, materialized by a downward trend in income, while expenses increase. We should note that during the financial crisis of 2008–9, Irish public spending experiences significant upward fluctuations, which is probably a result of the various measures taken by the Irish government during the crisis.

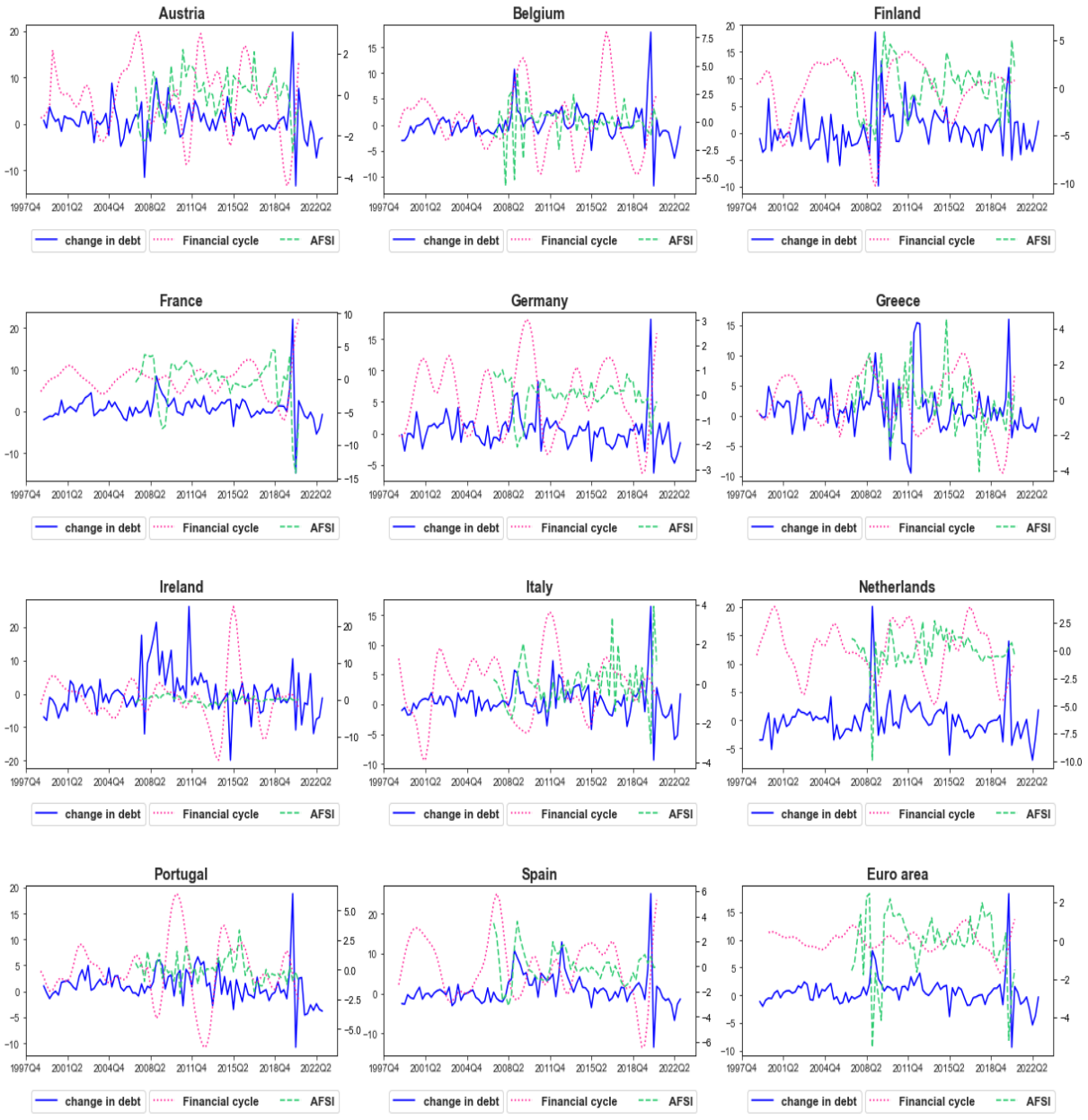
Figure 2: General government debt and fiscal balance (in % of GDP)



Source: Author'own computation.

On the left-hand axis, Figure 2 presents the general fiscal balance, while the right-hand axis presents the public debt ratio to GDP. The figure shows that, in general, the fiscal balance of our country sample stays relatively negative over 1999Q1–2021Q4, except Finland, Ireland and Spain, where the fiscal balance is relatively positive over the periods 1999Q1–2008Q3, 2002Q1–2007Q4, and 1999Q1–2008Q4, respectively. These periods of positive fiscal balance result in a lower debt to GDP ratio for these countries. Concerning the debt to GDP ratio, the figure shows that the eurozone's debt to GDP ratio rises from 32% to 51% in 2021Q2, before declining (see euro area chart).

Figure 3: General government debt in % of GDP and financial cycle and stability index



Source: Author'own computation.

For the following, let $d_t = log\left(\frac{D_t}{Y_t}\right)$ be the logarithm of the government debt (D_t) and GDP (Y_t) ratio. $\Delta d_t = d_t - d_{t-1}$ denotes the percentage change in debt – in other words the quarterly growth of debt. And $\Delta^Q d_t = 4 * (d_t - d_{t-1})$ denotes the annualized quarter-over-quarter (QoQ) growth of debt ratio. Figure 3 shows that the annualized QoQ growth of debt ratio increases during financial stress, underscoring the interdependence between fiscal policy, financial stability, and macroeconomic resilience. This highlights the importance of proactive policy responses, effective crisis management strategies, and structural reform to mitigate fiscal risks and safeguard long-term fiscal sustainability in the euro area.

Based on the official recessions defined by the National Bureau of Economic Research (NBER), the Centre for Economic Policy Research (CEPR), and the Economic Cycle Research Institute (ECRI), three official recessions can be identified over our study period. These recessions correspond to the global financial crisis of 2007Q2–2009Q3, the European debt crisis of 2011Q2–2012Q3, and the COVID-19 pandemic crisis of 2020Q1–2020Q2. These recessions represent the periods with high financial stress. Overall, Figure 3 shows that the government debt ratio follows an upward trend from 2007 to 2019, when it reaches its peak, for Austria, Belgium, Finland, France, Greece, Italy, Portugal, and Spain. This increase slows down for Greece toward 2010, marked by the onset of the European debt crisis. The debt ratio evolutions of Germany, the Netherlands, and Ireland share some similarities. We can see an increase from 2008 to 2012, when it reaches its peak for these three countries, followed by a decrease, because of the COVID-19 pandemic crisis, for Germany and the Netherlands. Figure 3 displays the annualized QoQ growth of debt ratio (the blue line) on the left-hand axis, with the financial cycle (red dotted line) and financial stability proxy (AFSI in the dashed green line).

One might wonder why we are using both financial cycle and financial stability variables here. Why not one or the other? Is there a difference between the financial cycle and financial stability index? The financial cycle describes the pattern of credit and asset market dynamics over time, while financial stability pertains to the overall health and robustness of the financial system to maintain its essential functions and avoid systemic disruptions. Indeed, the financial cycle refers to the periodic fluctuations in financial variables such as credit growth, asset prices, and leverage over time (see, for instance, Alfaro and Drehmann, 2009). It encompasses the expansion and contraction phases of credit and asset markets, reflecting the dynamics of financial intermediation and risk-taking behavior. The financial cycle typically operates over longer periods than the business cycle and can influence economic activity and financial stability.[96] Financial stability refers to the ability

[96] See, for example, Borio (2014).

of the financial system to function effectively and withstand shocks without disruptions that could impair its intermediatory role or jeopardize overall economic stability (see, for instance, Borio and Drehmann, 2009; Strassberger and Sysoyeva, 2016). It involves the resilience of financial institutions, markets, and infrastructure to absorb and mitigate disturbances, ensuring the smooth functioning of the financial system and minimizing the risk of systemic crises. The aim of financial stability is to prevent situations where widespread failures or distress in the financial sector lead to broader economic downturns. For this goal, financial stability has macroprudential policy as its primary instrument, which involves two actions: countercyclical and cross-cutting.[97]

Comparing the evolutions of both variables with those of the annual public debt is important for four main reasons. The first is *macroeconomic stability*: public debt levels and their growth can have significant consequences for macroeconomic stability. High and rising government debt may limit fiscal policy options and raise concerns about debt sustainability and the government's ability to repay debt. Monitoring the interaction between public debt dynamics and the financial cycle can provide insights into the macroeconomic impact of fiscal policy decisions. The second reason is *financial system resilience*: public debt levels and fiscal policy decisions affect the resilience of the financial system. Excessive government debt crowds out private investment, increases borrowing costs, and increases government credit risk, all of which affect the financial sector and undermine financial stability. Understanding how changes in government debt interact with financial cycles can help policymakers to assess systemic risks and develop appropriate regulatory and policy responses to maintain financial stability. The third reason is *contagion risk*: high levels of government debt and fiscal vulnerabilities could lead to risks of contagion within the financial system. Market assessments of sovereign creditworthiness could spill over into other sectors, disrupting financial markets and potentially triggering systemic crises. Monitoring the links between sovereign debt dynamics, financial cycles, and financial stability can help to identify the channels through which sovereign risks spread and support measures to mitigate contagion effects. And the final reason is *policy coordination*: aligning financial policy with financial stability objectives is critical to maintaining macroeconomic stability. Coordinating fiscal policy decisions with measures to address financial cycle fluctuations and promote financial stability can increase the effectiveness of policy interventions and reduce the likelihood of negative consequences, such as financial crises or periods of financial instability. Comparing public debt developments with financial cycle and financial stability indicators can facilitate policy coordination efforts and contribute to a holistic approach to macroeconomic management. To sum up, comparing the development of public debt with the dynamics of financial cycles and financial stability is crucial for understanding the interaction

[97] See N'Goran (2023) for more details.

between financial policy, financial market dynamics, and systemic risks. It provides valuable insights for policymakers seeking to maintain macroeconomic stability and mitigate financial system vulnerabilities.

5. Results

5.1 Threshold testing

We test whether the data indicate the presence of a statistically significant threshold, γ, as defined by the values of government debt ratio growth quarter over quarter (QoQ) annualized $(\Delta^{Q} d_t)$, and whether the detected threshold value is reasonable in terms of identifying high and low debt periods related to the financial stability evolution. To do so, we consider the linear model specification (equation (3)) and Hansen's (2000) approach to test and estimate the value of the threshold. The results of Hansen's (2000) threshold test are presented in Table 1.

Table 1: Hansen's (2000) threshold test result

Number of Bootstrap Replications	1000
Trimming Percentage	0.150
Threshold Estimate	17.049
LM-test for no threshold	20.546
Bootstrap p-value	*0.001*

Notes: Test of null hypothesis of no threshold against alternative of threshold. Allowing Heteroskedastic Errors (White Corrected).
Author'own computations.

The estimated threshold value of $\Delta^{Q} d_t$ is 17.05%[98] of GDP and significant with a p-value less than 0.001 for the LM-test statistic (20.55). This means the public debt to GDP ratio quarterly growth is 17.05 divided by 4, which is 4.26. And the value of debt to GDP ratio is given by an exponential of 4.26 equal to 70.98 (71%). The estimated threshold value of 71% for the public debt to GDP ratio within our sample implies a critical threshold level at which public debt can jeopardize financial stability. This result exceeds the often-cited threshold of 60% of GDP commonly used in economic literature and policy discussions – including those used under the Maastricht criteria by the European Union (see discussion in Section 6). The criteria include the public debt threshold of 60% of GDP. This figure is a reference value adopted to guarantee the sustainability of public finances in member states so they do not incur excessive deficit. The 60% level is based on

[98] The threshold splits the sample into a high debt regime with around 15% observation and a low debt regime with the remaining portion. Indeed, this division aligns with the observation that a low debt period tends to last longer than a high debt one.

historical averages, plus some econometric models that indicate that this level is generally bearable under normal economic growth (see, for instance, Buiter et al., 1993; Reinhart and Rogoff, 2010; European Commission, 2012a).

However, the empirical discovery of the 71% tipping point indicates that the actual threshold level in our sample of countries is higher than the Maastricht benchmark. The difference could be explained by various factors, such as the economic structure and growth potential and institutional strength and external influences on debt dynamic. A higher threshold of 71% implies that these countries may have greater fiscal capacity or resilience to manage higher debt levels without immediately compromising financial stability. This could be due to more robust economic fundamentals, better debt management practices, or more robust institutional frameworks capable of effectively mitigating the risks associated with higher debt levels.

Comparing the two thresholds, it is clear that the figure of 60% is a conservative benchmark, with the aim of fostering fiscal discipline in the long-term horizon and curbing the probability of debt crises. It considers a precautionary principle whereby countries are required to hold a buffer for their economies against shocks and uncertainties. On a different note, our study finds that the 71% threshold provides an insight that is more specific to the context – it hints at higher levels of debt that these sample countries can bear without plunging into instability that is stormy enough to wreck their finances.

However, it is worth mentioning that crossing the 71% bar does not automatically mean financial instability – it simply means a heightened risk should be noted. Therefore, authorities should still aim to keep debt at substantially lower levels than this threshold, because this would help to sustain economic growth and ensure fiscal space. The bottom line is that while the threshold of 60% remains a practical rule-of-thumb, the critical level of debt can differ from country to country depending on individual peculiarities and situations.

5.2 Impulse response functions

In order to determine whether the effects of fiscal policy shock on both the financial cycle and financial stability are different, depending on the growth of debt ratio, we estimate our baseline state-dependent model (equation (3)). Since the aggregate financial stability index starts in 2007Q1, our sample is 2007Q1–2021Q4. The estimated coefficients of the financial cycle and financial stability index responses to a positive fiscal (government spending and revenue) shock are presented in Tables 2 and 3. The tables show that the coefficients are generally statistically different,

depending on the debt regime. Figures 4 and 5 (below) present the impulse response functions. Figure 4 presents the response of both the financial cycle and financial stability to a positive government spending shock, while Figure 5 shows the response of the financial cycle and financial stability to a positive government revenue shock in both debt regimes. The red color represents the high debt regime and the blue color the low one.

Table 2: Response of AFSI to…

	Linear Model	High Debt	Low Debt
		Government spending shock	
4 quarters	-0.004	**0.051**	**-0.021**
	(0.013)	(0.022)	(0.012)
8 quarters	**0.026**	**0.041**	0.027
	(0.016)	(0.019)	(0.020)
12 quarters	-0.005	0.005	-0.011
	(0.013)	(0.240)	(0.017)
		Government revenue shock	
4 quarters	**-0.063**	**-0.092**	-0.058
	(0.025)	(0.034)	(0.036)
8 quarters	**-0.034**	-0.006	-0.021
	(0.019)	(0.029)	(0.036)
12 quarters	0.011	-0.007	0.040
	(0.018)	(0.018)	(0.034)

Source: Author' own computations.
Note: The values in brackets under the estimate's coefficients give the standard errors. Values in bold indicate significant coefficients.

Table 3: Response of Financial cycle to…

	Linear Model	High Debt	Low Debt
		Government spending shock	
4 quarters	-0.002	**-0.027**	0.012
	(0.010)	(0.016)	(0.015)
8 quarters	0.030	-0.084	**0.094**
	(0.027)	(0.063)	(0.034)
12 quarters	0.044	0.005	-0.011
	(0.053)	(0.240)	(0.017)
		Government revenue shock	
4 quarters	-0.051	0.003	**-0.083**
	(0.020)	(0.019)	(0.028)
8 quarters	**-0.160**	0.005	**-0.241**
	(0.058)	(0.070)	(0.089)
12 quarters	0.037	0.040	0.164
	(0.072)	(0.075)	(0.130)

Source: Author' own computations.
Note: The values in brackets under the estimate's coefficients give the standard errors. Values in bold indicate significant coefficients.

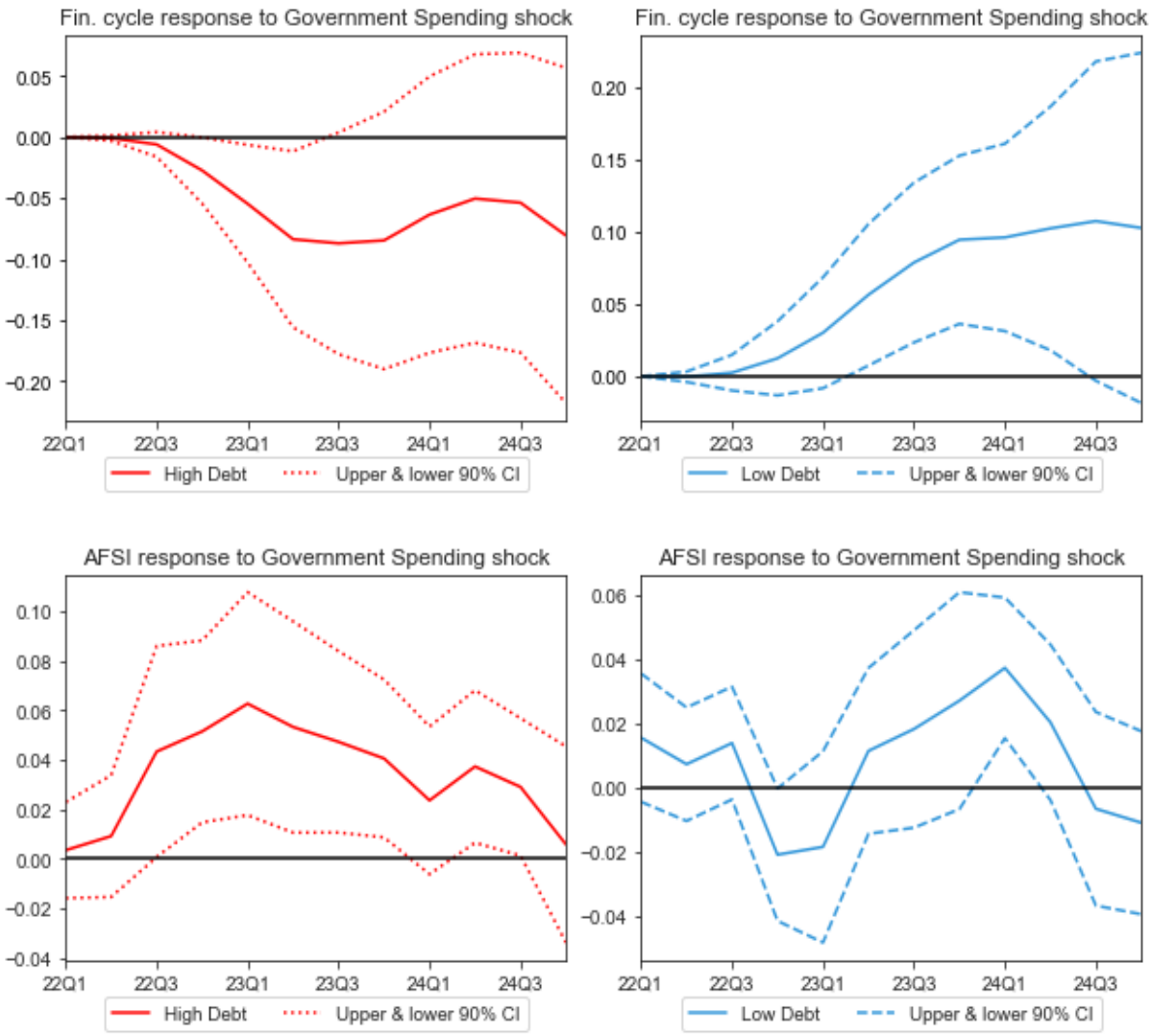
5.2.1 The effects of government spending shock

Figure 4 shows that in a ***high debt regime*** government spending shock has a negative impact on the financial cycle (the financial cycle decreases after the shock) but a positive impact on financial stability (financial stability goes up after the shock). The negative impact of shock on the financial cycle is smaller during the two first quarters and becomes increasingly stronger, reaching -0.09 after eight quarters. Several processes could be involved in this situation. (i) The negative impact of the positive shock on the financial cycle is that, despite increased government spending, there may be detrimental effects on the financial markets and economic indicators associated with the financial cycle. These may include increased price volatility, a slowdown in credit growth, or a higher degree of investor risk perception. This observed negative impact of government spending shocks on the financial cycle, especially in a high debt context, suggests a crowding-out effect. This effect occurs when an increase in government spending leads to an increase in demand for funds, thereby raising interest rates and discouraging private sector investment. Empirical studies such as Romer and Romer (2010) and Auerbach and Gorodnichenko (2012) demonstrate this crowding-out effect and its impact on economic activity. Moreover, in a high debt regime, these negative effects are exacerbated by concerns about the long-term viability of public finances, which is associated with high debt. This underlines the importance of fiscal sustainability considerations. Giavazzi and Pagano (1990) and Elmendorf and Mankiw (1998) emphasize the need for policymakers to address structural imbalances and ensure that fiscal policy decisions are consistent with long-term debt sustainability objectives. A failure to address structural imbalances and ensure debt sustainability could undermine investor confidence and exacerbate financial market volatility. (ii) Despite the negative effects on the financial cycle, the increased stability of the financial system (the AFSI chart goes up after the shock and stays positive for several quarters) following the government spending shock suggests that the overall resilience and sustainability of the financial system are increased. This can occur if the government dedicates funds to improving stability, such as infrastructure, regulatory reform, or targeted assistance for vulnerable industries. Additionally, during times of economic uncertainty or slowdown, increased public spending can have a stabilizing effect by increasing demand and preventing system-wide disruption. This stabilizing effect of increased public spending in times of economic uncertainty is consistent with the role of fiscal policy as a countercyclical tool. Studies by Alesina and Perotti (1995) and Ramey (2011) highlight the effectiveness of fiscal stimulus in supporting aggregate demand and mitigating systemic risks during recessions.

This scenario demonstrates the need to maintain a balance between short- and long-term fiscal goals. While the positive impact on financial stability mitigates the immediate risks and

vulnerabilities, policymakers must also address the structural factors that lead to the negative impact on the financial cycle. This may necessitate implementing supplementary policies that promote debt stability, increase productivity, and promote long-term economic growth.

Figure 4: Financial cycle and AFSI responses to government spending shocks



Source: Author' own computations.
Note: Blue lines correspond to the response of financial cycle and financial stability index to fiscal shocks in the low debt regime. Red lines refer to the response of financial cycle and financial stability index to fiscal shocks.

In a ***low debt regime*** a positive government spending shock has a positive effect on the financial cycle. Its effect on financial stability is positive during the first three quarters following the shock, but it becomes negative after three quarters. In this scenario several processes are involved. (i) The positive impact on the financial cycle suggests that the government spending shock initially increases economic activity and improves faith in financial markets. This leads to an increase in investment, consumption, and overall economic growth. The positive impact noted in the financial

cycle due to the government spending shock underscores the notion that when governments spend more money on different sectors, this can increase aggregate demand – which stimulates economic growth. The finding is therefore supportive of earlier works that point out how fiscal stimulus action, such as investment on infrastructure or public sector employment, could trigger multiplier effects, leading to expansion dynamics in an economy. These include work by Blanchard and Perotti (1999). Moreover, in a low debt environment, the concern about fiscal sustainability is relatively low, and the effect of government spending is therefore more pronounced. This implies that in such a situation both households and business establishments would be certain about the effectiveness of government spending initiatives, which can elicit a stronger reaction by way of consumption and investment, as well as economic activity generally (see, for instance, Auerbach and Gorodnichenko, 2012). (ii) In the first three quarters following the shock, the increase in financial stability indicates the initial increase in activity that contributes to the stability of the financial system. This occurs if public spending increases demand, decreases unemployment, and supports price increases, all of which improve the overall health of the financial sector (see Perotti, 2002). Additionally, increased economic activity may lead to increased tax revenue and enhanced debt management, both of which are paramount to stability. However, the beneficial effects on financial stability start to diminish, and they become negative after three quarters. This transition may be caused by multiple factors. For example, if the government takes a spending shock that is not accompanied by a sustainable fiscal strategy, or if the shock leads to overheating in certain sectors of the economy, this may ultimately threaten financial stability. Additionally, if the initial beneficial effects of the spending shock are lost over time, or if it amplifies economic imbalances, such as inflation or the bubble of assets, this may lead to instability in the long term.

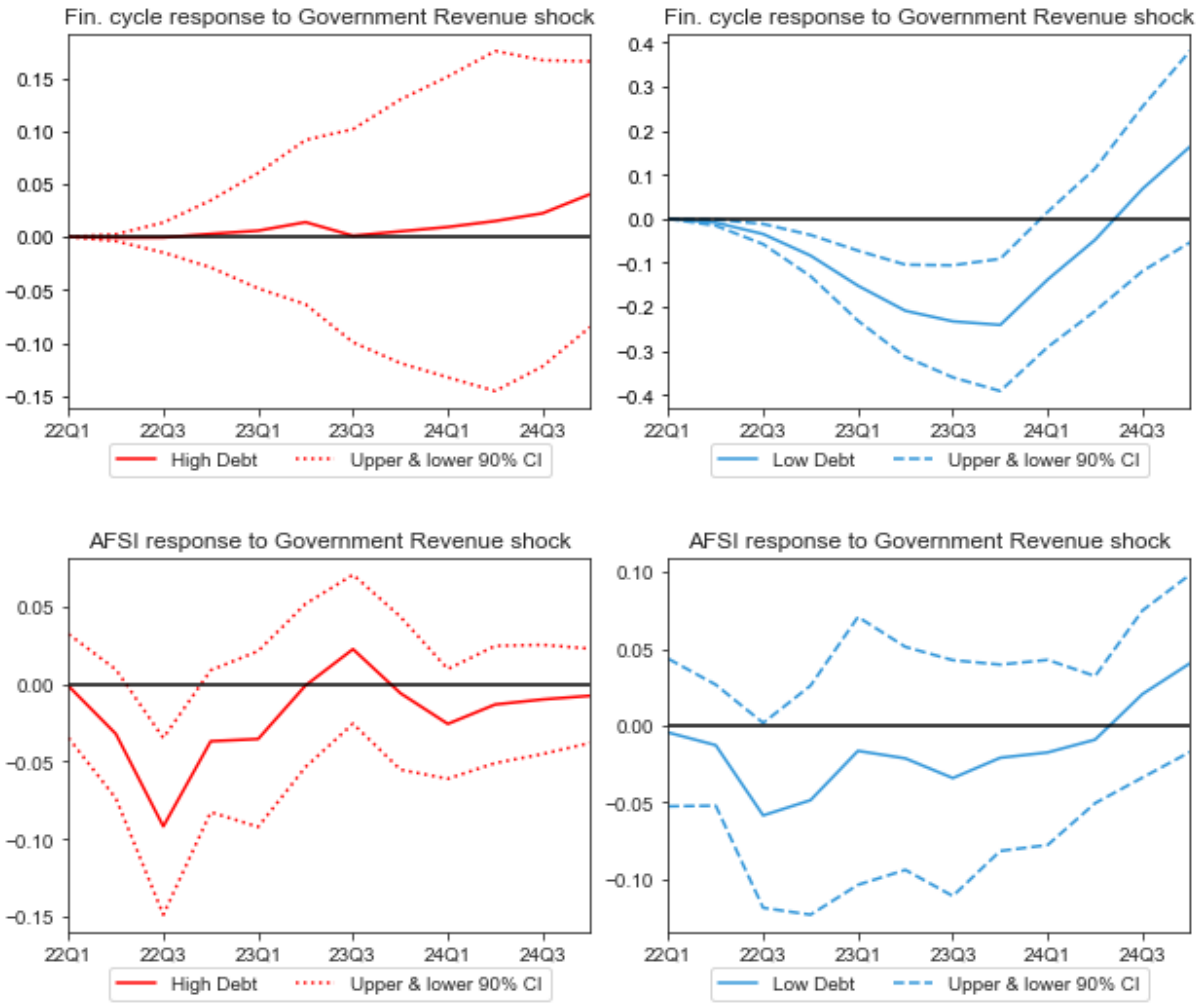
This scenario demonstrates the value of cautious policy changes and forward-looking risk management. While government spending increases may provide short-term boosts and support financial stability, policymakers must be aware of the potential for long-term harm and vulnerabilities. This may necessitate implementing strategies to ensure fiscal sustainability, monitoring the price of assets, and taking macroprudential measures to avert potential financial risks. Additionally, policymakers must consider the duration and magnitude of fiscal actions in order to maintain a balance between short- and long-term goals.

5.2.2 The effects of government revenue shock

Figure 5 demonstrates that in a ***high debt regime*** a positive increase in government revenue has a smaller positive effect on the financial cycle and a negative effect on financial stability. We can

deduce that the financial stability index decreases following the shock and reaches a low of -0.09 after three quarters before increasing. This scenario has several implications.

Figure 5: Financial cycle and AFSI responses to government revenue shocks



Source: Author' own computations.
Note: Blue lines correspond to the response of financial cycle and financial stability index to fiscal shocks in the low debt regime. Red lines refer to the response of financial cycle and financial stability index to fiscal shocks.

(i) The smaller positive effect on the financial cycle indicates that increased government revenue may not have a significant impact on economic activity. In a high debt regime, the concern about fiscal sustainability is greater. As a result, households and businesses have to anticipate future increases in tax rates or decreases in government spending, which leads to cautionary behavior and a limited response to the revenue shock. Additionally, if the revenue shock is not devoted to productive investment, or if it diminishes consumer and business faith, the effect on the financial cycle may be mitigated. This result is in line with Barro (1974), Lucas (1976), and Mertens and Ravn (2014), who underpin a proper appreciation of how households and business entities foresee future

fiscal measures. This leads to effects of Ricardian equivalence. They argue that in cases where the government has high levels of debt, taxpayers take this into consideration when they anticipate the taxes they are supposed to pay, or even government expenditure, and there are situations that mitigate the stimulative effects of revenue shocks on economic activity because some people withhold their money. (ii) The negative impact on financial stability indicates the vulnerability of the financial state to a small increase in revenue, despite the limited promotional blitz in the financial sector. The revenue shock is said to have an adverse effect on financial stability or confidence. This occurs if the tax shock leads to an increase in the tax burden on households and businesses, which reduces the amount of disposable income and investment incentives. This finding is consistent with Christiano et al. (2011), who indicate that revenue shocks, which necessitate increased government borrowing, can crowd out private investment by competing for scarce financial resources, thereby dampening economic growth and exacerbating financial stability concerns. Furthermore, if the revenue shock is considered a sign of poor economic conditions or financial stress, it can lead to risk aversion and capital outflow from financial markets, which can lead to instability (see, for example, Baker and Wurgler, 2006). (iii) In a high-debt regime, the adverse effect of a revenue increase on financial stability can be amplified by the concern of fiscal sustainability. If the revenue shock is not sufficient to cover increasing debt levels, or if it fails to improve the government's fiscal position, investors may become more concerned with the risk of default on the debt or loss of credit. This leads to higher borrowing costs for the government, which exacerbates fiscal issues and threatens financial stability.

This scenario highlights the value of prudent fiscal strategies and addressing structural issues in a high debt regime to promote financial stability. Policymakers may want to consider ways to increase revenue through tax reform that is sustainable, or ways to reduce the reliance on debt in order to do so. Additionally, the pursuit of fiscal faith and credibility is essential to maintaining financial stability. This may involve communicating detailed fiscal plans regarding spending, improving fiscal institutions, and addressing long-term budgetary issues that would mitigate the dangers associated with high debt.

On the other hand, the figure shows that in a ***low debt regime*** positive shocks to government revenue can have negative consequences for the financial cycle and financial stability. The financial cycle slowly declines after the shock, reaching -0.2 points after eight quarters, and then rises again, turning positive after ten quarters. The financial stability index falls back after the shock, reaching -0.05 points three quarters later, but it remains negative until the tenth quarter.

(i) The negative impact on the financial cycle suggests that positive government revenue shocks do not stimulate economic activity or financial market dynamics. This occurs if an income shock leads

to an increase in the tax burden on households and firms, reducing disposable income and investment incentives (Blanchard, 1981). The resulting reduction in disposable income and investment incentives can lead to slower economic growth and a shortened financial cycle. Moreover, the inertia inherent in the economic system may prolong the recovery process as households and businesses adjust their behavior in response to negative shocks. Furthermore, if an income shock weakens consumer and business confidence or is seen as a sign of economic weakness, this can lead to cautious behavior and dampen demand, leading to a downturn in the financial cycle. Behavioral economics research, including the works of De Grauwe and Ji (2012), suggests the importance of consumer and business confidence in determining economic results. Negative thoughts about fiscal policy or concerns about the long-term viability of government revenue can affect confidence, leading to hesitant spending and a decrease in demand. This can increase the negative effect of revenue changes on the financial cycle, as households and companies delay consumption and investment decisions in response to the increased uncertainty. The slow recovery from the financial cycle after a shock suggests that it takes time for economies to adjust and regain momentum after a shock negatively impacts incomes. This may reflect continued weakness in consumer and business confidence, as well as ongoing difficulties in returning investment and consumption patterns to pre-shock levels. Bloom (2009) and Baker et al. (2016) explain how the uncertainty of the economic situation can reduce consumer and business faith, leading to hesitant behavior and tardy investment decisions. After a shock, the lingering uncertainty about the future may prolong the recovery process; households and companies are still unsure about their participation in spending and investment, which prevents the normalcy of economic activity. The delay in recovery highlights the importance of implementing supportive policy measures to stimulate economic activity and enhance the vitality of financial markets.

(ii) Negative effects on financial stability suggest that positive shocks to government revenue increase the fragility of the financial system or undermine investor confidence. This occurs when a government revenue shock leads to a negative market reaction, such as capital outflows or asset price declines because of concerns about the economic outlook or the sustainability of public finances. Bernanke and Gertler (1989) and Shiller (2000) show how the market's perception of risk and the expected future growth of assets play a significant role in determining asset prices and maintaining financial stability. Positive government revenue shock leads to negative financial reactions in the market if investors believe the government is incapable of managing fiscal issues effectively or the economy is below average. Concerns about the long-term viability of public finances or insufficient revenue to address fiscal issues can degrade investor confidence and increase the volatility of the financial market, leading to a decline in financial stability. Furthermore,

if the positive revenue shock is insufficient to correct the underlying fiscal imbalances or reassure investors about the government's fiscal position, this can increase uncertainty and risk aversion in financial markets and lead to a deterioration in financial stability.

Moreover, the negative impact of the positive government revenue shocks on financial stability may also stem from broader systemic risks and contagion effects within the financial system. The studies of Acharya et al. (2010) and Adrian and Brunnermeier (2016) highlight the interconnectedness of financial markets and show how shocks in one sector can spill over and exacerbate vulnerabilities in other sectors. If income shocks lead to financial market chaos or exacerbate systemic risks, this will destabilize the entire financial system, increase the negative impact on financial stability, and weaken market confidence. Rajan (2005) and Chinguel (2020) highlight structural weaknesses in the financial sector, such as excessive leverage, interconnectedness, and opacity, which may exacerbate the negative impact of income shocks on financial stability. The persistence of the negative financial stability may reflect underlying weaknesses and vulnerabilities in the financial system that income shocks have not been able to adequately address. These structural weaknesses may result from regulatory gaps, inadequate risk management practices, or distorted incentive structures, all of which can weaken the resilience of the financial system and lead to instability. Continued negative financial stability could signal ongoing concerns about the sustainability of public finances, including high debt burdens, budget deficits, and contingent liabilities, which could undermine investor confidence and increase market volatility. Addressing these fiscal challenges through prudent financial management, structural reforms, and de-leveraging strategies is critical to restoring market confidence and stabilizing the financial system. The persistence of negative financial stability underscores the need for proactive policy measures to address vulnerabilities and mitigate systemic risks. Research by, for example, Borio et al. (2011) and Coelho and Restoy (2023) emphasizes the importance of macroprudential policies, regulatory reforms, and crisis management frameworks in safeguarding financial stability and enhancing the resilience of the financial system. Proactive measures such as strengthening regulatory oversight, enhancing risk management practices, and improving transparency and disclosure standards can mitigate systemic risks and build confidence in the stability of the financial system. Additionally, coordinated efforts among policymakers, central banks, and regulatory authorities are essential for addressing systemic vulnerabilities and restoring stability in the financial sector.

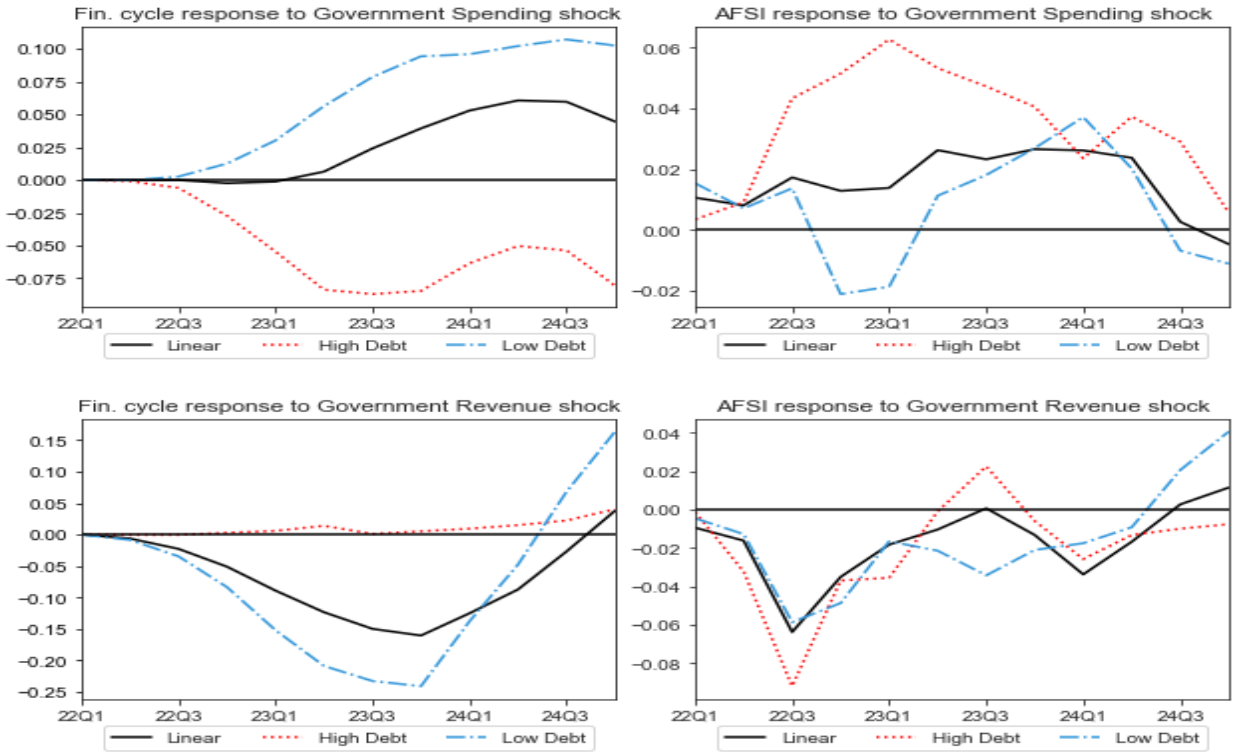
This situation highlights the importance of carefully balancing fiscal policy measures to support economic recovery and financial stability in a low-debt regime. Policymakers may need to reassess the composition and timing of revenue measures to ensure they do not inadvertently dampen

economic activity or exacerbate financial vulnerabilities. Furthermore, efforts to strengthen the resilience of the financial system and improve policy coordination between financial and monetary authorities are critical to promoting stability and mitigating the negative impact of income shocks on the financial cycle and financial stability.

5.3 Robustness

The results of our model suggest there is a difference in the financial cycle and financial stability responses across the debt regime. For robustness, we consider the linear model (equation (2)) and compare its results to the non-linear one. The estimated coefficients are also presented in Tables 1 and 2.

Figure 6: Financial cycle and AFSI responses to fiscal shocks (linear vs non-linear model)



Source: Author' own computations.
Note: Blue lines correspond to the response of financial cycle and financial stability index to fiscal shocks in the low debt regime. Red lines refer to the response of financial cycle and financial stability index to fiscal shocks.

Figure 6 presents the financial cycle and AFSI responses to a variety of fiscal shocks in different specifications (linear vs non-linear model). Figures show that the responses of the financial cycle and financial stability to the fiscal shocks in the linear model are closer to their responses in the low debt regime when we consider the non-linear model. However, the responses in the low debt

regime when we consider the non-linear model are greater than the linear model. These results could be a result of the number of observations in each debt regime of the non-linear model. Indeed, the smaller number of observations in the high debt regime could make the model less parsimonious in this regime (see, for instance, Afonso et al., 2011; Adämmer, 2019).

6. Long-term fiscal policy evolution of the eurozone from the perspective of institutional economics and political economy

Although free to define their fiscal policy, the countries of the eurozone are subject to a budgetary framework: the budgetary framework of the European Union. Originating from the Maastricht Treaty of 1992, which led to the Stability and Growth Pact (SGP) of 1997, the objectives of the European fiscal framework are as follows.[99] First*, ensure the sustainability of public debt.* The aim of the SGP is to prevent – and fix – any excessive deficits in order to maintain a sustainable debt level. Safe levels of debt allow for operation of the so-called "automatic stabilizers" (e.g., higher expenditure on unemployment benefits plus lower tax revenue during downturns) without any fiscal or financial stress. Without any prejudice against the objective of sustainability, there should also be an allowance for fiscal-based macroeconomic stabilization. The second objective of the SGP is to *correct excessive deficits when they occur*. The Maastricht Treaty sets forth deficit and debt thresholds: a deficit lower than 3% of GDP and a ratio of debt to GDP less than 60%, unless the ratio is moving at a satisfactory pace toward that level – such situations are regarded as "gross policy errors," leading to initiation of an excessive deficit procedure (EDP), as elaborated in article 126 of the Treaty on the Functioning of the European Union (TFEU). Member states under an EDP are required to correct their excessive deficit by a deadline established by the council, which can escalate the procedure if a member state does not comply with its recommendations. The affected member states could face suspension of payments or commitments from the European Structural and Investment Funds.

The third SGP objective is to *prevent the occurrence of excessive deficits and ensure sound public finances*. The aim is to ensure that member states build fiscal buffers during economic upturns, giving them sufficient fiscal space for economic stabilization during downturns. This requires member states to achieve a country-specific medium-term budgetary objective (MTO), defined in structural terms, meaning adjusted for the economic cycle. Achieving the MTO enables member states to use fiscal policy for macroeconomic stabilization during bad economic times by allowing automatic

[99] See European Commission (2020a) for more details.

stabilizers to operate or by implementing policies that support the economy, such as increasing investment. The minimum level of a country's MTO is determined based on its debt level, the budgetary impact of an aging population, and the cyclical volatility of its economy to ensure an appropriate safety margin with respect to the 3% of GDP deficit threshold. For euro area member states, the MTO cannot be lower than a structural deficit of 1% of GDP.[100] And, fourth, there is the objective of *the 2011 six-pack reform*, which reinforces the pact's preventive measures, emphasizing aggregate expenditure and revenue policies controlled by governments. The progress of member states toward their MTO is assessed annually via (i) the growth rate of primary expenditure net of discretionary revenue measures (the "expenditure benchmark") and (ii) the change in the cyclically adjusted budget balance net of one-off measures (the "structural balance"). Significant deviations (over 0.5% of GDP) must be corrected promptly. Euro area member states that fail to correct deviations may face sanctions, such as an interest-bearing deposit.

The fifth objective is *the 2013 two-pack reform*, which enhances the coordination of budgets in the eurozone. This is based on an appreciation of the possible spillover effects within the EMU. Draft budgetary plans are now required to be submitted by euro area member states to the European Commission before being adopted by national parliaments. It also advances coordination through enhancing discussions at Eurogroup levels on opinions delivered by the EC, as well as a comprehensive assessment of budgetary positions and prospects within the euro area. Surveillance for euro area member states with excessive deficits is strengthened.

The questions that we will try to answer in the following sub-sections are as follows: Is this fiscal framework suitable or sufficient for the euro area? What are the European Fiscal Board's (EFB's) proposals for the eurozone? Are these proposals sufficient to ensure the financial stability of the eurozone?

6.1 The EFB proposals for euro area

A series of measures have been proposed by the EFB to improve the fiscal framework of the euro area. The proposals stress simplifying the existing rules on national budget to enhance transparency, as well as enforcement and the use of key indicators such as the debt to GDP ratio and growth rate of public spending – with a major call for an expenditure rule that limits public spending growth tied to potential GDP but adjusted for economic cycle to foster and promote sustainable fiscal policies (European Fiscal Board, 2020). An advocacy for debt anchor has also been made by the

[100] In addition, the inter-governmental Treaty on Stability, Coordination, and Governance in the Economic and Monetary Union (EMU) establishes a lower limit for a structural deficit of 0.5% of GDP for its signatories.

EFB, prescribing clear targets on reducing public debt to sustainable levels (European Fiscal Board, 2018), since another proposal is about strengthening the role and independence of national fiscal councils – tasked with oversight on budget implementation at national level – to ensure greater fiscal discipline and compliance (Hallerberg and Strauch, 2002). Moreover, the EFB supports the creation of a central fiscal capacity for the euro area that includes a budgetary instrument for macroeconomic stabilization and support for structural reforms. A green investment clause is also proposed to address climate change – allowing temporary deviations from fiscal targets to finance sustainable projects (Bénassy-Quéré et al., 2016; European Fiscal Board, 2020). In its latest publication, the European Fiscal Board suggests more automatic sanctions for non-compliance, among other enforcement mechanisms. The aim of these holistic measures is to build a more shock-resilient and fiscally sustainable framework at all times, addressing issues of primary importance like fiscal discipline and debt reduction, not forgetting macroeconomic stabilization in the eurozone (EFB, 2019).

The measures introduced by the EFB are undoubtedly a major step forward in enhancing economic stability within the euro area. But it is important to realize that ensuring financial stability – in an area like economy and politics, which is multi-dimensional – requires a multifaceted approach. Even though the EFB's proposals address some very important aspects, such as discipline, debt reduction, and macroeconomic stabilization, they might not be sufficient on their own. Financial stability depends on a range of different components, such as robust fiscal polies, coordinating an effective monetary strategy, and implementing structural reforms aimed at improving competitiveness and productivity: these efforts rely, in turn, on the availability of a favorable global economic climate (see, for example, Cecchetti and Kharroubi, 2012; IMF, 2023). Although what is done by the EFB is undoubtedly beneficial, actions in other areas are required. The success of these proposals, and the control, as well as compliance – if any – by member states, depend on the most important factors (European Commission, 2020b). Strong political commitment and cooperation at national level among euro area countries are needed in order to reach optimal effects, as well as coordination between fiscal and macroprudential policy.

6.2 Coordination between fiscal policy and macroprudential policy

Coordination between fiscal and macroprudential policy is an important element in maintaining financial stability. Fiscal policy – which involves government spending and taxation – can control the economy, while macroprudential policy is aimed at containing risks within the financial system. It is very important for these two policy domains to be well coordinated. For instance, during

periods of economic recovery, fiscal policy should prioritize the creation of reserves and the reduction of public debt, while macroprudential measures should be implemented to safeguard against systemic risks in the financial sector (IMF, 2013a).

In times of economic contraction, the need to coordinate efforts between fiscal and macroprudential policies cannot be underestimated to ensure that fiscal expansions designed to revitalize the economy do not harm – in any way – financial stability. Such coordination requires the strategic use of countercyclical fiscal policies in conjunction with targeted macroprudential measures. On the one hand, countercyclical fiscal policies – such as government spending – aim to stimulate aggregate demand in order to sustain economic activity and contain the effects of a recession. As noble as these policies are, they can lead to an increase in public debt, even sectoral overheating, if not properly monitored (Schoenmaker, 2014). To balance these risks, macroprudential policy tools can be deployed to maintain the robustness of the financial sector. For example, in an economic downturn, the authorities can temporarily ease some macroprudential regulations such as loan-to-value ratios or capital buffer requirements. This means that the banks are better able to lend and ensure that the credit reaches households and businesses – which is necessary for economic recovery – through their own mechanisms. In relaxing these regulations, banks can support their liquidity and prevent a credit crunch that could otherwise worsen the contraction of the economy. Moreover, these macroprudential adjustments must be carefully calibrated to avoid creating long-term vulnerabilities. While temporary easing can support immediate stimulus efforts, there needs to be a clear plan for tightening these regulations as the economy stabilizes. This approach avoids the build-up of systemic risks that could lead to future financial instability. The IMF (2013b) emphasizes the importance of such coordination.

In addition to regulatory easing, other macroprudential measures may involve adjusting countercyclical capital buffers or providing targeted liquidity support to critical financial institutions. For example, during the COVID-19 pandemic, many countries adopted measures to ensure that banks could continue to support the economy, including temporary reductions in capital buffer requirements and extensions of forbearance programs.[101] The European Systemic Risk Board (ESRB, 2020) also highlighted the role of macroprudential policies during the pandemic, recommending the release of countercyclical capital buffers to support bank lending and economic recovery. The success of such concerted actions hinges on smooth communication and coordination among fiscal authorities, central banks, and financial regulators. Clear rules and open policy frameworks are needed to ensure that all involved understand that the measures are

[101] See, for example, Couaillier et al. (2022) for a large literature review.

temporary and can be adjusted only under certain conditions. By ensuring a dynamic balance between fiscal expansion and macroprudential stability, policymakers can help to support a sustainable recovery while preserving long-term financial stability.

Another important element that the interaction between fiscal and macroprudential policies should address is cross-border financial risks within the eurozone. Given the high degree of financial integration in the region (European Commission, 2021), risks in one country can quickly spread to others. It is therefore essential to coordinate policy responses at national and eurozone level. This requires strong institutions and collaborative frameworks, such as the ESRB, which plays a key role in identifying and mitigating systemic risks across the EU (ESRB, 2019). For this reason, it would be interesting to reconsider the idea of a fiscal union within the eurozone. In the following section we discuss the potential impact of such a union on financial stability.

6.3 Fiscal union and financial stability in eurozone

To reinforce financial stability, the idea of a fiscal union in the eurozone has been proposed (see, for instance, Berger et al., 2018). A fiscal union is the coordination of more aspects of fiscal policies among member states, including having common budgetary policies and fiscal transfers designed to manage asymmetric shocks more effectively (Fuest and Peichl, 2012). These would create a central mechanism to help countries in economic difficulty, reducing the chances that financial instability that extends beyond the national level will spread across the eurozone (Furceri and Zdzienicka, 2015). Moreover, a fiscal union might comprise the following components: a centralized fiscal capacity to fund investments in times of economic vicissitude and automatic stabilizers – like an unemployment insurance scheme – which could help to cushion the effects of downturns on member states (see, for instance, Buti and Carnot, 2018). These measures would help to ensure that fiscal aid is available where and when it is most needed, without unduly burdening national budgets.

Furthermore, creating a fiscal union would ensure enhanced coordination between fiscal and macroprudential policies at euro area level.[102] If there is one authority to which all financial issues are directed, it becomes more feasible for any fiscal policies that are drawn up to match the macroprudential policies aimed at dealing with system-wide risks, since each measure must complement the other, resulting in high-level financial stability within the eurozone and strengthening its resilience. It would be a centralized fiscal authority that can apply countercyclical

[102] For instance, Allard et al. (2013) discuss the potential benefits of a fiscal union for the eurozone, including better coordination of fiscal and macroprudential policies.

fiscal policies to the entire eurozone to ensure that fiscal stimuli or austerity are used in a coordinated fashion during periods of economic expansion (IMF, 2013b). Such an authority could develop fiscal reserves during booms, which could be used as stimulus injections during downturns at national level without leading to structural deficits or increasing the debt burden – thus dampening future profligate borrowing. Proportional responses lead to new problems that might have been prevented; hence, prevention methods using this centralized approach would ensure that no procyclical fiscal policies take place, leading to negative economic growth, where efforts are made by individual countries through their independent budget management and oversight responsibilities (see Buti and Carnot, 2012).

A central fiscal authority could also intervene in certain sectors or regions where shocks are disproportionately affecting them. This approach is more effective than the policy of universal use and must deal with specific weaknesses within the euro area – to reduce the risk of financial contagion, which can spread over the entire euro area.[103] In having a wider perspective on the economic scopes within the eurozone, such an authority would be in a position to see that resources reach areas where they are most needed, promoting stability and fostering economic cohesion among member states, which in turn fosters solidarity across different economies. The coordination of fiscal and macroprudential policies under a centralized authority would make it possible to elaborate a more systematic and harmonized response to financial instability (see Claeys, 2017). Adjusting macroprudential policies such as capital requirements, leverage ratios, and liquidity buffers, in addition to fiscal policy development, would help to manage the systemic risks more effectively. For instance, when facing a financial crisis, the central authority could use a fiscal stimulus and at the same time remove any constraints on prudential lending so that banks could freely lend. And during periods of excessive credit expansion, it could tighten prudential rules while implementing fiscal policies aimed at cooling down overheated sectors.

Moreover, a fiscal union would improve the reliability and efficiency of the eurozone's framework to maintain financial stability (Thirion, 2017). With a central fiscal authority, economic policies of the eurozone can be well managed in a unified manner – ensuring predictability and promoting trust from investors. Such institutional harmonization would enable easy coordination of holistic policy actions and reforms, since decisions are made with the collective interest of the eurozone at heart, as opposed to reconciling divergent interests among member states (Bénassy-Quéré et al., 2016). Creating a fiscal union would also make it easier to create more solid risk-sharing

[103] For example, the European Commission (2012b) proposed steps toward a more integrated economic and monetary union, including creating a central fiscal capacity to respond to specific shocks disproportionately affecting certain regions or sectors.

mechanisms (see Berger et al., 2018; D'Imperio, 2015), like an unemployment insurance scheme common to all euro area members or a euro-area-wide deposit guarantee scheme. These mechanisms would represent additional shock absorbers for shocks to the economy, further stabilizing the financial system (Barbier-Gauchard, 2020). For example, having such a common unemployment insurance scheme in place would help to cushion the negative effects of local economic downturns, which would reduce the reliance of individual countries on austerity measures that could ultimately be more procyclical and less effective.

However, attaining a fiscal union is no mean feat, requiring significant political will and cooperation among the member states involved. This action involves a transfer of some level of fiscal sovereignty to a central authority – which might be a bone of contention. Nevertheless, the rewards that come with such integration – increased economic stability (plus more robust mechanisms for risk-sharing) and solid collective financial resilience – make it an alluring objective for sustaining stability over time in the eurozone.

7. Conclusion

The purpose of this chapter has been to contribute to the ongoing effort to understand how fiscal shocks can impact financial stability and the financial cycles of the euro area, while also considering the level of debt. This was achieved using non-linear local projection impulse response function analysis to assess the effect of fiscal policy on the financial cycle and stability, depending on the level of public debt. First, however, we had to determine a threshold value of the public debt to GDP ratio, which splits our data sample into two regimes: high debt and low debt regime.

Our methodology was as follows. First, we used Hansen's (2000) approach to test and estimate the value of the threshold of the public debt to GDP ratio. Then, following Auerbach and Gorodnichenko (2013b), Owyang et al. (2013), Jordà et al. (2015), and Ramey and Zubairy (2018), we estimated a non-linear panel local projection model and assessed the effect of fiscal shock on both financial cycle and stability, considering different public debt regimes. From this analysis, we found that the model's impulse response functions yielded interesting results that can be summarized as follows.

First, we determined that the threshold of public debt to GDP in our sample is 71%, surpassing the Maastricht criterion of 60%. This indicates that these countries can manage higher levels of debt without facing immediate financial instability. It is possible that this elevated threshold is a result of more solid economic fundamentals, improved debt management practices, or a resilient

institutional framework. Although the purpose of the 60% benchmark is to encourage responsible fiscal management and offer a safety net against unforeseen events, our findings indicate that the actual threshold for significant debt may vary. Surpassing the threshold of 71% does not automatically indicate instability, rather serving as a warning sign of heightened risks. This emphasizes the importance of maintaining low levels of debt to foster sustainable economic growth and preserve fiscal flexibility.

Second, in a high debt regime the effect of a positive government spending shock is complex. The shock has an adverse impact on the financial cycle by increasing price volatility, slowing credit growth, and raising interest rates. This results in crowding out private investment and has negative repercussions for the real economy. This negative effect tends to be most severe after a few quarters and can fall as low as -0.09, revealing concerns about the ability of debt to be paid in the long term and also highlighting structural weaknesses. But shocks have a positive impact on financial stability too: they enhance economic resilience through prudent investment in infrastructure that helps to grow the economy under stable control (Romer and Romer, 2010; Auerbach and Gorodnichenko, 2012).

On the other hand, in a low debt regime a positive shock of government spending has a positive impact on the financial cycle and financial stability in the short run. The initial surge of economic activity and trust leads to higher investment and consumption, which later results in an expansion of the economy. The financial stability improvement is due to the rise in demand, fall in unemployment, and tax revenue increase. However, after three quarters, this positive impact starts to wane and may even turn negative for reasons such as overheating, inflation, or asset bubbles if sustainable fiscal strategies are not adopted at the same time. The situation depicted here makes it clear that prudent policy design – forward-looking risk management and fiscally balanced actions – is required to ensure long-term macroeconomic stability without compromising the need for short-term economic support (Blanchard and Perotti, 1999; Perotti, 2002).

Third, concerning the government revenue shock, in a high debt regime the shock has mixed effects: it tends to moderately stimulate the financial cycle, but there is a negative impact for financial stability, with a low of -0.09 reached after three quarters. The limited positive effect on the financial cycle suggests concerns about future tax increases or spending cuts, which prompt cautious behavior and dampen the stimulative effect. This is in line with the Ricardian equivalence theory, introduced by Barro (1974) and developed by Lucas (1976). The adverse effect on financial stability results from higher tax duties that take away part of disposable income and work against investment incentives – as observed in Baker and Wurgler (2006) and Christiano et al. (2011) –

pointing to the importance of prudent fiscal sustainability while also addressing structural issues for financial stability maintenance.

However, in a low debt regime the government revenue shock has a negative impact on both financial cycle and stability. The financial cycle decreases by -0.2 points after eight quarters, while financial stability remains negative until the tenth quarter. This implies that higher taxes reduce disposable income and investment incentives (Blanchard, 1981), and uncertainty hinders recovery (Bloom, 2009; Baker et al., 2016). The negative effect on financial stability could be caused by investors' worries about fiscal sustainability and systemic risks (as mentioned by Bernanke and Gertler, 1989; Acharya et al., 2010). Fiscal actions must not crowd out financial stability measures, and in turn financial stability considerations should also consider macroeconomic stability. This is essential to policy consistency, which would mean keeping pace with changes introduced from other fields, such as trade or monetary policies, without losing sight of long-term development goals or externalities affecting different sectors of the economy.

These results show the importance of coordinating fiscal and macroprudential policies, especially in the euro area. Fiscal policy that involves government spending and taxation has the ability to control the economy, while macroprudential policy is meant to contain risks within the financial system. During periods of economic recovery, fiscal policy should prioritize the creation of reserves and the reduction of public debt, while macroprudential measures should be implemented to safeguard against systemic risks in the financial sector (IMF, 2013a). However, in times of economic contraction, the need to coordinate efforts between fiscal and macroprudential policies cannot be underestimated. This is to ensure that fiscal expansions designed to revitalize the economy do not harm – in any way – financial stability. Such coordination requires the strategic use of countercyclical fiscal policies in conjunction with targeted macroprudential measures.

Nevertheless, to ensure good coordination between fiscal and macroprudential policies, and reinforce financial stability, the idea of a fiscal union in the eurozone should be reconsidered. If there is one authority to which all financial issues are directed, it becomes more feasible for the fiscal policies that are drawn up to match the macroprudential policies aimed at dealing with system-wide risks, since measures must be complementary, resulting in high-level financial stability within the eurozone and strengthening its resilience. However, attaining a fiscal union is no mean feat, requiring significant political will and cooperation among the member states involved.

Regulating financial cycles in the euro area:

What role for macroprudential policy?

General conclusion

Financial stability in the euro area is a crucial issue, particularly after the recent financial crises (the 2008-2009 financial crisis and the subsequent European debt crisis) that have highlighted the structural vulnerabilities of the European financial system. These crises have revealed the limits of traditional regulatory policies in terms of financial stability and have highlighted the need to renew and/or complement these policies, notably by adopting a macroprudential approach. In the euro area, for example during the 2008-2009 crisis, the single monetary policy, although essentially used as the main tool for macroeconomic adjustment, proved insufficient to regulate the financial cycle and instead amplified divergences within the area (see, for example, Bank of Spain, 2009; Schnabl, 2013; Georgiadis, 2015). On the other hand, a regulatory approach aimed at controlling the financial cycle, integrating countercyclical macroprudential policy measures, could have better prevented the formation of these financial imbalances. Macroprudential policy, according to the CGFS (2012), can be defined as having the aim of limiting systemic risk, both in its transversal and temporal dimension. Its objective is to prevent dysfunctions in the financial system that could lead to negative macroeconomic repercussions on the real economy (Borio, 2003). Therefore, rather than managing financial crises once they have broken out, this policy seeks to avoid them by preventing financial imbalances, procyclical phenomena, and speculative bubbles. Its effectiveness is based on three pillars: i) adequate governance, ii) identification of market failures and selection of appropriate instruments to correct them, and iii) understanding of transmission mechanisms and interaction with other economic policies, notably fiscal, monetary and microprudential (CGFS, 2010; IMF, 2013; Galati and Moessner, 2013).

This is not an entirely new approach, but it has regained prominence after the 2008–2009 financial crisis, with the introduction of numerous instruments at the macroeconomic and microeconomic levels in response to the global financial instability caused by this crisis (Galati and Moessner, 2013; Claessens, 2014). This resurgence has sparked much scholarly debate due to the challenges posed by the macroprudential approach. First, it is not independent of other economic policies, which can lead to interference or blockages between different authorities. Second, the effectiveness of macroprudential policy is inherently difficult to ensure. On the one hand, the implementation of such measures is politically delicate, which can lead to inaction. On the other hand, after several

severe crises, regulators may be prone to excessive interventionism. This thesis aims to contribute to these debates based on two main aspects. First, it proposes an efficient and robust measure of the financial stability of the euro area and its member countries, taking into account the diversity of financial cycles among member countries. Second, it studies the impact of macroprudential policies in promoting financial stability within the euro area. To do so, it relies on a rigorous methodology and in-depth empirical analyses. Namely, principal component analysis, VAR models, quarterly projection models as well as non-linear local projection models. More formally, the thesis is structured around three main chapters: the measurement of financial stability in the euro area and the comparison of financial risk surveillance indicators (Chapter 1), quarterly projection models for macroprudential analysis and financial stability in the euro area (Chapter 2), and, finally, the effect of fiscal shocks on the financial stability of the euro area according to the level of public debt (Chapter 3).

In Chapter 1, we revisited the issue of financial stability and its measurement, and developed aggregate financial stability indices (AFSIs) for euro area countries. These indices, composed of 23 variables from various markets, have proven to be effective tools for monitoring financial stability, both in times of crisis and prosperity. The methodology used is inspired by the work of Cheang and Choy (2009) and Akosah et al. (2018). It allowed us to standardize the variables empirically and construct composite indices through arithmetic means and principal component analyses. The AFSIs have proven robust in tracking financial stability during economic recessions as documented by the NBER, the CEPR, and the ECRI. The indices have fallen significantly during recessions and reached high values in good times, especially for key countries such as Germany, France, the Netherlands, and Austria. This highlights the importance of these countries for the overall financial stability of the euro area. Following these first results, considering the AFSI as financial risk surveillance indicators, we performed a comparative analysis of the dynamics of the financial cycle after a shock measured by different surveillance indicators through the impulse responses functions of a VAR model. The financial risk surveillance indicators involved in this comparison with the AFSI are the indices of financial risk, macroeconomic risk and liquidity risk. The results of this comparison revealed that the AFSIs offer a better estimate of the response of the financial cycle after a shock, i.e. the decline of the cycle after the shock, thus demonstrating another interesting property (i.e. the ability to predict the intuitive effect of the financial cycle after a shock) of the aggregate financial indices through this comparative analysis.

The results of this first chapter highlight the importance of using AFSIs as a complementary tool for financial stability monitoring by macroprudential authorities. By providing a clear picture of financial stability, these indicators help identify areas of stability, instability and crisis, helping

policymakers to respond more effectively to financial shocks. The flexibility of the AFSI method also allows for the easy incorporation of sector-specific risks, such as cryptocurrencies or natural disasters. Future research could focus on improving the accuracy of AFSIs by incorporating more variables specific to certain financial sectors, such as the insurance and/or capital market sectors. Furthermore, it would be beneficial to study how AFSIs can be adapted to address the challenges posed by new forms of financial risks, such as cyber risks or the economic implications of climate change. Furthermore, for the comparison exercise, it would also be interesting to consider other risk indicators such as the credit risk of financial and non-financial agents. One could also consider using other much more advanced econometric methodologies such as TP-VAR or Bayesian VAR models in order to test the robustness of our results.

In Chapter 2, the previously defined and constructed AFSIs are used to develop a New Keynesian analytical framework based on the new Keynesian quarterly projection model (QPM), initiated by the International Monetary Fund, to improve the assessment of systemic risks and the implementation of the Basel III agreements. Formally, we analyze in this chapter how public decision-makers can define monetary and macroprudential policies to simultaneously promote economic stability and financial stability in the euro area. More precisely, we assess the effect of a financial shock on the banking system as well as on the macroeconomic environment, on the one hand, and examine the role of a bank capital instrument in promoting financial stability, on the other hand. The model parameters are defined through calibration and Bayesian estimation. Indeed, this parameterization method allows for a better understanding of the interaction between monetary policy, macroeconomic variables and financial stability. The results from the model's impulse response functions showed significant results, improving the understanding of economic dynamics and the impact of macroprudential policies on financial stability.

The analysis of aggregate demand, credit demand and financial stability shocks have revealed important insights into the dynamics of the Euro area economies and the interaction between the different variables. Our results are the following. Firstly, aggregate demand shocks have notably shown how changes in demand affect the output gap, inflation and interest rates. Secondly, credit demand shocks have highlighted the importance of maintaining adequate capital buffers to ensure the resilience of the banking system. Thirdly, financial stability shocks have illustrated the interconnection between financial conditions and macroeconomic outcomes. Consequently, they have highlighted the need to monitor and mitigate risks to maintain overall economic health. The QPM model developed in this thesis shows the importance of integrating macroprudential policies into economic models to better assimilate and manage financial risks. Regulators and central banks could use these models to assess the potential impact of financial policies and shocks on the

economy. By allowing a more precise assessment of the effects of macroprudential policies, the QPM model could help design more effective measures to promote financial stability.

However, setting up this model can be a long-term task ranging from the implementation of the equations to the parameterization of the model. Particularly, the parameterization of the model is a very critical exercise, since it determines the properties of the model. Typically, studies using the QPM model mainly prioritize calibration over estimation when defining the parameters. This consists of fixing the model parameters according to the economic fundamentals of the area under study. This approach has many advantages. For example, it facilitates a deeper understanding of the model properties. However, when the study focuses on a panel of countries with the same fundamentals, calibration can lead to similar results. In this context, estimation or the combination of estimation and calibration is considerably preferable. Future research could explore the integration of new dimensions of financial risks into the QPM model. For example, one could examine risks related to technological innovations, climate change, or geopolitical risks that are particularly increasingly important in shaping economic policies and macro-financial stability in Europe (Caldara and Iacoviello, 2022; Yilmazkuday, 2024). Furthermore, adding a fiscal policy block to the model could provide a better understanding of the interaction between fiscal and macroprudential policies and their impact on financial stability.

Chapter 3, the last of this thesis, studied the impact of fiscal policy shocks on financial stability and the financial cycle depending on the level of public debt. Indeed, as shown by the European Central Bank (ECB, 2010), governments' fiscal policies are directly linked to the financial system. Variables such as the level of public debt can significantly affect the correlation between fiscal policy and financial stability. This is why we included this variable in this analysis of the interaction between fiscal policy and financial stability. First, using the methodology proposed by Hansen (2000), we determine the threshold of public debt beyond which an increase in debt would constitute a threat to financial stability. This threshold is 71% of GDP. It is higher than the threshold set at 60% by the Maastricht Treaty. This higher threshold suggests that some euro area countries can manage higher debt levels without immediately compromising financial stability, due to strong economic fundamentals and improved debt management practices. In a second step, impulses responses functions analysis are used to assess the effect of fiscal shocks on financial stability and the financial cycle across different public debt regimes (high and low regimes). The results of this analysis show that the effects of government expenditure and revenue shocks are varied across high and low debt regimes. First, in a high debt regime, government expenditure shocks negatively influence the financial cycle, while enhancing financial stability, reflecting complex interactions. Conversely, in low debt situations, these shocks initially boost both the financial cycle and financial stability, but

then their effects diminish. Second, government revenue shocks in highly indebted regimes moderately stimulate the financial cycle, but they have a negative impact on financial stability.

The results of this final chapter highlight interesting insights into public debt management and its implications for financial stability and the financial cycle in the euro area. First, the public debt threshold set at 71% of GDP, exceeding the Maastricht criterion of 60%, implies that the countries in the sample are able to cope with higher debt levels without risking immediate financial instability. This could be due to more resilient economic structures or improved debt management capacities. However, this threshold may vary depending on many factors, including overall economic conditions, fiscal policies and institutional credibility. Furthermore, the model used may oversimplify the complex linkages of real economic systems. Moreover, the data used to determine this threshold are specific to a sample of 11 euro area countries and could vary by modifying this sample.

Then, regarding the effects of government spending shocks, it is worth noting that in high debt regimes, positive government spending shocks increase price volatility, slow credit growth and lead to higher interest rates. These negative effects on the financial cycle can be interpreted by increasing concerns about debt sustainability, and therefore encourage investors to demand higher risk premiums (Alesina and Ardagna, 2010). However, a prudent allocation of government spending can strengthen financial stability. This can be due to public investments in productive projects that strengthen long-term economic resilience (Ramey, 2011; Corsetti et al., 2012). Conversely, in high debt regimes, government spending shocks initially boost the financial cycle and financial stability mainly in consideration of increased demand and economic activity (see, for example, Blanchard and Perotti, 2002). However, after a few quarters, these effects become negative due to economic overheating or the formation of asset bubbles, as suggested by the study of Borio and Lowe (2002) on the risks of overheating and financial imbalances. This highlights the risk of prolonged expansionary fiscal policies in low-debt environments, a warning corroborated by the analyses of Reinhart and Rogoff (2010) on the consequences of public debt and financial crises.

Finally, with regard to government revenues, in *high debt regimes*, these positive shocks moderately stimulate the financial cycle. This can be attributed to an increase in investor confidence and the allocation of additional resources for public policies. However, the impact of such shocks is significant because they can further undermine financial stability by increasing concerns about the feasibility of long-term debt servicing. These results are consistent with research by Corsetti and Müller (2006) who indicate that while an increase in government revenues may improve economic performance initially, they could have negative effects on financial stability if such measures aggravate concerns about debt sustainability. Conversely, in *low debt regimes*, government revenue

shocks can have negative effects on the financial cycle, thereby undermining stability and reducing disposable income and the attractiveness of investment. In some cases, such a phenomenon may be a sign of increased fragility, particularly when government revenues fluctuate considerably in a low-debt context. This observation is supported by studies by Auerbach and Gorodnichenko (2012) which indicate that unexpected changes in revenues are likely to trigger instability in business cycles, thereby further eroding investor confidence levels, particularly in low-debt contexts. The influences of other determinants on the results, such as increasing the number of countries in the sample or using a different model, could also be examined.

Taken together, these results highlight the importance of coordinating fiscal and macroprudential policies. Policymakers should carefully monitor the balance between government revenues and expenditures so as not to add to the occurrence of excessive fluctuations in the financial cycle that destabilize financial stability. Thus, they should also monitor the evolution of debt levels. The differences between high and low debt regimes are important and should be taken into account in the economic policy agenda. However, even in high debt regimes, careful public investment policies could restore financial stability. This highlights the need to re-prioritize the quality of public spending. While these results are interesting, it is important to note that the long-term effects of fiscal shocks are not significantly captured, and some destabilizing consequences could remain hidden beyond the analysis period. Moreover, the model used does not fully integrate the interaction of monetary policy that plays a decisive role in economic processes and financial stability. Moreover, economic divergences across euro area countries imply that responses to fiscal shocks would differ considerably, undermining the direct applicability of these results to individual countries. Furthermore, policy biases associated with institutional biases may influence the recommendations – and these tend to focus more on the short term than on long-term stability. Moreover, the assumption that financial markets react rationally to fiscal shocks may be flawed and fail to account for irrational or erratic behavior. Finally, the conclusion that countries can sustain higher levels of debt without immediate instability may promote a policy approach to debt distress that, paradoxically, increases the risk of future debt crises and instability.

Future research could further explore the interactions between fiscal, monetary and macroprudential policies, especially in contexts of financial or economic crisis, using much more complex models (e.g. the QPM model of Chapter 2 could be a starting point), as well as analyses the long-term effects of fiscal shocks. Comparative study across euro area countries would also be relevant. The same applies to the analysis of financial market behavior that can lead to new indicators of financial stability. Moreover, the European fiscal union project still presents advantages and obstacles that are therefore worth exploring. Such research would aim to deepen

the understanding of financial and economic mechanisms, and to provide policy recommendations to strengthen long-term financial stability in the euro area.

Summary and recommendations

The results of this thesis highlight the crucial importance of coordination between fiscal and macroprudential policies to ensure financial stability in the euro area. Fiscal policies, by controlling government expenditure and revenue, and macroprudential policies, by containing systemic risks, need to be carefully synchronized to avoid financial disruptions. During periods of economic recovery, it is essential to build up reserves and reduce public debt, while implementing macroprudential measures to prevent systemic risks. During periods of economic contraction, increased coordination is needed to ensure that fiscal expansions aimed at revitalizing the economy do not have negative effects on financial stability.

The flexibility and adaptability of the models and methodologies developed in this thesis provide valuable tools for policy makers. The use of aggregate financial stability indices and quarterly projection models would allow for a comprehensive assessment of the effects of financial shocks and specific policies, facilitating more informed decision-making. Scenario analyses allow for predicting the potential consequences of different shocks and policy interventions, thus contributing to the promotion of financial stability and sustainable economic growth. In conclusion, this thesis highlights the importance of macroprudential policy in regulating financial cycles and promoting financial stability in the euro area. Coordination between fiscal and macroprudential policies is crucial to ensure long-term economic stability. The creation of a fiscal union in the euro area could strengthen this coordination, but this requires significant political will and increased cooperation between Member States.

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