École des Hautes Études en Sciences Sociales

École doctorale de l'EHESS

Paris-Jourdan Sciences Économiques

DOCTORAT

Discipline : Économie

ASMA BENHENDA

Education Policy, Inequalities and Student Achievement

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Date de soutenance: 27 février 2020

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À mes parents, pour m'avoir inculqué que l'école, c'est sacré.

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Remerciements

Mes années de thèse ont été des années d'épanouissement intellectuel exceptionnel. J'en sors avec la profonde volonté de continuer à me consacrer à la recherche et à l'analyse des politiques publiques.

Je remercie d'abord Julien Grenet et Thomas Piketty, qui ont encadré cette thèse, pour m'avoir transmis leur enthousiasme pour la recherche, et surtout pour une recherche résolument ancrée dans le débat public et motivée par les grandes questions. J'espère pouvoir être fidèle à cette vision dans les années à venir.

Il est difficile de résumer en quelques lignes ce que cette thèse doit à Julien. Il a contribué à de nombreuses étapes de mon développement intellectuel, et ceci bien avant la thèse. Alors que j'entrais à peine à l'École normale supérieure de Cachan, il a pris le temps de me former, avec un sens de la pédagogie hors norme. Je lui suis reconnaissante de ne pas avoir compté son temps, pour son niveau d'exigence et de rigueur qui m'a poussé à continuellement donner le meilleur de moi-même. Je lui suis aussi reconnaissante pour sa présence attentive tout au long de ces années : j'ai partagé avec lui mes succès, et, surtout, j'ai toujours pu compter sur lui dans les nombreux moments de doutes, de gros découragement, et d'échecs cuisants qui égrènent la vie de thésarde. Je mesure difficilement la chance que j'ai eue de le rencontrer si tôt dans mon parcours, et suis heureuse de continuer à travailler avec lui dans les années à venir.

Je remercie Thomas pour son soutien et ses encouragements indéfectibles et décisifs tout au long de la thèse, et plus spécifiquement lors des moments cruciaux qu'ont été mes séjours aux universités de Columbia et de Berkeley, ainsi pendant la période critique de transition vers le post-doc. Je le remercie de porter un agenda de recherche visant à mieux comprendre les mécanismes générateurs d'inégalités : je me souviens bien de ma lecture des *Hauts revenus en France* quand je n'étais qu'en prépa B/L : cette lecture a fait partie de celles qui m'avaient convaincue de m'orienter vers l'économie.

Je tiens à adresser des remerciements tous particuliers à Jonah Rockoff. Mon séjour à l'université de Columbia sous sa direction a été un tournant majeur de la thèse. Ses remarques et suggestions avisées tout au long de la thèse m'ont permis de considérablement progresser. Je le remercie chaleureusement pour son soutien et ses encouragements.

Merci à Pauline Givord, Corinne Prost et Roland Rathelot pour avoir accepté de faire partie du jury et pour avoir pris le temps de lire le manuscript de thèse. Leurs remarques attentives m'ont été très utiles pour le finaliser.

Merci aux chercheurs du campus Jourdan et au-delà avec qui j'ai échangé plus ponctuellement : Marc Gurgand, mais aussi Luc Behaghel, Adrien Bouguen, Julien Combe, Emma Duchini, Gabrielle Fack, Laurent Gobillon, Arthur Heim, Melina Hillion, Jesse Rothstein, Arnaud Riegert, Camille Terrier et Clémentine Van Effenterre.

Je remercie tous ceux qui m'ont permis de ne pas perdre de vue le lien entre recherche et débat public. Merci à ceux qui ont participé à *Regards croisés sur l'économie* entre 2011 et 2018 et plus spécifiquement Claire Montialoux et Gabriel Zucman pour m'avoir confié les clefs de cette maison que j'ai eue le plaisir de diriger pendant les années de thèse. Merci aussi à la DEPP : Catherine Moisan, pour avoir soutenu le projet de thèse à ses tout débuts, mais aussi Cédric Afsa, Pierrette Briant, Caroline Simonis-Sueur et Fabienne Rosenwald pour avoir facilité l'accès aux données, Caroline Caron et Sophie Ruiz pour avoir partagé leurs connaissances sur ces données, et Jean-Pierre Prudent pour ses indications cruciales sur les bases SIRH. Merci à la Cour des comptes, et surtout à Loïc Robert, pour avoir soutenu le projet sur les enseignants en Éducation prioritaire.

Merci à mes camarades jourdaniens pour leur bonne humeur : mes co-bureaux, Benjamin, Hélène, Luis, Martin, Nicolas, Quentin et Quitterie, mais aussi Alessandro, Aurélie, Fanny, José, Marianne, Simon, et Yannick.

Merci enfin à mes proches : mon parcours et cette thèse doivent beaucoup à leur confiance et soutien inconditionnels.

Résumé de la thèse

Cette thèse analyse l'efficacité des dispositifs mis en place par la puissance publique pour atteindre leurs trois principaux objectifs : attirer et retenir des enseignants de qualité, aider les enseignants à s'améliorer, et appareiller les enseignants à leurs élèves de façon à réduire les inégalités éducatives. Par rapport à l'essentiel de la littérature académique existante consacrée aux politiques éducatives à destination des enseignants, cette thèse élargit le champ d'analyse au rôle d'acteurs peu étudiés dans la littérature : les jurys des concours de recrutement, les inspecteurs d'académie et les chefs d'établissement (chapitre I), mais aussi les enseignants remplaçants, qu'ils soient titulaires ou contractuels (chapitre II). Elle étend enfin la discussion au système éducatif dans son ensemble à travers l'analyse d'un mécanisme d'incitations non-monétaires mis en place pour attirer et retenir les enseignants dans les établissements défavorisés (chapitre III).

Cette thèse commence par rappeler que le premier enjeu est, en amont, de mesurer la qualité des enseignants. Si cette thèse confirme le rôle proéminent de l'expérience des enseignants, et met en avant celui de la note pédagogique et du statut de contractuel, il semble cependant clair qu'aucun des indicateurs analyses ne permet, à lui seul, d'expliquer les variations de qualité des enseignants. Les résultats de cette thèse vont ainsi dans le sens de la littérature existante qui souligne qu'enseigner est une activité complexe et multidimensionnelle, qui ne saurait se réduire à une seule et unique compétence. En ce qui concerne objectif au lui-même de rétention des enseignants de qualité, cette thèse met en évidence le fait que les enseignants contractuels, recrutés « sur le tas » pour assurer continuité de la qualité de l'enseignement en l'absence d'enseignant titulaire, ne semblent pas être mesure de remplir pleinement cette mission, que ce soit dans le contexte d'affectation à l'année ou de remplacements plus ponctuels.

Cette thèse souligne ensuite la difficulté à mettre en place des interventions efficaces

visant à aider les enseignants déjà en poste à améliorer leur performance. Si la note d'inspection permet de capturer une dimension de la qualité des enseignants, l'inspection elle-même ne permet pas aux enseignants de progresser. Ce résultat contraste avec celui de la littérature, qui met en évidence l'impact positif de dispositifs comparables, mais beaucoup plus ciblés et intensifs - et donc beaucoup plus coûteux.

Cette thèse montre enfin que des mécanismes d'incitations non-monétaires existants tels que le dispositif Affectation prioritaire à valoriser ne semblent pas avoir d'effet statistiquement en termes de taux de mobilité ni de composition de la population enseignante dans les établissements défavorisés, même si ce dispositif permet de réduire les écarts, entre établissements défavorisés et les autres établissements, de taux de sortie de la profession pour les enseignants inexpérimentés. Réduire les inégalités dans la distribution des enseignants entre les différents établissements demeure donc un défi majeur pour la puissance publique.

Introduction Générale

Cette thèse part du constat suivant : les enseignants sont l'un des facteurs décisifs de la réussite de leurs élèves. Le consensus au sein de la littérature existante est que d'importantes variations existent entre les enseignants en termes de capacité à faire progresser leurs élèves (aussi appelée « valeur ajoutée »), et que ces variations ont des conséquences majeures, à court terme comme à long terme. A court terme, une différence d'un écart-type de valeur ajoutée se traduit par une différence d'environ 10 % d'écart-type dans le progrès de leurs élèves aux tests standardisés de compétences (Chetty et al., 2014a). A long terme, les élèves affectés à des enseignants à forte valeur ajoutée ont plus de chance de faire des études supérieures et de bénéficier de salaires plus élevés (Chetty et al., 2014b).

Ce constat soulève deux questions qui constituent la problématique de la thèse.

Premièrement, il est crucial de mieux comprendre ce qui fait un bon enseignant : quels sont les principaux déterminants de la qualité des enseignants ? Il n'existe pas encore de réponse claire à cette question. Les principales pistes explorées, tels que le niveau de diplôme ou la certification, ne sont pas concluantes (Kane et al., 2008). Seules les premières années d'expérience expliquent de façon significative les écarts de performance entre les enseignants : l'écart d'expérience entre un enseignant sans aucune expérience et un enseignant plus expérimenté peut expliquer entre 5 et 10 % de la valeur-ajoutée des enseignants (Rivkin et al., 2005). Cet effet se concentre cependant sur les premières années : au-delà de ces cinq premières années, l'expérience ne permet plus d'expliquer les différences de valeur ajoutée (Rockoff, 2004). Deuxièmement, il est essentiel d'identifier les politiques publiques susceptibles d'améliorer la qualité des enseignants. Aux États-Unis, la principale solution proposée consiste à lier directement des décisions majeures de ressources humaines telles que la promotion ou le licenciement des enseignants à des mesures de valeur ajoutée (Green et al., 2012). Cette approche est néanmoins très controversée

et fait l'objet de débats méthodologiques (Rothstein, 2016) et politiques (McNeil, 2012) importants.

Ces deux questions sont lourdes d'enjeux en termes de politique publique : en moyenne, les pays de l'OCDE consacrent 5 % de leur PIB aux dépenses éducatives, et plus de 80 % des dépenses éducatives de fonctionnement sont attribuées à la rémunération des personnels. En France, 65 milliards d'euros par an sont dédiés à la rémunération des enseignants, soit plus de 3 % du PIB (OCDE, 2018). Ces dépenses ne sont pas reparties de façon égale sur le territoire : d'après nos calculs, le salaire moyen brut des enseignants des établissements publics les plus favorisés est 10 à 15 % supérieur à celui des enseignants des établissements les moins favorisés (Benhenda, 2019). Ces disparités sont essentiellement dues à des différences de composition de la population enseignante entre ces établissements. Par exemple, en 2014, l'expérience moyenne des enseignants dans les établissements de l'Education prioritaire les plus défavorisés est de 11 ans contre plus de 14 ans hors Education prioritaire (Benhenda, 2018). La proportion d'enseignants de moins de 35 ans est, en 2015, de 38 % dans les établissements d'Éducation prioritaire les plus défavorisés contre 24 % hors Éducation prioritaire (Dgesco, 2015). Ce phénomène est commun à beaucoup d'autres pays développés (OCDE, 2018). Aux États-Unis par exemple, le nombre moyen d'années d'expérience des enseignants en sciences dans les établissements les plus défavorisés est de 11,5 années contre 15,5 années dans les établissements les plus défavorisés. Cela a des conséquences considérables en termes d'inégalités de réussite scolaire : l'écart de qualité des enseignants entre les établissements favorises et défavorisés représente 20 % des inégalités de réussite scolaire entre les élèves de ces établissements (US Department of Education, 2013).

A cela s'ajoute le fait que la plupart des pays développés font face à une crise majeure de recrutement. D'après l'OCDE (2018), « la pénurie d'enseignants est l'un des problèmes les plus urgents auxquels font face les systèmes éducatifs ». En France, le nombre d'admis aux concours enseignants du second degré public en 2016 est inférieur de 13 % aux besoins de recrutement. Cette pénurie touche principalement les mathématiques, où 35 % des postes au concours de l'Agrégation et 20 % au CAPES ne sont pas pourvus (DEPP, 2016). Dans ce contexte, améliorer, ou même maintenir, la qualité de l'enseignement est

un défi délicat, surtout dans les établissements les plus défavorisés.

Face à ce défi, la contribution de cette thèse est d'analyser l'efficacité des dispositifs mis en place par la puissance publique pour atteindre leurs trois principaux objectifs : « attirer et retenir des enseignants de qualité, aider les enseignants à s'améliorer, et appareiller les enseignants à leurs élèves de façon à réduire les inégalités éducatives » (OCDE, 2018). Par rapport à l'essentiel de la littérature académique existante sur les politiques éducatives à destination des enseignants, cette thèse se propose de dépasser le cadre d'analyse standard qui se limite aux deux principaux protagonistes du système éducatif : les enseignants titulaires d'un côté, et leurs élèves, de l'autre. Ce cadre d'analyse ne met pas suffisamment l'accent sur le fait que les enseignants font partie d'une organisation, avec de nombreux acteurs et mécanismes, souvent présentés comme auxiliaires, mais qui peuvent en fait jouer un rôle important dans la qualité de l'enseignement. Cette thèse élargit ainsi le champ d'analyse au rôle d'acteurs peu étudiés dans la littérature : les jurys des concours de recrutement, les inspecteurs d'académie et les chefs d'établissement (chapitre I), mais aussi les enseignants remplaçants, qu'ils soient titulaires ou contractuels (chapitre II). Elle étend enfin la discussion au système éducatif dans son ensemble à travers l'analyse d'un mécanisme d'incitations non-monétaires mis en place pour attirer et retenir les enseignants dans les établissements défavorisés (chapitre III).

Le recrutement des enseignants

Assurer la qualité de l'enseignement commence dès le recrutement des enseignants (chapitre I). Cette thèse analyse ainsi le rôle du jury des concours de recrutement des enseignants du secondaire public à travers les notes qu'ils attribuent aux candidats. En France, il existe deux principaux concours de recrutement pour les enseignants du secondaire public. Le premier est le CAPES (Certificat d'aptitude au professorat de l'enseignement du second degré). Les enseignants capétiens ont essentiellement vocation à enseigner au collège et au lycée. Le second est l'Agrégation. Les agrégés ont essentiellement vocation à enseigner au lycée et en classe préparatoire aux grandes écoles. Ces deux concours se déroulent en deux étapes : un examen écrit, puis, pour les candidats admissibles, un examen oral. Les examens écrits se composent de dissertations et de commentaires de do-

cuments en lettres et en histoire-géographie et d'exercices en mathématiques. Les examens oraux se décomposent en trois parties : leçon, entretien et analyse de texte ou exercices pour les mathématiques.

Deux spécificités de ce concours en font un objet d'analyse particulièrement pertinent par rapport aux résultats de la littérature existante sur l'effet de la certification sur la qualité des enseignants (Koedel et al., 2015). Premièrement, le concours français est plus sélectif que le processus de certification aux Etats-Unis, auquel l'essentiel de la littérature est consacrée. C'est particulièrement le cas pour l'Agrégation, dont une part significative de candidats sont issus des Grandes Écoles, et dont le taux d'admission à l'Agrégation est de 15 % contre plus de 30 % pour le CAPES (Depp, 2016). Deuxièmement, la spécificité du concours français est sa dimension très académique : il vise avant tout à évaluer les connaissances de contenu des candidats plutôt que leur savoir-faire pédagogique. Cela permet ainsi d'analyser, en creux, la contribution des connaissances académiques à la qualité des enseignants.

L'évaluation des enseignants

Une fois que les enseignants sont en poste, deux principaux acteurs sont en charge de mesurer leurs performances et de les aider à progresser : le chef d'établissement et les inspecteurs d'académie. Les chefs d'établissement évaluent leurs enseignants tous les ans. Chaque année, au mois de janvier, les chefs d'établissement rédigent un rapport sur leurs enseignants, où ils les évaluent en fonction de plusieurs critères : ponctualité (être à l'heure, respecter les échéances) ; assiduité (pas d'absences injustifiées) ; efficacité (initiative, organisation, jugement), autorité (prise de décision, sens des responsabilités) et influence (participation à des activités extra-scolaires, interactions avec les collègues). Ils évaluent également les enseignants de façon quantitative en leur attribuant une note sur 40, appelée note administrative. La principale originalité de la notation des enseignants par les chefs d'établissements en France par rapport à ses équivalents à l'étranger est son faible enjeu en termes de carrière. Contrairement à d'autres pays comme les États-Unis (Jacob et Lefgren, 2008), le chef d'établissement ne prend pas de décisions de ressources humaines (recrutement, licenciement, promotion, etc.) car le système éducatif français

est très centralisé. L'analyse menée dans cette thèse permet donc également de contribuer au débat sur la décentralisation du système éducatif qui donnerait plus de pouvoir décisionnaire au chef et ses conséquences en termes de qualité des enseignants (voir Eyles et Machin (2015) pour le débat sur « l'academisation » au Royaume-Uni par exemple).

Une autre spécificité de la note administrative par rapport aux évaluations étudiées dans la littérature est qu'il est explicitement demandé aux chefs d'établissement de donner « une appréciation sur la manière de servir de l'enseignant, en dehors d'appréciation à caractère pédagogique ». L'objectif de cette recommandation est que la note administrative soit complémentaire avec la note d'inspection, donnée par les inspecteurs d'académie. Les inspecteurs d'académie sont des cadres supérieurs de l'Education nationale, en général d'anciens enseignants. Leur principale mission est de veiller à la mise en œuvre de la politique éducative dans les classes et les établissements, et d'inspecter les personnels enseignants. A notre connaissance, il n'existe aucune étude consacrée à l'efficacité du processus d'inspection en France, malgré le fait que des ressources significatives y soient consacrées : il existe environ 3 000 inspecteurs, avec un salaire brut mensuel de 3 600 euros. Le processus d'inspection se déroule en trois grandes étapes. La première est la préparation de cette visite par l'inspecteur. L'inspecteur a accès à l'ensemble des supports pédagogiques de l'enseignant (cours, cahiers des élèves, etc.) ainsi qu'à ses précédentes évaluations (notes d'inspection et notes administratives). Puis l'inspecteur se rend dans la classe de l'enseignant pour observer un ou plusieurs de ses cours. Enfin, l'inspecteur fait un retour individuel à l'enseignant et lui prodigue des conseils pour progresser.

L'objectif de ce processus est double : évaluer les enseignants, mais aussi leur fournir un soutien pédagogique et un retour précis sur leur travail afin de leur donner les outils nécessaires pour progresser. Cette thèse analyse l'efficacité du processus d'inspection en fonction de ses deux objectifs. L'essentiel de la littérature existante consacrée au processus d'évaluation s'intéresse à des dispositifs très localisés, intenses et souvent dans des environnements contrôlés. Ils mettent en évidence pour l'essentiel l'efficacité de ces dispositifs à mesurer la qualité des enseignants (Kane et al., 2011) et à les aider à progresser (Taylor et Tyler, 2012). La contribution de cette thèse est de s'intéresser à un dispositif national, à grande échelle et peu intense. Par cette analyse, cette thèse contribue aussi en creux au débat sur la difficulté d'élargir l'échelle de dispositifs efficaces mais très locaux.

Les enseignants remplaçants

Le dernier type d'acteurs auquel se consacre cette thèse sont les enseignants remplaçants, dont la fonction première est d'assurer la continuité de l'enseignant en l'absence de l'enseignant titulaire. Il existe deux types d'enseignants remplaçants, de statuts et niveaux de qualification différents : les enseignants titulaires sur zones de remplacement (TZR) et les enseignants contractuels. Les enseignants TZR sont des enseignants titulaires, certifiés ou agrégés, mis en réserve et à la disposition du rectorat pour effectuer des remplacements sur une zone géographique définie appelée zone de remplacement. Les enseignants TZR, qui représentent environ 15 % de la population enseignante (Benhenda, 2018), ont des caractéristiques observables très comparables aux autres enseignants titulaires, à l'exception du fait qu'ils sont en moyenne moins expérimentés : les enseignants TZR ont en moyenne 10 années d'expérience contre 14 années pour les autres enseignants titulaires. Face au manque d'attractivité de la profession enseignante, l'Éducation nationale a recours de façon de plus en plus pérenne aux enseignants contractuels. Ces derniers sont recrutés directement par les académies via une procédure distincte de celle employée pour recruter les enseignants titulaires. Les candidats postulent directement sur une plateforme en ligne. Il y a deux conditions d'éligibilité : être titulaire d'une licence et ne pas avoir de casier judiciaire. Les candidats sélectionnés sont recrutés sur la base d'un contrat à durée déterminée d'une durée maximale d'un an. En 2016-2017, les enseignants contractuels représentent environ 7 % de la population enseignante. Leur poids dans la population enseignante est en forte croissance ces dernières années. En 2016-2017, la croissance annuelle du nombre d'enseignants de titulaire est de 1 % tandis que celle des enseignants contractuels est de 10 % (DEPP, 2018). Il existe de fortes disparités géographiques dans la présence de contractuels, même au sein d'une même académie : ainsi dans l'académie de Créteil, le taux de contractuels est de 13,7 % dans le département de Seine Saint-Denis contre 7,7 % en Seine-et-Marne (Cour des comptes, 2018). Dans les établissements les plus défavorisés de l'Education prioritaire, plus de 16 % des enseignants sont des contractuels (Benhenda, 2018).

Ce phénomène n'est pas propre à la France mais touche de nombreux pays développés (OCDE, 2018). En Italie, les enseignants non-titulaires représentent 26 % de la population enseignante dans établissements défavorisés contre seulement 12 % dans les établissements

les plus favorisés. Dans l'état américain du Massachussetts, seulement 2,7 % des enseignants sont contractuels dans les établissements les plus favorisés contre plus de 12.5 % dans les établissements les plus défavorisés.

Malgré l'importance de ce phénomène, qualifié par la Cour des comptes de « d'enjeu désormais significatif pour l'Education nationale », il existe très peu de travaux consacrés à l'effet des enseignants contractuels sur les performances de leurs élèves. La principale étude existante porte sur le contexte très spécifique d'un pays en développement, où le système de gestion des enseignants titulaires est défaillant, et où les enseignants contractuels ont un niveau de qualification comparable aux titulaires et sont étroitement contrôlés (Duflo et al., 2015). La contribution de cette thèse est donc de s'intéresser à un pays développé, la France, où le contexte très différent : les contractuels sont en général recrutés sur le tas, avec des critères d'éligibilité minimaux et sans vraiment de mécanismes incitatifs une fois qu'ils sont en poste.

Attirer et retenir les enseignants dans les établissements défavorisés

La dernière contribution de cette thèse élargit la focale : elle passe d'une analyse d'acteurs à l'analyse d'un dispositif centralisé visant à influencer les comportements de ces acteurs et ainsi améliorer leur allocation entre les différents établissements. Ce dispositif a pour objectif de pallier le fait que les élèves des établissements défavorisés sont plus susceptibles de faire face à une forte instabilité des équipes enseignantes. En moyenne, les enseignants affectés aux établissements les plus défavorisés de l'Éducation prioritaire passent six années consécutives dans le même établissement, contre plus de huit ans hors Éducation prioritaire, soit un écart de 25 %. Le taux de mobilité inter-établissement dans les établissements hors Éducation prioritaire est de moins de 5 % contre plus de 10 % en Éducation prioritaire (Benhenda, 2018). Cette forte instabilité des équipes peut affecter négativement les performances des élèves à travers deux principaux mécanismes. Le premier est un effet de composition, lorsque les meilleurs enseignants sont les plus susceptibles de quitter ces établissements (Adnot et al., 2017). Le second est lié à l'effet perturbateur et la perte de capital humain spécifique à l'établissement provoqué par cette instabilité (Ronfeldt et al., 2013).

Le principal dispositif analysé par la littérature pour faire face à ce phénomène est un système de compensation financière pour les enseignants affectés dans les établissements défavorisés. Les études existantes ne permettent pas de conclure sur leur efficacité : certaines, se focalisant plus spécifiquement sur les États-Unis (Feng et Sass, 2016), mettent en évidence un effet positif de ces dispositifs sur la qualité des enseignants et la stabilité des équipes, tandis que d'autres, analysant le contexte français (Prost, 2013) ne trouvent pas d'effets statistiquement significatif. Par ailleurs, de nombreux éléments suggèrent que les enseignants sont très sensibles aux dimensions non pécuniaires de leurs conditions de travail (Hanushek et al., 2004 ; Worth et al., 2018).

Cette thèse se propose ainsi d'analyser un dispositif centralisé et d'incitations non monétaires visant à attirer et retenir les enseignants dans les collèges publics défavorisés, baptisé « Affectation à caractère prioritaire justifiant une valorisation » (APV). En France, l'affectation des enseignants est réalisée au moyen d'une procédure informatique centralisée : les enseignants soumettent en ligne une liste hiérarchisée de vœux puis sont affectés selon une version modifiée de l'algorithme d'acceptation différée de Gale et Shapley (Combe et al., 2018). Les principaux critères définissant l'ordre de priorité des enseignants sont la situation familiale, l'expérience professionnelle (nombre d'années depuis l'entrée dans la profession enseignante), l'ancienneté (nombre d'années consécutives passées dans le même établissement), et l'ancienneté en établissement classé APV, souvent également classé Éducation prioritaire. L'objectif de cette étude est ainsi d'évaluer l'efficacité du bonus APV à atteindre ses deux principaux objectifs, tels qu'ils sont présentés dans les textes officiels : « rendre plus attractives les affectations à caractère prioritaire » et « d'inciter [les enseignants] à s'investir durablement pour une période d'au moins cinq ans ».

Plan de la thèse et principaux résultats

Cette thèse s'articule autour de trois parties. La première analyse le lien entre les notes des enseignants aux concours de recrutement, la note donnée par le chef d'établissement (appelée note administrative) et la note d'inspection d'une part, et la capacité des enseignants à faire progresser leurs élèves d'autre part. La deuxième partie s'intéresse à l'effet des absences et remplacements des enseignants sur les performances scolaires de leurs élèves. Enfin, la troisième partie analyse l'efficacité du dispositif Affectation prioritaire à

valoriser à attirer et retenir les enseignants dans les établissements les plus défavorisés. L'ensemble de cette thèse s'appuie sur des données administratives exhaustives fournies par la Direction de l'évaluation, de la prospective et de la performance du ministère de l'Education nationale (MENJ-DEPP).

Chapitre I

Ce chapitre s'appuie sur des données qui incluent des informations sur les enseignants telles que leur identifiant national, leur matière, leur niveau de certification, leur niveau d'expérience, leur établissement d'affectation, ainsi que leurs notes aux concours, leurs notes administratives et d'inspection. Ces données incluent également des informations sur les élèves telles que leur identifiant individuel crypté, leurs caractéristiques sociodémographiques, ainsi que leurs notes aux épreuves écrites du Diplôme national du brevet (DNB) et du Baccalauréat.

Pour identifier le lien entre les notes d'évaluation des enseignants et leur capacité à faire progresser leurs élèves, ce chapitre exploite les variations inter-matières et intra-élève (pour un élève donné) du nombre de jours d'absence et le nombre de jours de remplacement. Il s'agit d'exploiter le fait que chaque élève de troisième a plusieurs enseignants au cours de l'année et que ses performances scolaires sont mesurées séparément dans plusieurs matières à la fin de l'année, via les épreuves du DNB. De ce fait, chaque année, chaque élève est observé avec plusieurs enseignants, un par matière. La méthode ici employée consiste à faire le lien, pour chaque élève, entre les évaluations relatives de ses différents enseignants et ses performances relatives dans les différentes matières des épreuves finales du brevet (français, mathématiques, histoire-géographie). À niveau scolaire donné, les élèves obtiennent-ils de moins bons résultats dans une matière donnée, par rapport aux autres matières, quand l'enseignant de la matière considérée a de meilleures évaluations que les autres enseignants de l'élèves dans les autres matières ? Le principal objectif de cette approche (effets fixes élèves) est de neutraliser l'effet des déterminants inobservables des performances scolaires, considérés comme constants entre matières, qui peuvent être corrélés aux évaluations des enseignants.

Deux principaux résultats émergent de cette analyse. Premièrement, la note d'inspection est la seule note d'évaluation liée de façon statistiquement significative aux performances des enseignants. La magnitude de ce lien est très faible : une différence d'un

écart-type dans la note d'inspection est associée à une augmentation de 2 % d'écart-type des performances des élèves. Ce lien entre note pédagogique et qualité des enseignants est plus fort pour les élèves issus de famille à faible revenu que pour les autres. Le statut d'agrégé, les notes aux concours (écrit comme oral) ou la note du chef d'établissement ne semblent pas, quant à eux, être liés de façon statistiquement significative à la qualité des enseignants.

Deuxièmement, l'inspection ne semble avoir aucun effet durable sur les performances des enseignants. L'année de l'inspection, les enseignants sont légèrement moins absents. Ainsi, si l'inspection semble atteindre partiellement son premier objectif, mesurer la qualité des enseignants, elle ne semble pas être en mesure d'atteindre son second objectif, aider les enseignants à améliorer leurs performances.

Chapitre II

La spécificité des données exploitées dans ce chapitre par rapport à celles du chapitre précédent est qu'elles contiennent des informations détaillées sur les congés des enseignants telles que la date précise de ces congés et leur motif, pour chaque enseignant. Elles permettent également de faire le lien entre chaque congé et, le cas échéant, l'enseignant qui a effectué le remplacement.

Pour identifier l'impact causal du nombre de jours d'absence et de remplacement des enseignants sur les performances des élèves, ce chapitre combine la méthode « en coupe » utilisée au premier chapitre (exploitation des variations inter-matières et intra-élèves) à une approche longitudinale : il s'agit d'exploiter le fait que chaque enseignant est observé plusieurs années, et que son nombre de jours d'absence et de remplacement varie d'une année à une autre. La méthodologie employée consiste à faire le lien, pour chaque enseignant, entre ses variations dans le nombre d'absences et de remplacements et les variations interannuelles des performances scolaires de ses élèves. Les années où l'enseignant est davantage absent/moins souvent remplacé correspondent-elles à des années de moindre performance pour ses élèves ? Le principal objectif de cette approche est de « neutraliser » les déterminants inobservables de l'effet enseignant qui ne varient pas d'une année à une autre.

Cette analyse montre que les absences des enseignants ont un effet négatif et statistiquement significatif sur les performances scolaires des élèves, quel que ce soit le type

d'établissement considéré. En moyenne, un jour supplémentaire d'absence non remplacé réduit les performances scolaires des élèves d'environ de 0.02 % d'un écart-type, ce qui est comparable aux résultats mis en évidence par la littérature. Cet effet est statistiquement significatif, même s'il convient de souligner que sa magnitude est faible. L'effet moyen de 10 jours d'absence non remplacés est en effet équivalent à un quart de l'effet d'une augmentation de la taille des classes au collège d'un élève [1]. Seuls les enseignants titulaires sur zone de remplacement semblent avoir un effet compensateur statistiquement significatif : un jour de remplacement par un titulaire sur zone de remplacement compense jusqu'à 25 % de l'impact négatif d'un jour d'absence non remplacé sur les performances des élèves. À l'inverse, les enseignants contractuels n'ont aucun effet compensateur statistiquement significatif. Ce résultat suggère que les enseignants titulaires sur zone de remplacement sont en mesure d'assurer une partie de la continuité de la qualité de l'enseignement, contrairement aux enseignants contractuels.

Chapitre III

Les enseignants du secondaire sont affectés selon une procédure automatisée, qui prend en compte un certain nombre de critères tels que la situation familiale de l'enseignant, son nombre d'années d'expérience et son ancienneté dans l'établissement (nombre d'années consécutives passées dans le même établissement). Le dispositif Affectation prioritaire à valoriser (APV) consiste à attribuer des points de mobilité supplémentaires aux enseignants qui ont été affectés dans les établissements ayant reçus la classification APV, et qui y ont exercé pendant plusieurs années consécutives.

Afin d'évaluer ce dispositif, nous nous intéressons à une réforme majeure de la structure de ce bonus en 2005. Avant 2005, les enseignants en APV commençaient à bénéficier d'un bonus à partir de trois ans d'ancienneté. Après 2005, la durée d'ancienneté requise est passée à cinq ans. La valeur du bonus APV à cinq ans d'ancienneté est désormais équivalente à la valeur du bonus expérience pour un enseignant ayant accumulé 43 ans d'expérience. Notre analyse suggère que cette réforme a permis d'augmenter de 0,3 année l'ancienneté moyenne des enseignants exerçant dans les établissements concernés par la bonification APV, par rapport aux enseignants affectés à des établissements non concernés. Une analyse plus fine nous permet d'observer que le principal effet de cette réforme est

1. voir Benhenda (2018) pour le détail de ce calcul.

que les enseignants ont plus tendance à rester dans leur établissement APV jusqu'à 5 ans d'ancienneté, mais aussi à le quitter dès qu'ils atteignent le nombre d'années requises pour bénéficier de la bonification. Cette réforme a également permis de réduire la probabilité des enseignants inexpérimentés affectés à un établissement APV de quitter la profession enseignante.

Cette réforme n'a pas eu en revanche d'effet clair sur la composition des enseignants, telle qu'elle est mesurée par leur nombre d'années d'expérience, ni sur les écarts moyens de performance scolaire des élèves (mesurés par leurs notes standardisées aux épreuves du DNB) entre les établissements APV et les autres.

Principaux enseignements de la thèse

La principale contribution de cette thèse, comme énoncé au début de cette introduction, est d'analyser l'efficacité des dispositifs mis en place par la puissance publique pour atteindre leurs trois principaux objectifs : i) attirer et retenir des enseignants de qualité ; ii) aider les enseignants à s'améliorer ; iii) appareiller les enseignants à leurs élèves de façon à réduire les inégalités éducatives. Au terme de l'analyse menée dans cette thèse, nous mettons en évidence les conclusions pouvant être tirées par rapport à ces trois objectifs.

Attirer et retenir enseignants de qualité

Cette thèse rappelle que le premier enjeu est, en amont, de mesurer la qualité des enseignants. Si cette thèse confirme le rôle proéminent de l'expérience des enseignants, et met en avant celui de la note pédagogique et du statut de contractuel, il semble cependant clair qu'aucun des indicateurs analyses ne permet, à lui seul, d'expliquer les variations de qualité des enseignants. Les résultats de cette thèse vont ainsi dans le sens de la littérature existante qui souligne qu'enseigner est une activité complexe et multidimensionnelle, qui ne saurait se réduire à une seule et unique compétence.

En ce qui concerne objectif de rétention des enseignants de qualité, cette thèse met en avant l'urgence de politiques plus ambitieuses pour l'atteindre. La France, comme de nombreux autres pays développés, souffre d'une crise de recrutement des enseignants majeure. Cette crise a des conséquences directes sur la qualité de l'enseignement : un des principaux résultats de cette thèse est que les enseignants contractuels, recrutés sur

le tas pour assurer continuité de la qualité de l'enseignement en l'absence d'enseignant titulaire, ne semblent pas être mesure de remplir pleinement cette mission, que ce soit dans le contexte d'affectation à l'année ou de remplacements plus ponctuels.

Aider les enseignants à s'améliorer

Cette thèse met en évidence la difficulté à mettre en place des interventions efficaces visant à aider les enseignants déjà en poste à améliorer leur performance. Si la note d'inspection permet de capturer une dimension de la qualité des enseignants, l'inspection elle-même ne permet pas aux enseignants de progresser. Ce résultat contraste avec celui de la littérature, qui met en évidence l'impact positif de dispositifs comparables, mais beaucoup plus ciblés et intensifs - et donc beaucoup plus coûteux.

Appareiller les enseignants à leurs élèves de façon à réduire les inégalités éducatives

Cette thèse fait tout d'abord le constat d'une inégale distribution des caractéristiques observables des enseignants, telles que l'expérience, entre les établissements défavorisés et les autres. Aussi, dans les établissements défavorisés, les enseignants contractuels sont surreprésentés, et les enseignants plus fréquemment absents et moins remplacés.

Cette thèse montre ensuite que des mécanismes d'incitations non-monétaires existants tels que le dispositif APV ne semblent pas avoir d'effet statistiquement significatif en termes de taux de mobilité ni de composition de la population enseignante dans les établissements défavorisés, même si ce dispositif permet de réduire les écarts de taux de sortie de la profession pour les enseignants inexpérimentés. Réduire les inégalités de distribution des enseignants entre les différents établissements demeure donc un défi majeur pour la puissance publique.

Pour autant, la littérature internationale mentionnée dans cette thèse souligne que lorsque les moyens alloués sont ambitieux, il est possible d'agir de façon significative sur la composition de la population enseignante dans les établissements défavorisés. En France, la question reste de savoir si les reformes récentes d'incitations monétaires dans les établissements de l'Éducation prioritaire sont à même de relever ce défi. Un de nos travaux en cours s'intéresse à la réforme de l'Education prioritaire de 2015, dont l'un des volets est d'augmenter la prime des enseignants dans ces établissements de plus de 60 %,

la portant à près de 3.500 euros par an dans les établissements les plus défavorisés de l'Éducation prioritaire. Une analyse préliminaire suggère que cette réforme permet aux salaires moyens dans les établissements les plus défavorisés d'être équivalents à ceux des enseignants dans les établissements plus favorisés. La question qui reste ouverte est de savoir si cela est suffisant pour agir de façon conséquente sur la composition enseignante dans les établissements les plus défavorisés.

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Chapitre 1

Teacher Screening, On-the-Job Evaluations and Performance

I study the relationship between systematic screening, on-the-job teacher evaluations, and teacher performance in secondary school. Using comprehensive French administrative data, I exploit within-student across subject variation and find that having a non-certified teacher is associated with a 6 percent decrease in student achievement. Among certified teachers, only the evaluation based on classroom observation is significantly related to teacher performance. I then investigate whether classroom observation has an impact on teacher performance and behaviour during the year of evaluation and in subsequent years. An event study shows that classroom observation has no statistically significant impact on student achievement nor on teachers' probability to quit. I find that teachers are slightly less likely to be absent during the year of the evaluation, suggesting that this evaluation provokes a temporary change in teacher behaviour. **JEL** : I2, J2, M51.

1.1 Introduction

There is growing evidence showing substantial variation in teacher effectiveness (see Koedel et al., 2015 for a review). However, there is still little evidence on how to identify good teachers and how to improve teacher performance despite the considerable attention researchers dedicate to this question. [1] This paper analyses teacher evaluations, one of the main tools used by policy makers to solve this issue. How efficient are teacher evaluations

1. see Loyalka (2019) for a recent discussion

in identifying good teachers ? Do teacher evaluations have an impact on subsequent teacher performance ?

A lot of public resources are devoted to evaluating teachers. In the United States for example, evaluations can cost up to $4,000 per teacher each year. [2] Teacher evaluation is widespread in many developed countries : across the OECD, more than 75 % of students are enrolled in schools where teachers are evaluated (Isore, 2009). Because of the importance of this practice, more evidence on its efficiency is needed. The existing set of papers on this question are conducted in very specific contexts, often in controlled environments, with frequent, feedback intensive and high stake evaluations, which are not representative of most teacher evaluation systems (see Steinberg and Donaldson, 2016 for a review).

This paper analyses the relationship among nationwide certification exams, on-the-job teacher evaluations, and teacher performance in secondary school. I use administrative data on 22,519 teachers and 502,302 students covering French public secondary schools from 2006-2015. I analyse multiple evaluations, both before recruitment and on-the-job, aiming at measuring potentially relevant dimensions of effective teaching : i) written and oral certification exam scores, aimed at measuring content-knowledge ; ii) classroom observation grade by an external inspector, aimed at measuring pedagogical and relational skills ; iii) school principal grade, aimed at measuring good behaviour outside the classroom.

First, I examine the screening/accountability objective of teacher evaluation. How efficient are teacher evaluations in identifying good teachers ? I exploit the fact that, in secondary school, teachers are subject-specific to identify the relationship between teacher evaluations and student achievement. I exploit within student, across subject variation in teachers, and a fortiori in teachers' evaluations, to identify their relationship with teacher effectiveness in raising students' test scores in 9th grade and 12th grade. I find that having a non-certified teacher rather than a certified teacher is associated with a 6 percent decrease in student achievement. Among certified teachers, I find neither the certification level (high, called Agregation vs. basic, called CAPES), nor the certification grades (written nor oral) are associated with student achievement gains, whether analysed separately or jointly in a horse race with the other evaluation grades. I also find that the

2. This figure corresponds to the Cincinatti teacher evaluation system, see Taylor and Tyler (2012) for more details.

school principal grade is not statistically associated with student achievement, whatever the specification. The only evaluation grade significantly associated with student achievement gains is the classroom observation grade. Both in 9th grade and 12th grade, a one standard deviation increase in the classroom observation grade is associated with around two percent of a standard deviation increase in student achievement gains. I find that low income students are more sensitive to the classroom observation grade, especially in 12th grade. I find no statistically significant heterogeneity by teacher experience.

Second, I analyse the human capital formation dimension. Do teacher evaluations have an impact on subsequent teacher behaviour and performance ? I focus on classroom observation because i) the previous analysis shows its corresponding grade is the only one significantly related to teacher effectiveness ; ii) contrary to the school principal evaluation, this evaluation does not occur every year, which allows me to conduct an event study. I deal with endogeneity steming from non-random teacher - student matching with teacher and classroom-year fixed effects. I start by analysing the impact of the evaluation on teacher behaviour. The intuition I want to test is whether classroom observation and its feedback have a motivating effect both at the extensive and intensive margins. I measure the extensive margin with teachers' probability to quit. To measure the intensive margin, I follow the literature and use comprehensive administrative data on teacher absence spells to measure effort (see Jacob, 2013 for a discussion). I find that classroom observation has no statistically significant impact on the probability to quit. I find that teachers are slightly less likely to be absent during the year of the evaluation, suggesting that this evaluation provokes a temporary change on the intensive margin. To analyse the impact of the evaluation on teacher performance, I study its impact on student achievement. I find that the classroom observation has no statistically significant impact on student test scores.

The contribution of this paper to the literature is twofold. First, it contributes to the literature on teacher evaluations. This paper is globally consistent with the growing evidence that classroom observations do predict student achievement gains (Kane et al., 2013, Garret and Steinberg, 2015 ; Araujo et al., 2016, Bacher-Hicks et al., 2017, Jacob et al., 2018). However, this paper is at odds with the literature showing that the classroom observation has a positive impact on subsequent teacher performance (Taylor and Tyler, 2012). An important point to consider is, as mentioned above, most of the literature

analyses intensive, high stakes but small programs, focused on a few hundreds teachers. These targeted programs are not representative of most existing evaluation systems. In this paper, I study a nationwide program designed to handle the whole population of secondary teachers in France (hundred of thousands of teachers). While the certification exam is pretty high stakes, the two on-the-job evaluations are low stakes as they have limited impact on teacher careers. This is different from the setting studied by Taylor and Tyler (2012) where a successful evaluation is required to get tenure. Therefore, these results have major implication for public policy since they highlight the challenges of taking efficient but small programs to scale.

This paper also contributes to the literature on screening measures of effective teaching. This literature mostly focuses on teacher certification in the United States (Kane, Rockoff and Staiger, 2008) and finds that it is, at best, a very weak predictor of teacher quality. While teacher certification in the United States is neither selective nor competitive (Koedel, 2011), the certification process in France is academically demanding and has low passing rates. This is particularly the case for the higher level of certification, the *Agrégation*, which draws applicants from the elite French *Grandes Ecoles* and universities and has a passing rate of around 10 %. In that sense, this paper relates to the literature on Teach for America, a highly selective program which recruits college graduates from elite US universities to teach in low income areas. These papers find positive effects of this program (Boyd et al., 2006 ; Kane et al., 2008 ; Henry et al., 2014). While Teach for America is an alternative certification program, focused on a small fraction of candidates, the French certification process is government-run and the only way to become a tenured and certified teacher. Furthermore, in this paper, I analyse not only the impact of the certification level, but also of the precise certification test scores, at both stages (written then oral) of the certification process. This relates this present paper to recent work which uses detailed data on teacher applications to a centralized multi-stage application process (Goldhaber et al., 2017 ; Jacob et al., 2016).

The remainder of this paper proceeds as follows. Section 2 provide a detailed description of the evaluations. Section 3 describes the data. Section 4 analyses the relationship between teacher evaluations and student achievement. Section 5 studies the impact of the classroom evaluation on teacher effort and performance. Section 6 discusses the results and concludes.

1.2 Institutional Setting : Teacher Evaluations

1.2.1 Secondary School Teachers in France

The public French educational system is highly centralized. The French territory is composed of 25 large administrative regions. Contrary to the United States for example, schools have little autonomy : they are all required to follow the same national curriculum. School principals cannot hire nor fire their teachers. Certified teachers are assigned via a centralized point-based system. Candidates submit a rank-ordered list of choices and are assigned according to a modified version of the school-proposing Deferred Acceptance mechanism (Combes, Tercieux and Terrier, 2016).

Secondary school teachers are subject-specific : each subject is taught by a different teacher. In 9th grade, students are not tracked by major nor ability. In 12th grade, students are tracked by major, mainly hard science or social sciences. In both 9th and 12th grades, students stay in the same class, with the same peers throughout the school year and in every subject. At the end of 9th grade, students take a national and externally graded examination called *Diplome national du Brevet* in three subjects : French, Math and History. At the end of 12th grade, students take another national and externally graded examination called *Baccalaureat* .

1.2.2 The Certification Process

Teacher certification is obtained after passing a competitive national examination. This examination is taken after at least a year of intensive preparation at university departments specifically dedicated to teacher training. The examination for teaching in middle school (*collège*) or high school (*lycée*) is subject-specific. There are two main certification levels for teachers teaching in secondary or high schools. The basic certification level is called *Certificat d'aptitude au professorat de l'enseignement du second degré* (CAPES). Basic certification recipients are essentially meant to teach in secondary school (which includes 9th grade) or in high school (which includes 12th grade). The advanced certification level is called *Agrégation*. Advanced certification recipients are essentially meant to teach in the academic track of high school (which includes 12th grade) and sometimes in higher education, at the undergraduate level. [3] The advanced certification is more se-

3. The *Certifié* and *Agrégé* statuses are defined, respectively, by the Decree n°72-581 of July 4, 1972 and by the Decree n°72-580 of July 4, 1972.

lective than the basic one : for example, in mathematics in 2008, the passing rate for the basic certification is equal to 25 percent whereas the passing rate for the advanced certification is equal to 15 percent.

For both certification levels, the examination is composed of two successive stages : a written examination stage and an oral examination stage. First, candidates have to take written tests. For French literature and History, these tests are written essays. For mathematics, they consist of problem sets. In the second stage, candidates who pass the written stage can take the oral tests. These tests are composed of three main parts. The first part consists of a lesson given in front of the selection board. The second part consists in an interview. The last part consists of a critical analysis of a text in French literature and in an exercise in mathematics. Overall, the certification examinations are mostly academic exercises designed by public universities to provide comprehensive assessments of advanced subject-specific content knowledge.

1.2.3 The Classroom Observation Evaluation

The main objectives of the classroom observation is to both evaluate teachers and to provide them with feedback. The classroom observation is performed by professional inspectors, who are experienced teachers. Over the 2007-2015 period, there are approximately 3,000 inspectors in mainland France, that is, on average, approximately one inspector per 100 teachers.

The on-site visit unfolds as follows. First, inspectors prepare their visit and they notify teachers in advance about this visit. There is no mandatory period between this notification and the actual date of the visit. Before the visit, the inspector asks the teacher to give him access to documents of his choice, such as a sample of teaching material, students' homework, students' workbooks, *etc.* The teacher can also be asked to fill out a form about the extra curricular activities he supervises. If the teacher has been inspected before, the inspector has access to his previous reports and grades (Marcel and Veyrac, 2013).

Second, the inspection itself has four main parts :

- One-on-one meeting between the school principal and the inspector to discuss the principal's school overall strategy ;
- Classroom observation : inspectors can observe one or more courses (which may

be given to different students). The school principal can also join in though it is not mandatory to do so ;

- One-on-one meeting between the inspector and the teacher : this a debriefing of the classroom observation. The teacher explains his pedagogical strategy and the inspector gives him specific feedback and advice ;
- Meeting between the teacher, the school principal and the inspector : this last part is optional. Its main objective is to discuss potential requests from the teacher and questions regarding the overall school strategy.

Following the on-site visit, the teacher receives the inspector's official report. Usually this report is a one or two pages document where the inspector gives a qualitative assessment of the teacher, commenting on the classroom observation and the one-on-one meeting with the teacher (Cauterman and Daunay, 2007). In their qualitative analysis of 111 inspection reports, Poggi et al.(2006) describe the main items usually tackled in these reports : how the teacher manages his classroom (time management, how he gives students instructions, how he uses the board and/or his slides, *etc.*), how he interacts with his students (if he takes into acccount the heterogeneity of their needs etc.), his character (moral and relational qualities, observed during the classroom observation and the debriefing) and finally his content-knowledge.

This qualitative report does not include the classroom observation grade, which is the quantitative assessment of the on-site visit. The classroom observation grade is harmonized within region and communicated to the teacher at the begining of the following school year. Inspectors are asked to follow a national grading table, which depends on the teacher's certification level and ranking on the wage scale (Table 1.6). The aim of this grading scale is to make sure that there is enough variation within each notch of the wage scale [4] because, as we shall explain in detail below, this grade is used in the teacher promotion process. In Table 1.6, we mainly observe that the minimum and maximum grades increase with the ranking on the wage scale and the certification level. For example, the grade of teachers with basic certification whose rank on the wage scale is inferior to four must be between 32 and 47 points. This grading scale justifies in particular the standardisation of the classroom observation grade by teachers' certification level and ranking on

4. Memorandum n° 96-024 of January 9, 1996 : " *L'objectif est[...] d'assurer [...] pour chaque échelon, une répartition bien étalée des notes pédagogiques.*"

the wage scale.

1.2.4 The School Principal Evaluation

Teachers are evaluated each year by their school principal. School principals are teachers' immediate manager.

In January of each year, school principals fill in a report on their teachers. First, they assess them according to the following items : i) punctuality : being on time, respecting deadlines ; ii) assiduity : never being absent without authorisation ; iii) efficiency : initiative, organisation, judgment ; iv) authority : decision-making, sense of responsibility ; v) influence : taking part in the daily activities of the school outside the classroom, interactions with colleagues.

For each of these items, the assessment takes the form of a letter grade, from TB (Tres Bien, i.e. Very Good) to M (Mediocre). Second, school principals write a small paragraph providing a qualitative assessment of the teacher. Finally, the school principal gives a mark over 40. Like the classroom observation grade, the school principal grade depends on the teacher's certification level and ranking on the wage scale, according to a national grading scale (Table 1.8). The structure of the national grading scale for the school principal grade is, however, different from the classroom observation grading scale as the school principal grade scale has a smaller range. This means that there is much less room for variations in the school principal grade than in the classroom observation grade.

Importantly, principals are explicitly instructed not to take into consideration all pedagogical criteria from their evaluation. [5] They are also asked to explicitely motivate any negative assessment with "precise and detailed facts". Teachers' sickness or maternity leaves cannot motivate a negative assessment. If the school principal gives the teacher a lower grade than the one he got the previous year, he has to discuss it beforehand with the teacher.

School principals who give grades outside the range of this grading table must justify it to the regional authority with an additional report. A grade outside the range of the grading table can be contested both by the regional authority and the teacher.

5. Circular of December 13, 2013 : "*"appréciation sur la manière de servir de l'enseignant, en dehors d'appréciation à caractère pédagogique"*

1.2.5 Impact of the Classroom Observation and the School Principal Grades on Teachers' Careers

The two on-the-job evaluation grades can marginally impact teachers' wage progression. Teacher salaries are determined by the Ministry of Education through a national wage scale. The main criteria for promotion is teaching experience. However, promotion can also be fostered by positive on- the-job evaluations. More precisely, teachers are ranked on a list for promotion (*tableau d'avancement*) according to the weighted average of their classroom observation grade (60 percent) and their school principal grade (40 percent). Teachers ranked at the top of the list for promotion need less teaching experience to go up on the wage scale than teachers at the bottom of the list for promotion. For example, to go from the fifth notch to the sixth notch on the wage scale, teachers ranked at the top of the list for promotion need two years and six months of experience whereas teachers ranked at the bottom of the list for promotion need three years and six months of experience.

1.3 Data and Summary Statistics

1.3.1 Data

This study relies on administrative data provided by the Statistical Department of the French Ministry of Education (see the data appendix for a detailed description of the datasets). Its main strength is that it is comprehensive. I have information on six cohorts of candidates of the certification examination, from the school years 2005-06 through 2011-12. I also have data on teachers, including their on the job evaluation grades, and their students from 2007 to 2015. Its other strength is that I am able to match each teacher to all her students.

An important limitation of this data is that while it is a panel of all secondary school students, externally graded test scores are only available at the end of 9th grade and 12th grade. Thus, when I analyse teachers' impact on students, my analysis focuses on two samples of teachers who have passed the certification examination between 2006 and 2015, and their students between 2007 and 2015 : French, Math and History 9th grade teachers and 12th grade teachers.

1.3.2 Teacher and Student Characteristics

I present summary statistics on teacher and student characteristics. In order to discuss the external validity of the estimation samples for teacher quality, I also report statistics for all secondary school teachers teaching between 2006-2007 and 2011-2012. Teachers in the estimation sample are significantly younger and less experienced than all teachers (table 1.10) . The average age difference between all teachers and teachers in the estimation sample is equal to 11.2 years and is significant at the one percent level. This is because the sample is composed of teachers who had passed the certification examination from 2006 to 2011. On average, teachers in the sample have around three years of experience. Teachers in the sample are more likely to teach in the Parisian suburbs (Créteil and Versailles *académies*), which are the most unattractive areas for teachers based on their preference for job placement (DEPP, 2014). Table 1.11 reports average student characteristics for all students and for sampled students. Low-income students (identified by their financial aid status) and low achievers are over-represented in the samples. For example, 21 percent of all students are financial aid recipients against 31 percent of sampled students. The difference is significant at the 1 percent level. This confirms the fact that the samples over-represent unattractive areas.

1.3.3 Frequency of the Classroom Observation

I analyse empirically the average frequency of the classroom observation. In theory, novice teachers should be more frequently inspected : they should be systematically graded during their first year of teaching and are inspected every three years throughout the beginning of their career (Suchaut, 2012). In practice, I observe in the data that, on average, teachers are inspected approximately every seven years, with variations across teaching subject (Figure 1.6). For French teachers, the average number of years between two inspections is 7.51 years, whereas for Math teachers it is 6.37 years and for Physics teachers it is 5.89 years. The inspection is more likely to happen at the beginning of the career than at the end. As shown in Figure 1.7, approximately 20 % of inspections happen during the first five years of experience, with a peak of 8 percent during the third year of experience.

I also investigate whether inspectors are more likely to inspect teachers from the same school consecutively. This would imply that the probability of being inspected in a given

month for a teacher would depend of the probability of another teacher in the same school being inspected. I test this hypothesis by plotting the number of inspections per month and per school (Figure 1.8). I observe that the distribution of the number of inspections by month per school is pretty uniform, with probabilities falling between 0.2 and 0.3. This suggests that, for a teacher, the probability of being inspected in a given month does not depend on the inspections of the other teachers in the same school.

1.3.4 Correlation between the Evaluation Grades

The evaluation grades are described in the figures in the Appendix. I study the correlation between the three evaluation grades in order to get a grasp of the relationships between them (Table 1.1). The correlation between the oral certification grade and the written certification grade is weak. For both 9th and 12th grade teachers, the correlation coefficient is equal to 0.07 and is statistically significant at the one percent level. The classroom observation grade is midly correlated with both certification grades at the one percent level. The correlation coefficient is equal to 0.2 . Finally, the school principal grade is very weakly correlated with the certification grades : the correlation coefficient is equal to 0.02. The strongest correlation is between the school principal grade and the classroom observation grade, with a correlation coefficient equal to 0.4-0.5. Overall, all the evaluation grades are weakly to mildly correlated with each other, which suggests that these grades do not duplicate each other and measure different quantities or have large measurement errors.

1.3.5 Relationship between the Evaluation Grades and Teacher Characteristics

I analyse their relationship with observable teacher characteristics in order to get a better grasp of what is captured by the evaluation grades. I run regressions of teacher characteristics on each teacher evaluation grades.

The Certification Oral and Written Grades. Candidates who graduated from elite universities perform better both at the written and oral exam than those with a master degree and than those with only a bachelor's degree (Table 1.5). This is consistent with the fact that the certification grades aims at measuring content-knowledge. The oral and

written certification grades are weakly correlated : a standard deviation increase in the written exam grade is associated with only 9 % of a standard deviation increase in the oral exam grade. This weak correlation suggests that the written and the oral exams are not redundant.

The Classroom Observation Grade. To analyse the relationship between the classroom observation grade and teacher characteristics, I run several specifications (Table 1.7). One includes school fixed effect to allow comparison within school (column 2). Another takes advantage of the fact that each teachers can have multiple grades and includes teacher fixed effects (Column 3). Teacher characteristics include number of years of experience, teaching topic, certification level (*Agrégation* i.e. high level of certification), and absence behaviour (number of absence spells and number of days of absence). Whatever the specification, teaching experience is consistently positively associated with an increase in the classroom observation grade. However, there is no statistically significant correlation between teacher absence and the classroom observation grade in any specification. This suggests that the classroom observation grade captures skills that are associated with teacher experience, but not with teacher absence behaviour. This is consistent with the fact the classroom observation grade aims primarily at capturing teachers' pedagogical skills.

The School Principal Grade. I run the same specifications as for the classroom observation grade to analyse the relationship between the school principal grade and teacher characteristics (Table 1.9). In all specifications, teaching experience is statistically significantly associated with the school principal grade. The magnitude of this correlation is comparable to that of the classroom observation grade. Surprisingly, the correlation between teacher absences and the school principal grade is not statistically significant. This suggests that the school principal grade does not actually measure variations in attendance and that official guidelines might not fully implemented by school principals.

1.3.6 Teacher Evaluations and Student Background

I analyse the relationship between teacher evaluations and student socioeconomic background in order to analyse the assortative mating between teachers and students. I measure student socioeconomic background with their financial aid status. Figures 1.11

and 1.12 plots the average share of high certification teachers (*Agrégés*, ordered by percentile rank), the average percentile rank administrative, certification and classroom observation grades by the share of financial aid student per school (ordered by percentile rank). They both suggest non-random teacher-student matching. For example, in 12th grade, schools with the largest share of teachers with the high certification level (*Agrégés*) are those with the smallest share of financial aid students.

1.4 How Efficient are Teacher Evaluations in Identifying Good Teachers ?

In this section, I investigate whether teachers evaluations are able to capture teacher's impact on student achievement. The identification of this parameter raises empirical challenges that I discuss before moving to the results.

1.4.1 Empirical Strategy

Framework. The main objective of this analysis is to identify the relationship between teacher evaluations and teacher quality. Formally, the underlying education production function is that student test scores A_{iskt} are determined by student fixed effect θ_i, school fixed effect θ_k, year fixed effect θ_t, topic fixed effect θ_s, and teacher fixed effect θ_j :

$$A_{iskt} = \theta_i + \theta_j + \theta_k + \theta_t + \theta_s + \epsilon_{ijkts} \tag{1.1}$$

In that framework, the aim becomes to analyse the relationship between teacher fixed effects and teacher evaluations :

$$\theta_j = \rho T_j + u_j \tag{1.2}$$

where u_j is independent from ϵ_{ijkts}. Thus, equation 1.1 writes :

$$A_{iskt} = \rho T_j + \theta_i + \theta_k + \theta_t + \theta_s + (\epsilon_{ijkts} + u_j) \tag{1.3}$$

Identification Issues. The main identification issue stems from the non-random teacher-student matching : if teachers with higher evaluation grades tend to be systematically assigned to better students, a naive cross-section regression would lead to upward-

biased estimates of the relationship between teacher evaluation grades and student achievement gains. Steinberg and Garett (2017) for example show that classroom composition significantly influences teacher performance as measured by classroom observation scores.

Empirical Strategy. French students take only two externally graded examinations during their studies : at the end of 9th and 12th grades. I address the teacher-student sorting identification issue with student fixed effects. I do not exploit within-student variation in teacher evaluation grades *across years* but within-student variation in teacher evaluation grades *across subject* (Lavy, 2010 ; Clotfelter, Ladd and Vigdor ; 2010). Formally, the model is the following :

$$A_{i,s,k,t} = T_{j(i,s,k,t)}\beta + \theta_i + \theta_s * \theta_t + e_{i,s,k,t} \tag{1.4}$$

where $A_{i,s,k,t}$ the achievement of student i in subject s, in school k and in school year t ;the function $j(i,s,k,t)$ returns the identity of the unique teacher teaching student i, in subject s, in school k and in school year t. $T_{j(i,s,k,t)}$ is a vector of this teacher evaluation grades ; θ_i student i fixed effect to capture time-invariant student confounding factors such as student family background, ability, *etc.* ; and $\theta_s * \theta_t$ the interaction of θ_s subject s fixed effect and θ_t school year t fixed effect to take into account the fact that exam difficulty may vary across years and subject.

Identification Hypothesis. The identification hypothesis is that the unobservable determinants of students differential achievement across subject are uncorrelated with the corresponding differences in their teachers' evaluations. Intuitively, this identification hypothesis would be violated if students who are *relatively* more able in some subject ($(e_{i,s,k,t} - e_{i,s',k,t}) > 0$) were systematically assigned to teacher with better evaluation grades ($T_{J(i,s,k,t)} - T_{J(i,s',k,t)} > 0$). If it were the case, I could not disentangle the effect of teacher credentials from the fact that some students are intrinsically high-achievers in some subjects : the results would overestimate the effect of teacher evaluations.

I am able to test this hypothesis in 12th grade by controlling for each students' test scores in 9th grade, a proxy for their prior ability (see robustness checks below). Furthermore, in contrast to 9th grade, there are several tracks in 12th grade, corresponding to subject major (science (*série Scientifique*) and humanities (*série Économique et social*

).[6] Jackson (2014) for example shows that there is a positive teacher-student assortative mating across high school tracks. This would lead to the *relative* positive teacher-student assortative mating that threatens the validity of our identification hypothesis if, for example, students who are relatively better in Math than in French chose the science track rather than the humanities track. This why the 12th grade analysis is done by track.

1.4.2 Results

I now show the results from the estimation of the relationship between teacher evaluations and student achievement using the student fixed effect strategy described above.

1.4.2.1 Baseline Results

Impact of Non-Certified Teachers on Student Achievement. Table 1.4 shows the impact of having non-certified teacher, or contract teacher, on student achievement in 9th grade. The preferred specification controls for student fixed effects, year x topic fixed effect, as well as experience and seniority dummies. Non certified teachers may of course have different unobserved characteristics than certified teachers. But the purpose of this analysis is not to identify the causal impact of being a certified teacher but rather to assess the efficiency of the certification process as a screening mechanism as a whole, because this is the policy relevant parameter. With the preferred specification (column 3), having a non-certified teacher rather than a certified teacher is associated with a 6 percent decrease in student achievement.

Relationship between Evaluation Grades and Student Achievement Gains. With student fixed effects (Table 2.3), whatever the specification (grades included separately or in a horse race), the only statistically significant estimate is the one associated with the classroom observation grade. A one standard deviation increase in the classroom observation grade is associated with a 1.4-1.6 percent of a standard deviation increase in student achievement gain.

In 12th grade, with student fixed effects (Table 1.3) and when the evaluations are included jointly, a one standard deviation increase in the classroom observation grade is associated with a three percent of a standard deviation increase in student achievement in

6. There is a third track, called the literary track (série litéraire) that we do not study in the paper due to the low quality of the data for this track.

the humanities track. In the science track, the coefficient is smaller : a standard deviation increase in the classroom observation grade is associated with a 1.8 percent of a standard deviation increase in student achievement. The coefficient is statistically significant but only at the 10 percent level.

1.4.2.2 Robustness Checks

Standardization of the classroom observation and school principal grades. The first robustness check consists in not standardizing the classroom observation grade and the school principal grade (Table 1.14). The standardization implies that evaluators (inspectors or principals) are actually taking other teachers in the same rank in the wage scale, with the same level of certification, as the reference group. A limitation of this standardization is that it does not allow comparison between different ranks in the wage scale, and a fortiori between different levels of experience and different levels of certification. The first line of each panel reports regression estimates without the standardization of the pedagogical and the school principal grade. Overall, the sign and the statistical significance of the results are robust. In 9th grade for example, a one point increase in the classroom observation grade is associated with a 0.6 percent of a standard deviation increase in student achievement.

Teacher Characteristics. The second robustness check consists in adding teachers' characteristics as control variables. Student fixed effects control for all students' fixed characteristics but do not control for any of the teachers' individual characteristics that might bias the results. For example, teacher experience can be both correlated with her evaluation grade and her ability to raise student achievement. The second line of each panel reports estimates teachers' control variables : number of years of experience, number of years of experience squared, gender, year of the certification examination, number of years in the same school. For 9th grade, the sign, statistical significance and magnitude of the classroom observation grade coefficient remains the same. A standard deviation increase in the classroom observation grade is associated with a 1.5 percent of a standard deviation increase in student achievement gain. The coefficient is statistically significant at the one percent level. For 12th grade, in the humanities track, coefficients are also very similar : a standard deviation increase in the classroom observation grade is associated with a 2.6 percent of a standard deviation increase in student achievement gain. In the

baseline estimation, this coefficient was equal to 3.1 percent.

External Validity. The analysis so far relies on the sample of teachers for which the certification grade is observed. As mentioned in the data section, this implies that only teachers who passed the certification exam between 2006 and 2016 are analysed. This raises the issue of external validity of the results as teachers in the sample have different observable characteristics than the whole teacher population (Table 1.11). I test the external validity of the results by estimating the baseline model, with the classroom and school principal grades only, on the whole teacher population ((Table 1.14). I find that estimates on the whole population are comparable to those on the sample of teachers with the certification grade. This suggests that focusing on the sample of teachers with the certification grades does not threaten the external validity of results.

Subject-Specific Sorting. The identification strategy relies on the assumption that unobservable determinants of each student's differential achievement across subject is uncorrelated with the corresponding differences in their teachers' evaluations. I am able to test this hypothesis in 12th grade. First, I estimate the within student, across teacher model controlling for each students' test scores in 9th grade, a proxy for their prior ability. Both in the science and humanities track, the coefficients associated with the classroom observation grades are robust to the inclusion of prior test scores as control variables (Table 1.14). Second, I estimate value-added estimates with school fixed effects : I regress students' 12th grade test scores on their 9th grade test scores, a vector of student characteristics (financial aid status, gender, etc.), school fixed effects, and their classroom observation and school principal grades. Because value-added modelling requires a large number of observations (see Koedel et al., 2015), I run it on the whole sample of teachers (not only those for whom their certification grades is observed). This model provides a robustness test for subject-specific sorting because it does not rely on across subject variations in teachers. It amounts to comparing the relationship between teacher evaluation and students' test scores variations between 9th and 12th grade, within school. Both in the science and humanities tracks, estimates for the classroom observation and the principal grade are robust to this approach (Table 1.14). Thus, these two tests give strong evidence in favour of the validity of the identification hypothesis.

1.4.2.3 Heterogeneity Analysis

By Student Parental Income. Table 1.15 reports regression estimates by student parental income. Overall, whatever the grade or track, low income students are more sensitive to what is measured by the classroom observation grade than other students. Students' parental income is measured by student financial aid status. In 9th grade, for financial aid recipient, a one standard deviation increase in the classroom observation grade is associated with a 2 percent increase in student achievement. This coefficient is equal to 1.5 percent for non financial aid recipient. The difference is small but statistically significant at the one percent level.

In the science track of 12th grade, the coefficient associated to the classroom observation grade is equal to 1.6 percent for non financial aid recipients and is not statistically significant. For financial aid recipients, this coefficient is statistically significant at the five percent level and is equal to 2.9 percent. The difference is therefore larger than for 9th grade and is statistically significant at the one percent level. Finally, for the humanities track, the classroom observation grade coefficient is equal to, for non financial aid recipients, 2.9 percent and is statistically significant at the five percent level. This coefficient is equal to 4.3 percent for financial aid recipients. The difference between the two coefficients is equal to 1.4 percent and is statistically significant at the 1 percent level.

By Teacher Experience. Table 2.4 reports regression estimates by teacher experience (in years) in 9th grade. Overall, there is no statistically significant heterogeneity by teacher experience. Importantly, the interaction terms of the certification grades with experience are not statistically significant. This suggests that there is no drift over time of the detection power of the certification grade in identifying good teaching. The relationship between the certification grade and teacher quality is statistically the same for low experience teachers, who passed the certification examination a few months or years ago and high experience teachers, who passed this examination several decades ago.

1.4.2.4 Discussion

The main result is the classroom observation grade captures better what makes a good teacher than the other teacher evaluations. This result can be explained by the fact external and professional inspectors are more efficient at identifying good teaching than other actors such as the selection board of the certification examination or school

principals. They are former experienced teachers who go through specific screening and training to be able to evaluate teachers. This result can also be explained by the fact that inspectors have access to more relevant information about teachers than the other actors. Inspectors have access to the teaching material, observe the teacher inside their classroom and have a one-on-one meeting with him afterwards. At the end of this on-site visit, they are able to make a comprehensive assessment of the teacher according to multiple dimensions : quality of his teaching material, classroom management, relational qualities and content-knowledge.

This result is broadly consistent with the growing evidence that classroom observations do predict student achievement gains (Kane et al., 2013 ; Bacher-Hicks et al., 2017, Jacob et al., 2016). However, the magnitude of the coefficient (0.02 SD) is much smaller than in the literature (0.2 SD). This may be because most of other studies analyse small and targeted evaluation schemes that are purposely designed by researchers to be very intensive and that are conducted over an extended period of time (several weeks or months). Therefore, the difference in magnitude estimates can be due to the fact that, contrary to the evaluations studied in the literature, the classroom observation grade is based on a large scale programme consisting of a single on-site visit. This raises the issue of taking intensive but small programs to scale without losing their efficiency in the process.

1.5 What is the Impact of the Classroom Observation Evaluation on Teachers ?

The analysis so far shows that the classroom observation grade is statistically significantly correlated with teacher's impact on student achievement. This suggests that inspectors are able to capture at least some variation in teacher quality. This raises the question of the quality of the feedback given by the inspectors to teachers : does the classroom observation help teachers improve ? In the remainder of the paper, I analyse the classroom observation further and focus on its impact on teacher behaviour and performance.

The intuition I want to test regarding teacher behaviour is whether the classroom observation and its feedback have a motivating effect both at the extensive and intensive margins. I measure the extensive margin with teachers' probability to quit. To measure

the intensive margin, I follow the literature and use comprehensive administrative data on teacher absence spells to measure effort (see Jacob, 2013 for a discussion). The teacher absence data is taken from administrative payroll data and is therefore very reliable. There is considerable evidence that absences are at least partly discretionary, especially for teachers. Hansen (2009) finds that teachers absences respond to the presence of a new principal or proximity to retirement. Ost and Schiman (2017) find a strong relationship between teacher workload and school-level factors on the one hand, and teacher absences on the other. Finally, in another paper, I use the same absence data and find a strong correlation between teachers working conditions and absences (Benhenda, 2019).

I use two different estimation samples. To analyse the impact on teacher probability to quit and absence behaviour, I use the full sample of secondary school teachers. To analyse the impact on student achievement, I use the sample of French, Math and History teachers teaching 9th and 12th grade students. This sample is different from the one exploited in the previous section because it is not restricted to teachers for which certification test scores are observed.

1.5.1 Empirical Strategy

To overcome the empirical challenges associated with the non-random teacher-student matching, I implement a two-way fixed effect model with teacher and classroom-year fixed effects. I exploit the longititudinal dimension of the data with teacher-school fixed effects. I also exploit the cross-sectional dimension of the data : in secondary school, teachers are subject-specific and students stay with the same peers in the same classroom, throughout the school year and for all subjects. This allows me to use variation within classroom-year, across subject. This specification is different from Taylor and Tyler (2012) who only control for teacher fixed effects. I perform the following event study :

$$A_{j,s,c,t} = \sum_{t-\tau=-T}^{t-\tau=T} \delta_{j,t-\tau} 1\{t = \tau_j\}_{j,t-\tau} + Experience_{j,t} + \theta_j + \theta_s * \theta_t + \theta_{c,t} + X_{j,s,c,t} + \epsilon_{j,s,c,t} \tag{1.5}$$

where $A_{j,s,c,t}$ is the teacher j outcome variable (average student test scores per year or number of absence days per month) in subject s, classroom c and year t, τ_j is the year during which teacher j is evaluated. This specification includes teacher fixed effects which

account for time-invariant, non random differences in teacher - student matching within teacher. However, these teacher fixed effects do not account for time-varying confounders. The most straightforward confounder is teacher experience, which has been shown by many studies since Rockoff (2004) to be a major determinant of teacher quality. This is why I include teacher experience dummies as controls. Other confounders are linked to unobservable student characteristics. For example, teachers may be assigned to more difficult (easy) students the year of evaluation. I deal with this issue with classroom-year fixed effects, and a vector $X_{j,s,c,t}$ of students socioeconomic background (parental occupation and financial aid status) characteristics. This two-way fixed effect specification provides unbiaised estimates of the impact of evaluation if and only if, for a given teacher, the timing of her evaluation is not correlated to her students *subject-specific* ability.

The period just before the evaluation is the omitted category. The coefficients of interest are $\delta_{j,t-\tau}$. They capture variations in teacher outcome compared to the period just before evaluation. Robust standard errors are clustered by school, which is the most conservative level of clustering.

1.5.2 Results

Impact on teacher exit from the profession. The intuition I want to test is that the feedback following classroom observation has an impact on teachers' motivation.It can demotivate teachers and push them out of the teaching profession or it can motivate them enough to prevent them from quitting. Figure 1.1 reports estimates of the impact of classroom observation on teachers's probability to exit the teaching profession. The specification includes teacher-school, topic, year and classroom fixed-effects. The reference year is the year just before the evaluation. According to this graph, the classroom observation has no statistically significant impact on teachers' probability to quit.

However, the motivating impact of the classroom observation may depend on the classroom observation grade. For example, teachers who got a very high grade might be more motivated to stay and those who received a low grade might be demotivated and more likely to quit. To test this hypothesis, I perform a subgroup analysis by teachers's inspection grade percentile rank. I focus on the top 10 % and the bottom 10 % of teachers. Figure 1.13 shows that there is no clear difference between top ranked teachers and bottom ranked teachers. Therefore, it does not seem that there is any motivating effect of the

classroom observation impacting the probability to quit, even when focusing on top or bottom ranked teachers.

Impact on teacher absence. The classroom observation does not seem to have an effect on motivation significant enough to impact teachers' probability to quit. While it does not have an impact on the extensive margin, it might impact the intensive margin and how much effort teachers put into their job. Figure 1.2 shows the classroom observation has a negative impact on the number of days of teacher absence the year of the evaluation. Compared to the year just before, teachers are around 0.6 days less absent the year of the evaluation. This negative impact does not last though and absences are back to their pre-evaluation levels the year after the evaluation. Note that this result cannot be interpreted as selection (teachers assigned to better behaved students the year of the evaluation) because this effect is controlled for in the specification through the classroom-year fixed effects. This effect can be interpreted as suggesting that the classroom observation has a motivating effect on teachers, through possibly the feedback it provides. It can also be interpreted as an incentive effect : teachers have incentives to be less absent in the months leading to the inspection because the inspector has access to his absence record.

I also investigate whether the motivating effect of the classroom observation varies teachers' classroom observation grade. Figure 1.14 shows that there is no clear difference between top ranked teachers and bottom ranked teachers. Therefore, the classroom observation does have an statistically significant impact on the number of days of absence, even when focusing on top or bottom ranked teachers.

Finally, to better understand the mechanisms underpinning this result, I investigate whether, during the year of inspection, the impact on teacher absence is concentrated in the months leading to the inspection or in the subsequent months. If the negative impact on teacher absence is concentrated in the months leading to the inspection, that would suggest that, in the short run, teacher classroom observation triggers a behavioral response from teachers by decreasing their effort in the month following the evaluation, as they know for a fact that they will not be evaluated again during this period. Figure 1.3 reports estimates of the impact of the classroom observation on the number of teacher absence days. The specification includes teacher-school, topic, year and month fixed effects. The reference month is the month just before the evaluation. I observe that teacher are less

absent in the months preceding the evaluation than in the months following it. Compared to the month just before the evaluation, the number of absence days in the months following the evaluation increases by 0.35-0.5 days.

Thus, overall, this graph suggests that classroom observation triggers a behavioral response from teachers by temporarily increasing their effort in the month leading to the evaluation.

Impact on student test scores. Overall, results so far shows that classroom observation has very limited to no impact on teacher observable behaviour in subsequent years. While it does not impact observable teacher behaviour, it can still impact teacher quality if the feedback from inspectors actually helps teachers to improve. Figure 1.4 shows that the classroom observation has no statistically significant impact on student achievement gains. This suggests that the classroom observation fails to reach one of its objectives, which is to provide feedback that help teachers improve. However, the impact of feedback may depend on teacher experience : inexperienced may benefit more from this feedback than experienced teachers. To test this hypothesis, I perform a subgroup analysis distinguishing teachers with less than five years of experience from others. The choice of this five year cutoff is motivated by evidence from the literature showing that most of the impact of teacher experience on teacher quality is concentrated in the first five years of teaching (Rockoff, 2004). Figure 1.15 shows that there is no clear difference between inexperienced teachers and more experienced ones.

1.6 Conclusion

This paper aims at answering the two following questions : how efficient are teacher evaluations in identifiying good teachers ? Do teacher evaluations have an impact on subsequent teacher performance ?

In order to answer these questions, I exploit a rich French administrative dataset to analyse a set of systematic screening and on the job evaluation schemes. I find that the classroom observation grade is the only evaluation grade significantly related to teacher performance. I then investigate whether the classroom observation has an impact on teacher performance and behaviour during the year of evaluation and in subsequent years. An event study shows that the classroom observation has no statistically significant impact

on teacher probability to quit nor on student achievement. I also find that teachers are slightly less absent during the year of the evaluation, but this effect does not last in this subsequent years.

Discussion. These results diverge from Taylor and Tyler (2012) who find that teachers are more productive during the school year when they are being evaluated, and even more productive in the years after evaluation. In both settings, the evaluations studied have two dimensions : accountability (they aim at measuring effective teaching) and human capital formation (personal feedback for teachers). However, both accountability and human capital formation are much more intensive and thorough in the Cincinnati Teacher Evaluation scheme analysed by Taylor and Tyler (2012). In the Cincinnati Teacher Evaluation, around a hundred of teachers were observed in the classroom and scored four consecutive times in the school year. Teachers can be fired depending on their evaluation scores. In my setting, the evaluations are very low stakes : they can only marginally impact teacher wage progression. Teachers receive thorough feedback, in person and in writing but it is based on a single observation rather than four. Thus, the difference with Taylor and Tyler (2012) may stem from two factors. First, it may be because the evaluation is very low stakes and does not provide strong enough incentives for teachers to change their behaviour significantly enough. Second, it might also be because the feedback is too noisy to significantly help teachers improve their teaching practices.

An important point to consider is that Taylor and Tyler (2012) analyse a small and intensive program, targeted on a few hundreds teachers whereas I study a nationwide program designed to manage the whole population of secondary teachers in France (hundred of thousands of teachers). This is really important for public policy because it highlights the challenges of taking efficient but small programs to scale (Steinberg and Donaldson, 2016 ; Kraft et al., 2018).

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1.8 Tables and Figures

Table 1.1 – Pearson Pairwise Correlation Coefficient between the Certification Grades, the Classroom Observation grade and the School Principal Grade

	Certif. (written)	**Certif. (oral)**	**Classroom obs.**	**Principal eval.**
A. 9th grade teachers (N= 13,815)				
Certif. (written part)	1.00	0.07***	0.21***	0.02**
Certif.(oral part)	0.07***	1.00	0.22***	-0.02**
Classroom obs.			1.00	0.39***
B. 12th grade teachers (N = 8,704)				
Certif. (written part)	1.00	0.07***	0.19***	0.05***
Certif.(oral part)	0.07***	1.00	0.13***	-0.07***
Classroom obs.			1.00	0.49***

Notes : *** $p < 0.01$; Classroom observation and school principal grades are averaged over years. The statistics are computed on the sampled teachers (see data appendix for the definition of the sample).

Table 1.2 – Regression Estimates of Student Test Scores on Teacher Evaluations in 9th Grade – With Student Fixed Effects

	Advanced Certif. (1)	Certif. (written) (2)	Certif. (oral) (3)	Classroom obs. (4)	Principal grade (5)
Eval. Separately	-.0011	-.0020	.0059	.0144***	.0054
	(.0163)	(.0047)	(.0043)	(.0042)	(.0045)
Eval. jointly	-.0108	-.0059	-.0001	.0160***	.0071
	(.0175)	(.0049)	(.0049)	(.0049)	(.0056)
Controls	No	No	No	No	No
Student fixed effects	Yes	Yes	Yes	Yes	Yes
Nb of observations	1,206,907	1,206,907	1,206,907	1,206,907	1,206,907

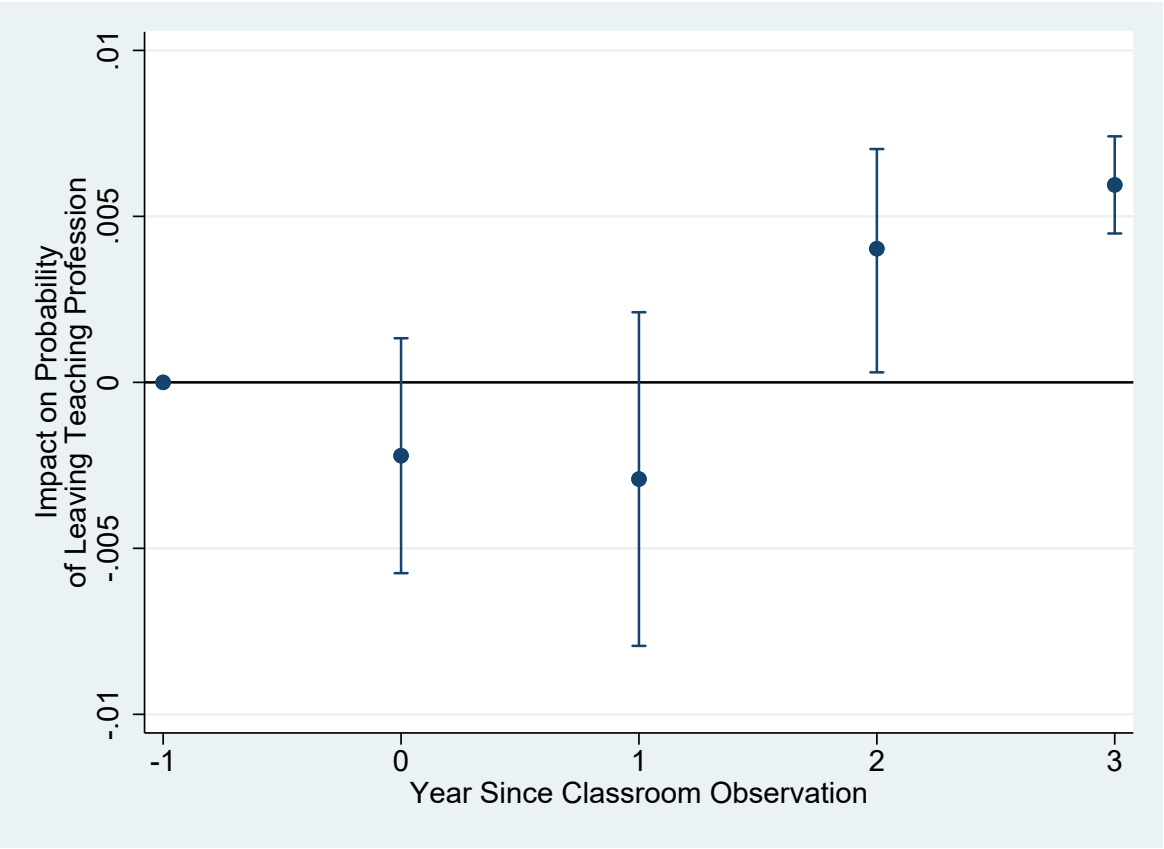
Notes : * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors clustered by teacher in parenthesis. The dependent variable is the teacher's student standardized test scores at the 9th grade national exam (Diplôme national du brevet). In the first column, the variable advanced certification (Agrégé) is a dummy variable equal to one if the teacher has the Agrégation. For column 2 to 5, the evaluation grades are standardized. The certification grades are standardized by year, topic and level of certification (Agrégation vs. Capes). The classroom observation grade and the school principal grades are standardized according to their respective national grading table (cf. Table 1.6 and Table 1.8). For the first line (teacher evaluations included separately), each column corresponds to a different regression. For the second line (evaluations included jointly in the same regression) corresponds to a single regression. The level of observation is teacher (topic) x student, from 2006 to 2012. The regressions are run on the sample as defined in the data appendix. All regressions include year fixed effects, topic fixed effects and the interaction between year fixed effects and topics fixed effects.

Table 1.3 – Regression Estimates of Student Test Scores on Teacher Evaluations in 12th Grade – With Student Fixed Effects

	Advanced Certif. (1)	Certif. (written) (2)	Certif. (oral) (3)	Classroom Obs. (4)	Principal grade (5)
A. Science Track (N =255,128)					
Eval. Separately	.0300	.0039	.0095	.0230***	.0025
	(.0174)	(.0081)	(.0080)	(.0089)	(.0084)
Eval. jointly	.0150	.0024	.0056	.0177*	-.0002
	(.0209)	(.0093)	(.0092)	(.0108)	(.0094)
B. Humanities Track (N= 149,981)					
Eval. Separately	-.0089	-.007	.0027	.0202**	-.008
	(.0202)	(.0027)	(.0099)	(.0095)	(.006)
Eval. jointly	-.0370	-.0129	-.0113	.0311***	-.0064
	(.0242)	(.0108)	(.0115)	(.0114)	(.0103)
Controls	No	No	No	No	No
Student fixed effects	Yes	Yes	Yes	Yes	Yes

Notes : * p < 0.1 ; ** p < 0.05 ; *** p < 0.01. Robust standard errors clustered by teacher in parenthesis. The dependent variable is the teacher's student standardized test scores at the 12th grade national exam (Baccalauréat). In the first column, Advanced certification(Agrégé) is a dummy variable equal to one if the teacher has the Agrégation. For column 2 to 5, the evaluation grades are standardized. The certification grades are standardized by year, topic and level of certification (Agrégation vs. Capes). The classroom observation grade and the school principal grades are standardized according to their respective national grading table (cf. Table 1.6 and Table 1.8). For the first line (teacher evaluations included separately), each column corresponds to a different regression. For the second line (evaluations included jointly in the same regression) corresponds to a single regression. The level of observation is teacher (topic) x student, from 2006 to 2012. The regressions are run on the sample as defined in the data appendix. All regressions include year fixed effects, topic fixed effects and the interaction between year fixed effects and topics fixed effects.

Figure 1.1 – Impact of the Classroom Observation on Probability of Teacher Exiting Profession



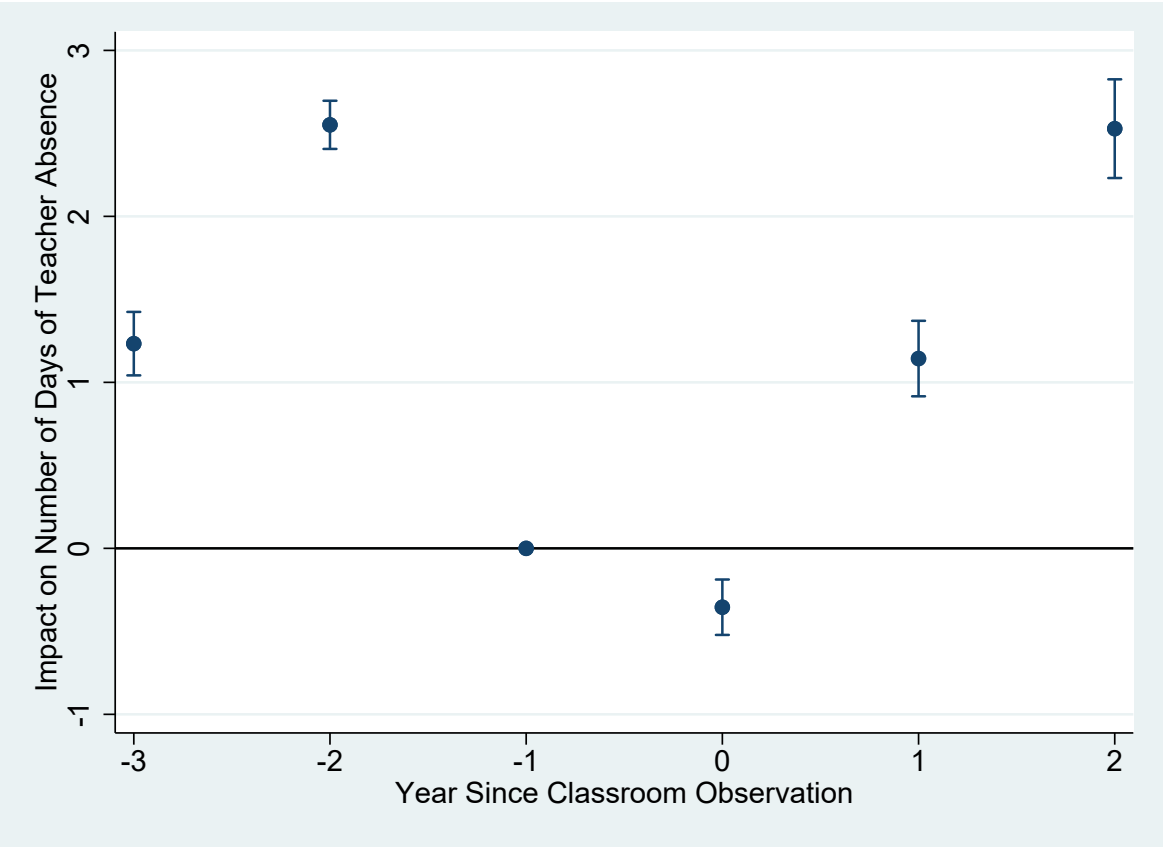
Notes : The specification includes teacher and classroom-year fixed effects. The sample includes all secondary teachers between 2006 and 2015. Standard errors are clustered by school.

Table 1.4 – Impact of Having a Non-Certified Teacher on Student Achievement in 9th Grade

	(1)	(2)	(3)
Non-certified Teacher	-0.251***	-0.092***	-0.061***
	(0.012)	(0.008)	(0.008)
Student Fixed Effect	No	Yes	Yes
Year x Topic Fixed Effect	Yes	Yes	Yes
Experience and seniority dummies	No	No	Yes
N	11,389,368	11,389,368	11,389,368

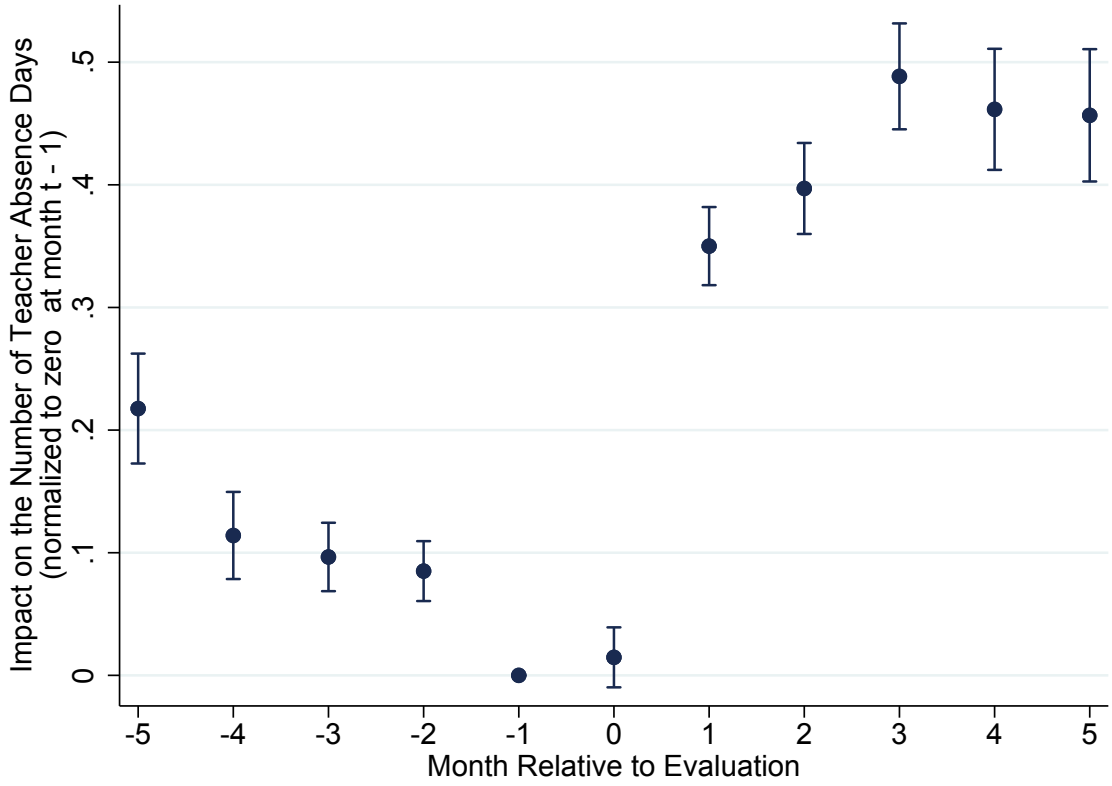
Notes : *** $p < 0.01$;

Figure 1.2 – Impact of the Classroom Observation on Number of Days of Teacher Absence in the Subsequent Years



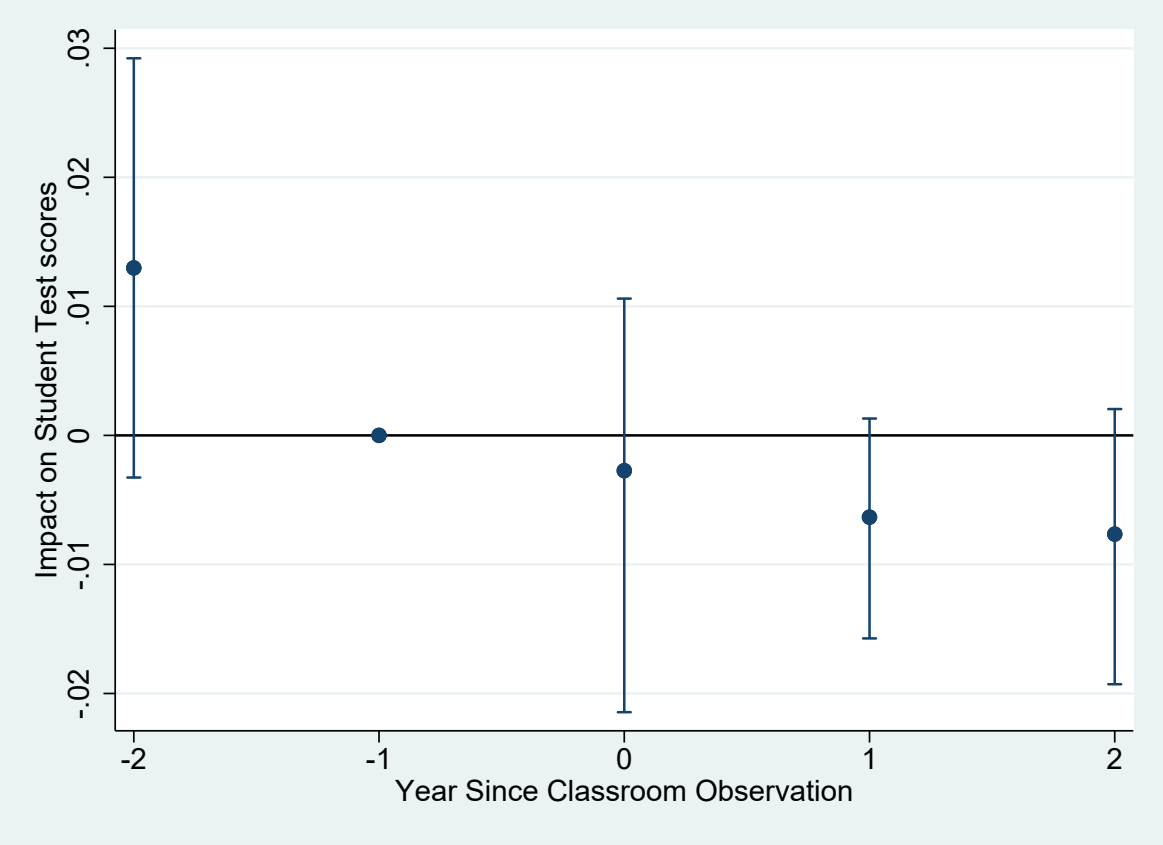
Notes : The specification includes teacher and classroom-year fixed effects. The sample includes all secondary teachers between 2006 and 2015. Standard errors are clustered by school.

Figure 1.3 – Impact of the Classroom Observation on Teacher Absence during the Year of Classroom Observation



Notes : This figure plots the impact of the classroom observation on the number of teacher absence days (zero included). This corresponds to a single regression. The specification includes teacher-school, topic, year and month fixed effects. The reference month is the month just before the evaluation. The level of observation is teacher x classroom x month x year. Robust standard errors are clustered by school.

Figure 1.4 – Impact of the Classroom Observation on Student Test Scores



Notes : The specification includes teacher and classroom-year fixed effects. The sample includes all secondary teachers between 2006 and 2015. Standard errors are clustered by school.

Table 1.5 – Regression Estimates of Certification Grades on Candidates' Individual Characteristics

Dependent variable :	All		Passed	
	Written Grade (1)	Oral Grade (2)	Written Grade (3)	Oral Grade (4)
Previous occupation (Ref. : Certified teacher)				
Student	0.182***	0.234***	-0.515***	-0.075***
	(0.007)	(0.017)	(0.016)	(0.020)
Contract teacher	- 0.141***	0.100***	-0.458***	-0.017***
	(0.008)	(0.020)	(0.019)	(0.023)
Male	0.033***	-0.134***	0.112***	0.009***
	(0.005)	(0.009)	(0.008)	(0.009)
Age	-0.016***	-0.018***	-0.008***	-0.009***
	(0.000)	(0.000)	(0.000)	(0.001)
Degree (Ref. : Bachelor's degree)				
Master's degree	-0.141***	-0.050***	0.115***	-0.043***
	(0.007)	(0.013)	(0.012)	(0.014)
Grande école	0.045	-0.042***	0.200***	0.110**
	(0.029)	(0.054)	(0.048)	(0.052)
Written exam standardized grade	–	0.490***	–	0.089***
		(0.008)		(0.009)

Note : * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors in parenthesis. This table reports estimates of regressions of the certification grades (written exam and oral exam) on candidates' individual characteristics. Each column corresponds to a single regression. Columns (1) and (2) reports regression estimates on all candidates. Columns (3) and (4) reports regression estimates on admitted candidates. The sample is all candidates and all admitted candidates, in all teaching topics, from 2002 to 2012.

1.9 Additional Tables and Figures

Table 1.6 – National Grading Table for the Classroom Observation grade by Certification Level

Ranking on the wage scale	*Basic Certification*		*Advanced Certification*	
	Min. grade	Max. grade	Min. grade	Max. grade
1,2,3,4	32	47	37	48
5	33	48	39	50
6	34	49	41	51
7	35	50	43	54
8	36	51	45	56
9	38	53	47	58
10	40	55	49	60
11	42	57	51	60

Source : French Ministry of Education website (http ://www.education.gouv.fr/cid58632/notations-des-personnels-enseignants.html). This table reports the official national grading table given to inspectors. For example, inspectors are instructed to give teachers who have the Capes and are on the fifth rank on the wage scale (*échelon*) a classroom observation grade comprised between 33 and 48.

Table 1.7 – Regression Estimates of the Standardized Classroom Observation grade on Teacher Characteristics

Dependent variable : Standardized classroom observation grade	(1)	(2)	(3)
Male	-0.059***	-0.079***	–
	(0.020)	(0.024)	
Experience (in years)	0.034***	0.032***	0.064**
	(0.009)	(0.010)	(0.028)
$Experience^2$	-0.001	-0.000	-0.002
	(0.000)	(0.000)	(0.003)
Subject (Ref. : History)			
French	-0.125***	-0.127***	–
	(0.025)	(0.028)	
Math	-0.030	-0.018	–
	(0.024)	(0.027)	
Nb of absence spells	0.000	-0.001	-0.003
	(0.000)	(0.003)	(0.003)
Nb of days of absence	0.002	0.000	0.002
	(0.002)	(0.000)	(0.000)
Adjusted R^2	0.006	0.147	0.644
School Fixed Effect	No	Yes	No
Teacher Fixed Effect	No	No	Yes

Note : * p < 0.1 ; ** p < 0.05 ; *** p < 0.01. Robust standard errors clustered by teacher in parenthesis. This table reports estimates of regressions of the pedagogical on secondary school teachers (middle and high school) individual characteristics. Each column corresponds to a single regression. The level of observation is teacher x year. The dependent variable is the standardized (according to the national grading table, cf. Table 1.6).

Table 1.8 – Grading Table for the School Principal Grade by Certification Level

	Basic Certification		*Advanced Certification*	
Ranking on the wage scale	Min. grade	Max. grade	Min. grade	Max. grade
1,2	30	35	32	35
3	30	35	32.2	36
4	31	36	32.5	37
5	33.5	37.5	33.5	38
6	34.5	38.5	34.5	39
7	36	39	36	40
8	36.5	39.5	37	40
9	37	40	37.5	40
10	38	40	38.5	40
11	39	40	38.5	40

Source : French Ministry of Education website (http ://www.education.gouv.fr/cid58632/notations-des-personnels-enseignants.html). This table reports the official national grading table given to school principals. For example, school principals are instructed to give teachers who have the Capes and are on the third rank on the wage scale (*échelon*) an school principal grade comprised between 30 and 35.

Table 1.9 – Regression Estimates of the Standardized School Principal Grade on Individual Teacher Characteristics

Dependent variable : Standardized school principal grade	(1)	(2)	(3)
Male	-0.053***	-0.031*	–
	(0.015)	(0.020)	
Experience	0.073***	0.079***	0.090***
	(0.007)	(0.007)	(0.019)
$Experience^2$	-0.002***	-0.002***	-0.003
	(0.000)	(0.000)	(0.005)
Topic (Ref. : History)			
French	0.005	0.009	–
	(0.019)	(0.019)	
Math	0.000	-0.016	–
	(0.019)	(0.019)	
Nb of absence spells	-0.004	-0.002	0.000
	(0.002)	(0.003)	(0.000)
Nb of days of absence	0.000	0.000	0.002*
	(0.000)	(0.000)	(0.003)
Adjusted R^2	0.018	0.22	0.53
School Fixed Effect	No	Yes	No
Teacher Fixed Effect	No	No	Yes

Note : * p < 0.1 ; ** p < 0.05 ; *** p < 0.01. Robust standard errors clustered by teacher in parenthesis. This table reports estimates of regressions of the administrative on secondary school teachers (middle and high school) individual characteristics. Each column corresponds to a single regression. The level of observation is teacher x year. The dependent variable is the standardized (according to the national grading table, cf. Table 1.8).

Table 1.10 – Average Teacher Characteristics by Grade (All Teachers and Sampled Teachers)

	All (1)	Sample (2)	Difference (3) = (1) - (2)
A. Demographics			
Female	0.66	0.64	0.02
	(0.47)	(0.48)	(0.02)
Age (in years)	41.40	30.20	11.20***
	(10.10)	(4.90)	(0.22)
B. Qualifications			
Experience (in years)	15.70	2.90	12.70***
	(10.2)	(1.30)	(0.07)
Advanced Certif.	0.06	0.09	-0.03**
	(0.25)	(0.28)	(0.01)
Basic Certif.	0.84	0.85	-.01
	(0.36)	(0.35)	(0.01)
Other certification status	0.09	0.06	0.03***
	(0.29)	(0.24)	(0.01)
C. School			
Average school size	471.80	544.28	-72.40***
	(213.90)	(201.90)	(8.80)
Teaching in the Parisian suburbs	0.16	0.38	-0.22***
	(0.37)	(0.49)	(0.02)
Number of teachers	106,892	22,519	

Notes : The t-statistic for the comparison of means (columns 3 and 6) is equal to the ratio of the mean of the difference to the standard error of the difference. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Standard errors in parenthesis. The statistics are reported for all secondary school teachers (column 1) and for teachers in the estimation sample(column 2), as defined in the data appendix.

Table 1.11 – Average Student Characteristics (All Students and Sampled Students)

	All (1)	**Sample** (2)	**Difference** (3) = (1) - (2)
A. Demographics			
Female	0.50	0.51	-.01**
	(0.50)	(0.50)	(0.00)
Financial aid recipient	0.21	0.31	-0.10***
	(0.41)	(0.46)	(0.00)
B. Achievement			
Average test scores (/20)	10.40	9.20	1.30***
	(3.90)	(4.0)	(0.04)
Repeated at least once since kindergarten	0.28	0.38	-.11***
	(0.44)	(0.46)	(0.00)
Number of students	1,288,858	502,302	

Notes : The t-statistic for the comparison of means (columns 3 and 6) is equal to the ratio of the mean of the difference to the standard error of the difference. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Standard errors in parenthesis. The statistics are reported for all student in 9th or 12th grade (column 1) and for all students in the estimation sample(column 2), as defined in the data appendix.

Table 1.12 – Regression Estimates of Student Test Scores on Teacher Evaluations in 9th Grade – Naive Estimation

	Advanced Certif. (1)	Certif. (written) (2)	Certif. (oral) (3)	Classroom Obs. (4)	Principal grade (5)
Eval. Separately	.0918***	.0005	.0063**	.0097***	.0099***
	(.0099)	(.0031)	(.0031)	(.0031)	(.0032)
Eval. Jointly	.0892***	-.0002	.0032	.0078**	.0138***
	(.0105)	(.0033)	(.0034)	(.0035)	(.0040)
Controls	No	No	No	No	No
Student fixed effects	No	No	No	No	No
Nb of observations	1,206,907	1,206,907	1,206,907	1,206,907	1,206,907

Notes : * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors clustered by teacher in parenthesis. The dependent variable is the teacher's student standardized test scores at the 9th grade national exam (Diplôme national du brevet). Student test scores are standardized by topic and year. In the first column, Agrégé is a dummy variable equal to one if the teacher has the Agrégation. For column 2 to 5, the evaluation grades are standardized. The certification grades are standardized by year, topic and level of certification (Agrégation vs. Capes). The classroom observation grade and the school principal grades are standardized according to their respective national grading table (cf. Table 1.6 and Table 1.8). For the first line (teacher evaluations included separately), each column corresponds to a different regression. For the second line (evaluations included jointly in the same regression) corresponds to a single regression. The level of observation is teacher (topic) x student, from 2006 to 2012. The regressions are run on the sample as defined in the data appendix. All regressions include year fixed effects, topic fixed effects and the interaction between year fixed effects and topics fixed effects.

Table 1.13 – Regression Estimates of Student Test Scores on Teacher Evaluations in 12th Grade – Naive Estimation

	Advanced Certif. (1)	Certif. (written) (2)	Certif. (oral) (3)	Classroom obs. (4)	Principal grade (5)
A. Science Track (N =255,128)					
Eval. Separately	.0525***	-.0010	.0251***	.0150**	.0047
	(.0126)	(.0064)	(.0061)	(.0062)	(.0049)
Eval. jointly	.0324**	-.0009	.0190***	.0033	.0076
	(.0145)	(.0069)	(.0066)	(.0070)	(.0056)
B. Humanities Track (N= 149,981)					
Eval. Separately	.0060	-.0063	.0027	.0167**	-.0048
	(.0136)	(.0068)	(.0068)	(.0070)	(.0044)
Eval. jointly	-.0163	-.0088	-.0066	.0205***	-.0033
	(.0157)	(.0074)	(.0072)	(.0080)	(.0053)
Controls	No	No	No	No	No
Student fixed effects	No	No	No	No	No

Notes : * p < 0.1 ; ** p < 0.05 ; *** p < 0.01. Robust standard errors clustered by teacher in parenthesis. The dependent variable is the teacher's student standardized test scores at the 12th grade national exam (Baccalauréat). In the first column, Agrégé is a dummy variable equal to one if the teacher has the Agrégation. For column 2 to 5, the evaluation grades are standardized. The certification grades are standardized by year, topic and level of certification (Agrégation vs. Capes). The classroom observation grade and the school principal grades are standardized according to their respective national grading table (cf. Table 1.6 and Table 1.8). For the first line (teacher evaluations included separately), each column corresponds to a different regression. For the second line (evaluations included jointly in the same regression) corresponds to a single regression. The level of observation is teacher (topic) x student, from 2006 to 2012. The regressions are run on the sample as defined in the data appendix. All regressions include year fixed effects, topic fixed effects and the interaction between year fixed effects and topics fixed effects.

Table 1.14 – Regression Estimates of Student Test Scores on Teacher Evaluations in 9th Grade and 12th Grade– Robustness Checks

	Advanced Certif. (1)	Certif. (written) (2)	Certif. (oral) (3)	Classroom Obs. (4)	Principal grade (5)
A. 9th grade					
Without standardisation	-0.001	-0.002	-0.000	0.006***	0.002
(N = 1,206,907)	(0.016)	(0.005)	(0.005)	(0.002)	(0.004)
With teacher control variables	-0.012	-0.004	-0.000	0.015***	0.004
(N = 1,206,907)	(0.023)	(0.005)	(0.005)	(0.005)	(0.005)
External validity	0.006			0.026***	0.006
(N=7,0074,093)	(0.006)			(0.003)	(0.008)
B. 12th grade – Science Track					
Without standardisation	0.040	0.004	0.011	0.002	-0.005
(N = 255,128)	(.025)	(.009)	(.009)	(.003)	(.003)
With control variables	0.033	0.004	0.008	0.013	-0.003
(N = 255,128)	(0.026)	(0.009)	(0.009)	(0.011)	(0.009)
With 9th test scores	-0.004	-0.003	0.008	0.013*	-0.001
(N=19,755)	(0.018)	(0.008)	(0.008)	(0.008)	(0.009)
External validity	-0.035**			0.013***	-0.004
(N=3,879,758)	(0.015)			(0.009)	(0.007)
Value-added estimates	-0.02	—	—	0.030**	-0.090
(N=343,998)	(0.032)			(0.015)	(0.073)
C. 12th grade – Humanities Track					
Without standardisation	-0.028	-0.010	-0.007	0.005**	-0.005
(N = 149,981)	(.029)	(.011)	(.011)	(.002)	(.004)
With teacher control variables	-0.024	-0.013	-0.009	0.026**	-0.009
(N = 149,981)	(0.030)	(0.011)	(0.011)	(0.011)	(0.010)
With 9th test scores	-0.03*	-0.008	-0.011	0.031**	-0.014
(N=11,457)	(0.025)	(0.012)	(0.011)	(0.012)	(0.013)
External validity	-0.028			0.046***	0.007
(N=1,481,483)	(0.020)			(0.009)	(0.045)
Value-added estimates	0.03**	—	—	0.037***	0.009
(N=131,295)	(0.014)			(0.006)	(0.030)

Notes : * p < 0.1 ; ** p < 0.05 ; *** p < 0.01. Robust standard errors clustered by teacher in parenthesis. Student fixed effects included except for value-added estimates. The dependent variable is, for 9th grade, the teacher's student standardized test scores at the 9th grade national exam (Diplôme national du brevet) and for 12th grade, the teacher's student standardized test scores at the 12th grade national exam (Baccalauréat). In the first column, Agrégé is a dummy variable equal to one if the teacher has the Agrégation. For column 2 to 5, the evaluation grades are standardized. The certification grades are standardized by year, topic and level of certification (Agrégation vs. Capes). The classroom observation grade and the school principal grades are standardized according to their respective national grading table (cf. Table 1.6 and Table 1.8). Each line corresponds to a single regression, where all five evaluation grades are included jointly. The level of observation is teacher (topic) x student, from 2006 to 2012. The regressions are run on the sample as defined in the data appendix. All regressions include year fixed effects, topic fixed effects and the interaction between year fixed effects and topics fixed effects.

Table 1.15 – Regression Estimates of Student Test Scores on Teacher Evaluations in 9th Grade and 12th Grade – Subgroup Analysis by Student Socio-economic Status

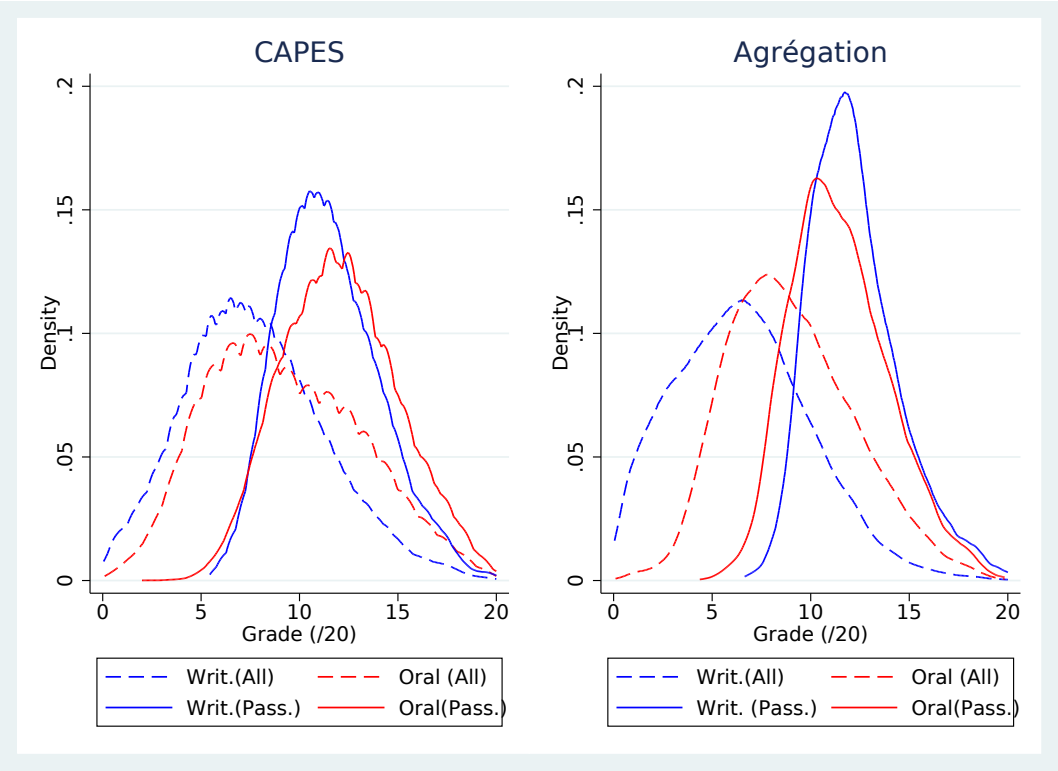
	Advanced Certif. (1)	Certif. (written) (2)	Certif. (oral) (3)	Classroom obs. (4)	Principal grade (5)
A. 9th Grade					
Non Financial Aid(N=856,905)	.001	-.004	.001	.015***	.005
	(.018)	(.005)	(.005)	(.005)	(.006)
Financial Aid (N=349,994)	.008	-.009	-.005	.020***	.010*
	(.022)	(.006)	(.006)	(.006)	(.005)
B. 12th Grade – Science track					
Non Financial Aid(N=214,858)	.017	.002	.009	.016	-.000
	(.021)	(.009)	(.009)	(.011)	(.009)
Financial Aid (N=40,270)	.009	.002	-.011	.029**	.002
	(.032)	(.015)	(.014)	(.014)	(.014)
C. 12th Grade – Humanities track					
Non Financial Aid(N =121,773)	-.027	-.015	-.009	.029**	-.003
	(.026)	(.011)	(.012)	(.012)	(.011)
Financial Aid (N=28,208)	-.080**	-.003	-.019	.043**	-.020
	(.037)	(.016)	(.016)	(.017)	(.016)
Student fixed effects	Yes	Yes	Yes	Yes	Yes

Notes : * p < 0.1 ; ** p < 0.05 ; *** p < 0.01. Robust standard errors clustered by teacher in parenthesis. The dependent variable is, for 9th grade, the teacher's student standardized test scores at the 9th grade national exam (Diplôme national du brevet) and for 12th grade, the teacher's student standardized test scores at the 12th grade national exam (Baccalauréat). In the first column, Agrégé is a dummy variable equal to one if the teacher has the Agrégation. For column 2 to 5, the evaluation grades are standardized. The certification grades are standardized by year, topic and level of certification (Agrégation vs. Capes). The classroom observation grade and the school principal grades are standardized according to their respective national grading table (cf. Table 1.6 and Table 1.8). Each line corresponds to a single regression, where all five evaluation grades are included jointly. The level of observation is teacher (topic) x student, from 2006 to 2012. The regressions are run on the sample as defined in the data appendix. All regressions include year fixed effects, topic fixed effects and the interaction between year fixed effects and topics fixed effects.

Table 1.16 – Regression Estimates of Student Test Scores on Teacher Evaluations in 9th Grade – Heterogeneity by Teaching Experience

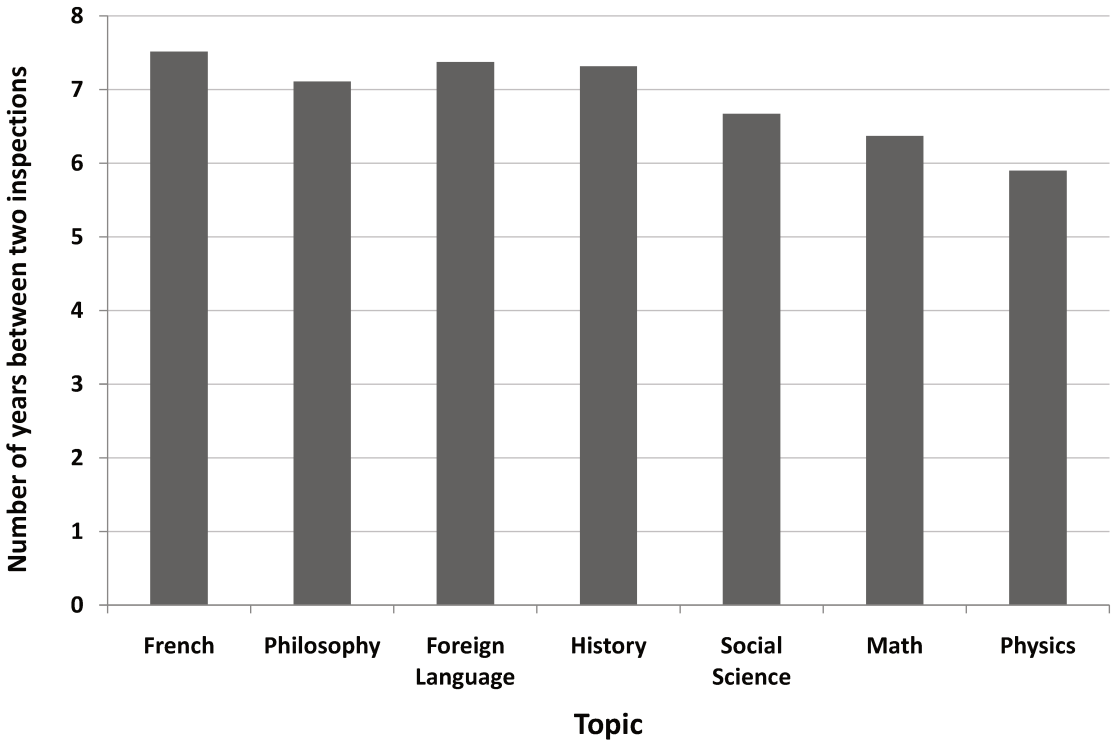
Experience	0.030***
	(0.010)
Advanced Certification	0.010
	(0.020)
Advanced Certification x Experience	-0.002
	(0.002)
Certif. written	-0.008**
	(0.004)
Certif. written x Experience	0.001
	(0.000)
Certif. oral	-0.002
	(0.004)
Certif. oral x Experience	0.000
	(0.000)
Classroom Obs.	0.020***
	(0.004)
Classroom Obs. x Experience	-0.003
	(0.006)
Principal grade	0.004
	(0.003)
Principal grade x Experience	0.000
	(0.000)
Student Fixed Effects	Yes
Controls	Yes
N	1,204,754

Figure 1.5 – Kernel Density of the Certification Grades (Written and Oral) for all Candidates and for Passing Candidates



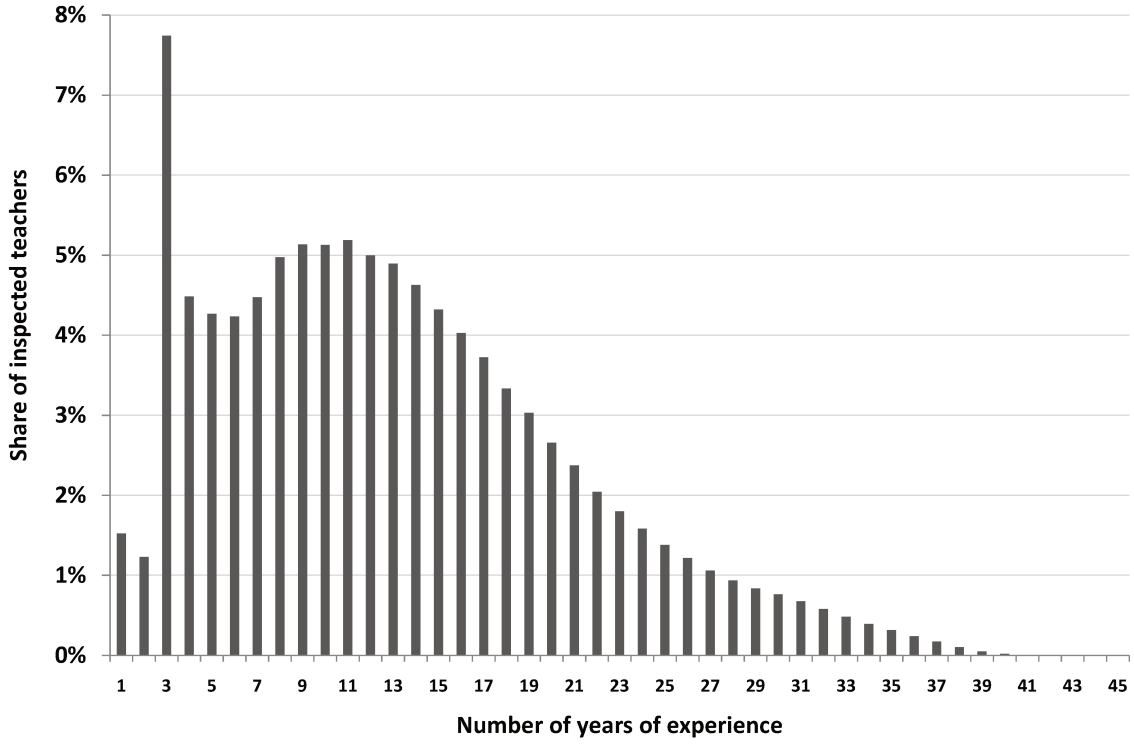
Notes : This figure plots the kernel density of the written exam grade (blue line) and the oral exam grade (red line) for all candidates (solid line) and for candidates who passed the exam (dotted line). The left graph plots the density for the Capes and the right graph plots the density for the Agrégation. The sample includes all the candidates who are present to the exam (see notes to Figure **??**) from 2002 to 2012, in Math, French and History.

Figure 1.6 – Average Number of Years between Two Classroom Observations by Teaching Topic



Notes : This figure plots the average number of years between two inspections, by teaching topic. The sample includes all active secondary school teachers, from 2004 to 2012, for which at least two inspections are observed over the 2004-2012 period. Both middle school and high school teachers are included in the sample, except for Philosophy and Social Sciences, because these topics are only taught in high school.

Figure 1.7 – Distribution of Classroom Observations by Teachers' Number of Years of Experience



Notes : This figure plots the distribution of inspections by inspected teachers' year of experience. The sample includes all secondary school teachers (middle and high school), from 2004 to 2012 who are inspected at least over in the observed periode (2004 - 2012). The number of years of experience is defined as the number of year since entry in the teaching profession.

Figure 1.8 – Number of Inspections per Month and School

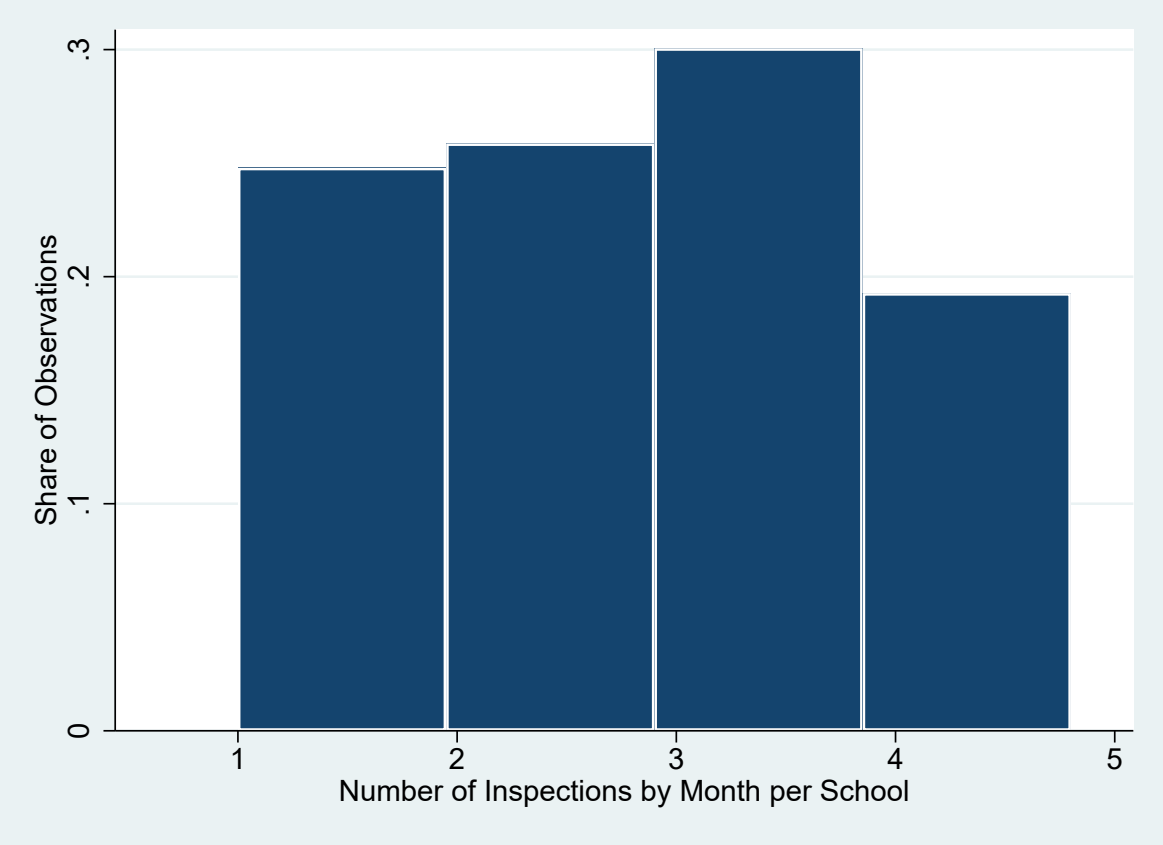
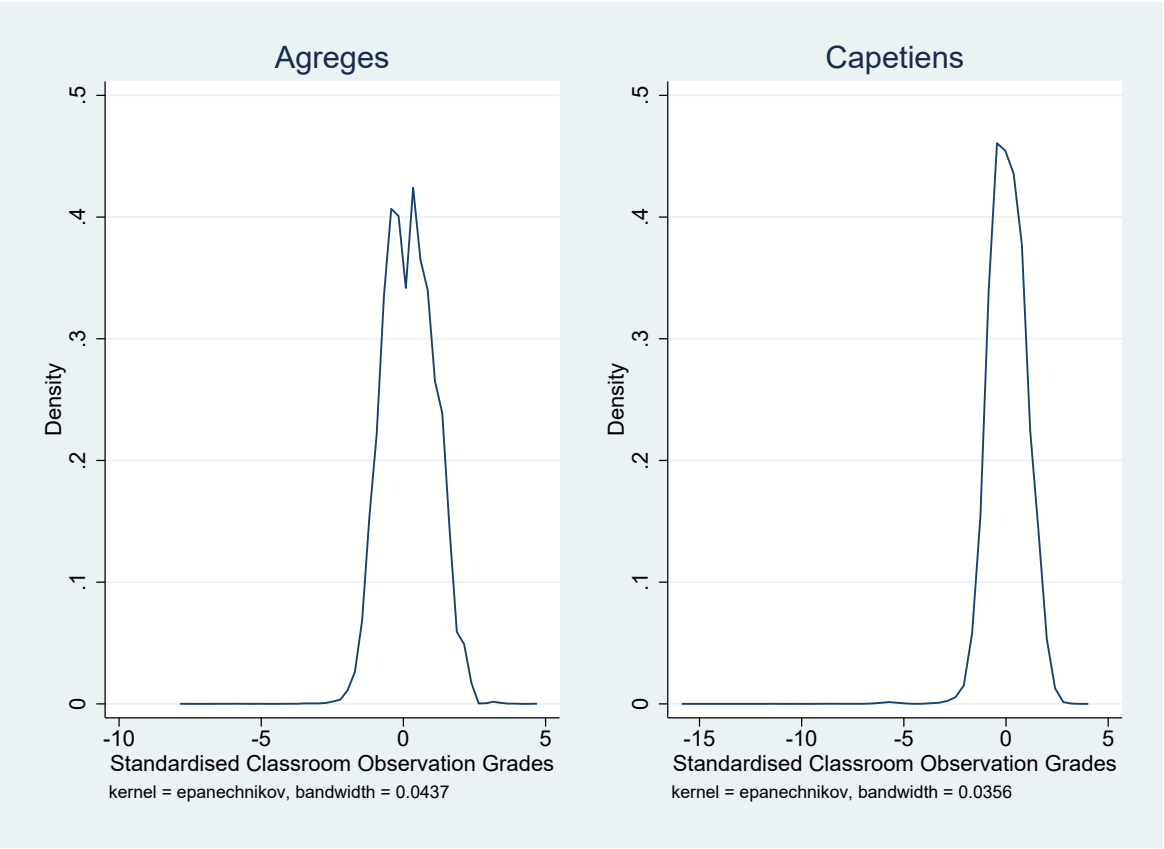
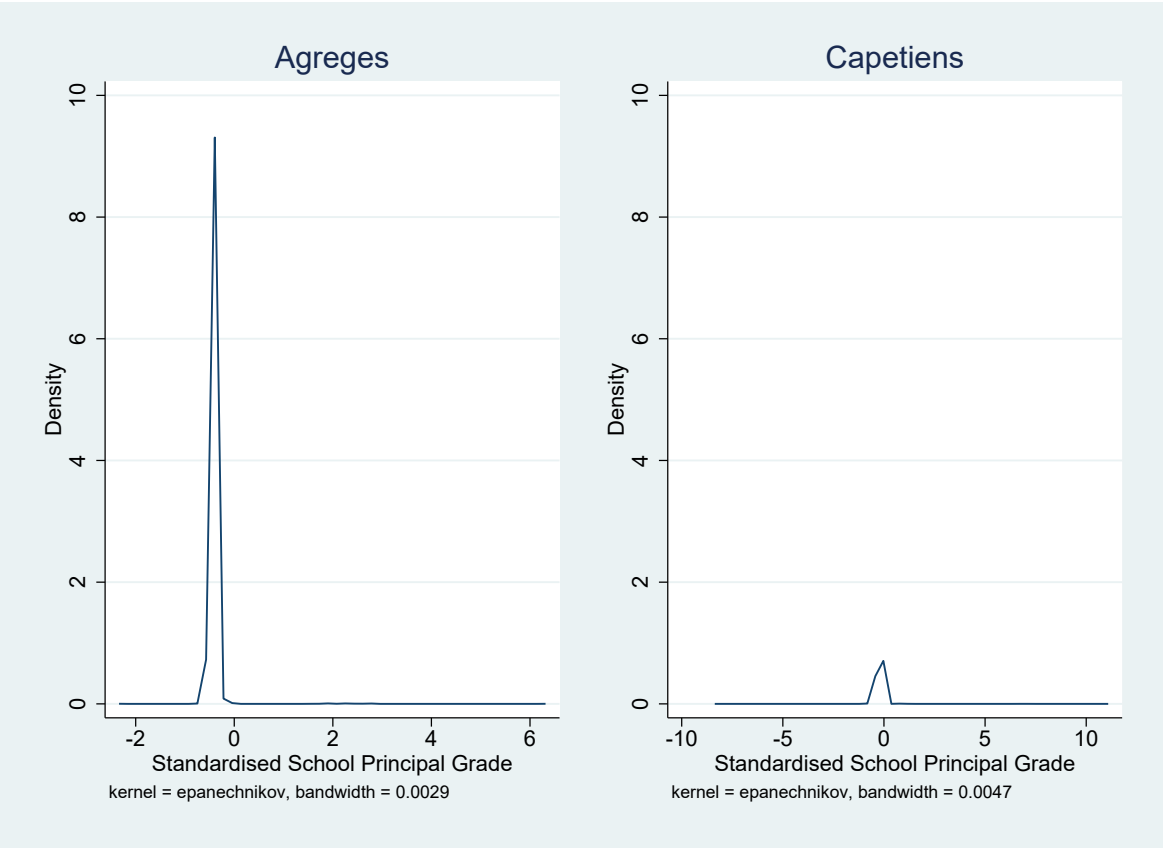


Figure 1.9 – Kernel Density of the Standardised Classroom Observation Grade, by Level of Certification



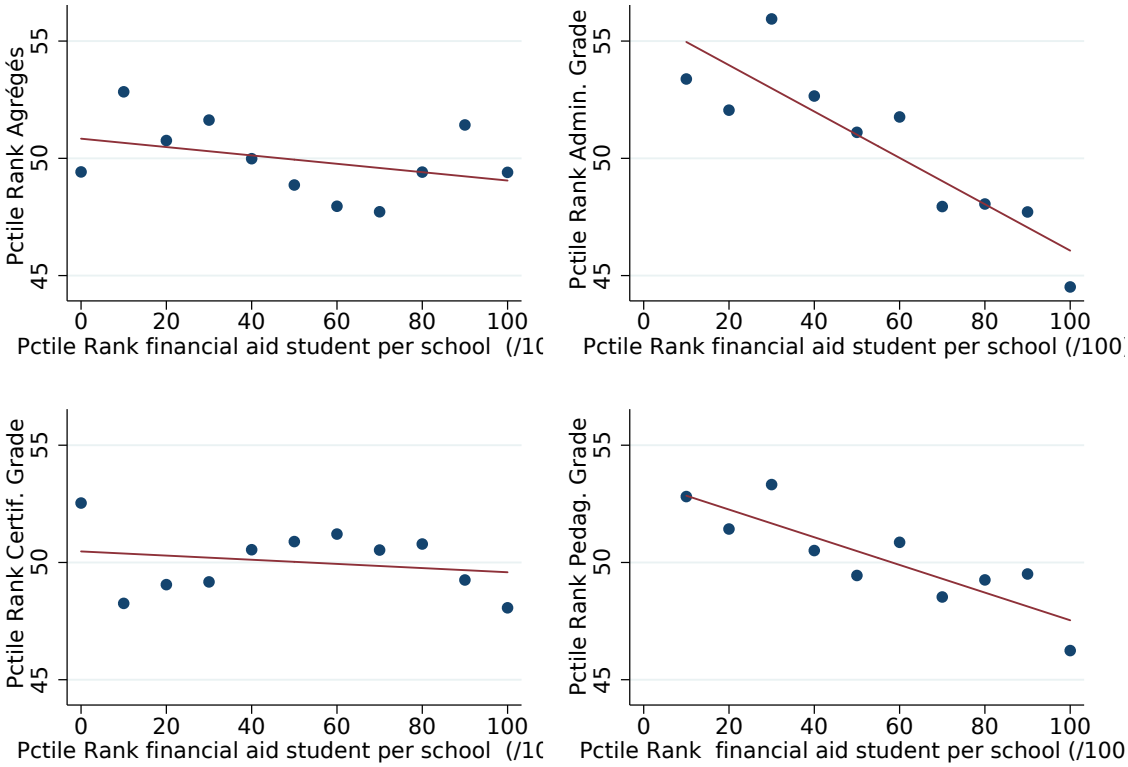
Notes : This figures plots the distribution of the classroom observation grade, by certification level, with standardisation. The sample includes all secondary teachers who are inspected at least once over the observed period (2004-2012).

Figure 1.10 – Kernel Density of the Standardised School Principal Grade, by Level of Certification



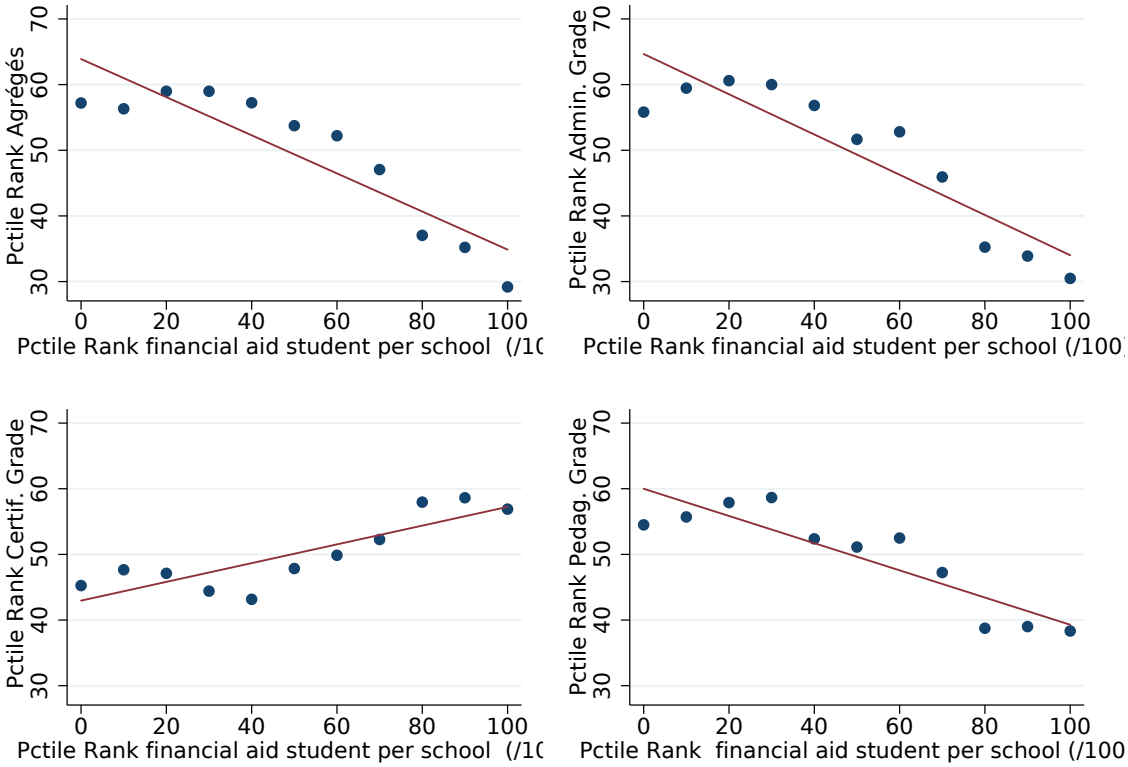
Notes : This figure plots the distribution of the administration grade, without standardization. The blue line represents the distribution for teachers with the Capes (Capésiens) and the red line the distribution for teachers with the Agrégation (Agrégés). The sample includes all secondary teachers over the observed period (2004-2012).

Figure 1.11 – Percentile Rank of the Evaluation Grades by Percentile Rank Share of Financial Aid Student per School – 9th Grade



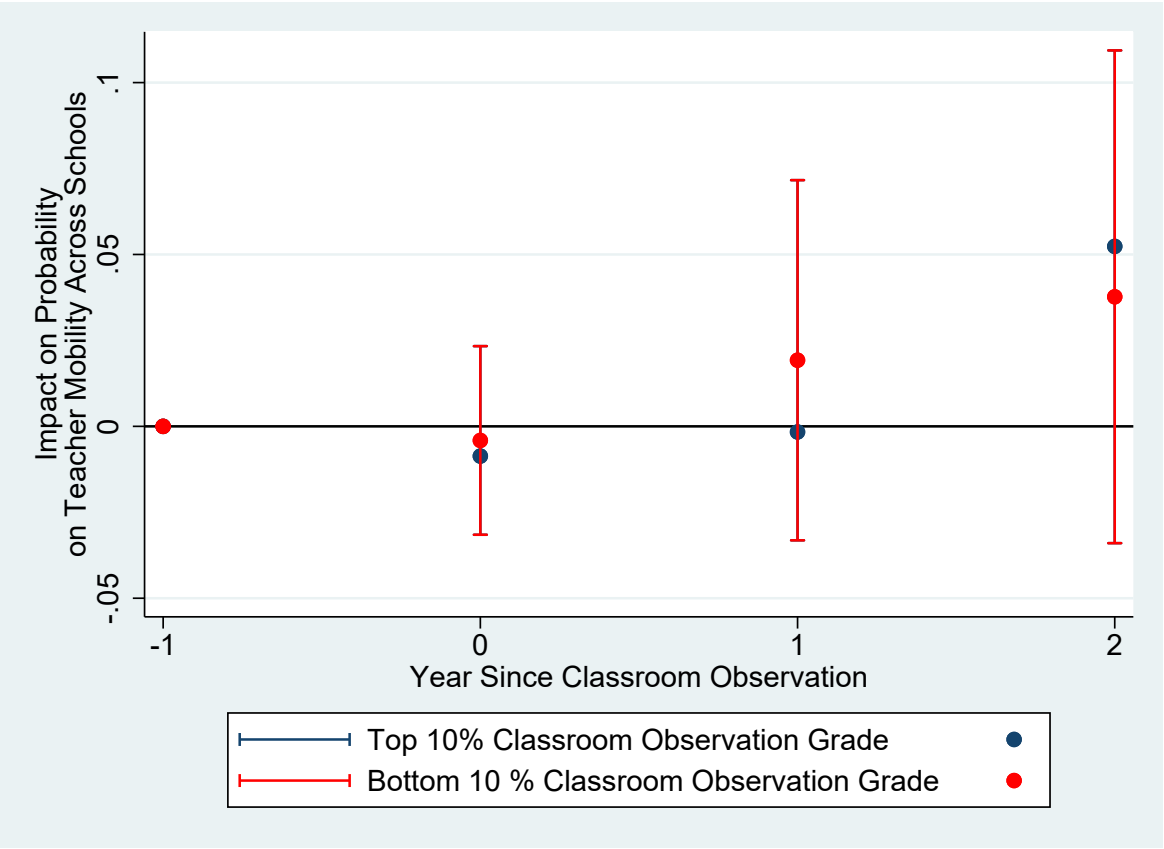
Notes : This figure plots the average share of *Agrégés*(ordered by percentile rank), the average percentile rank administrative, certification and classroom observation grades by the share of financial aid student per school (ordered by percentile rank). The sample includes all 9th grade teachers over the observed period (2004-2012).

Figure 1.12 – Percentile Rank of the Evaluation Grades by Percentile Rank Share of Financial Aid Student per School – 12th Grade



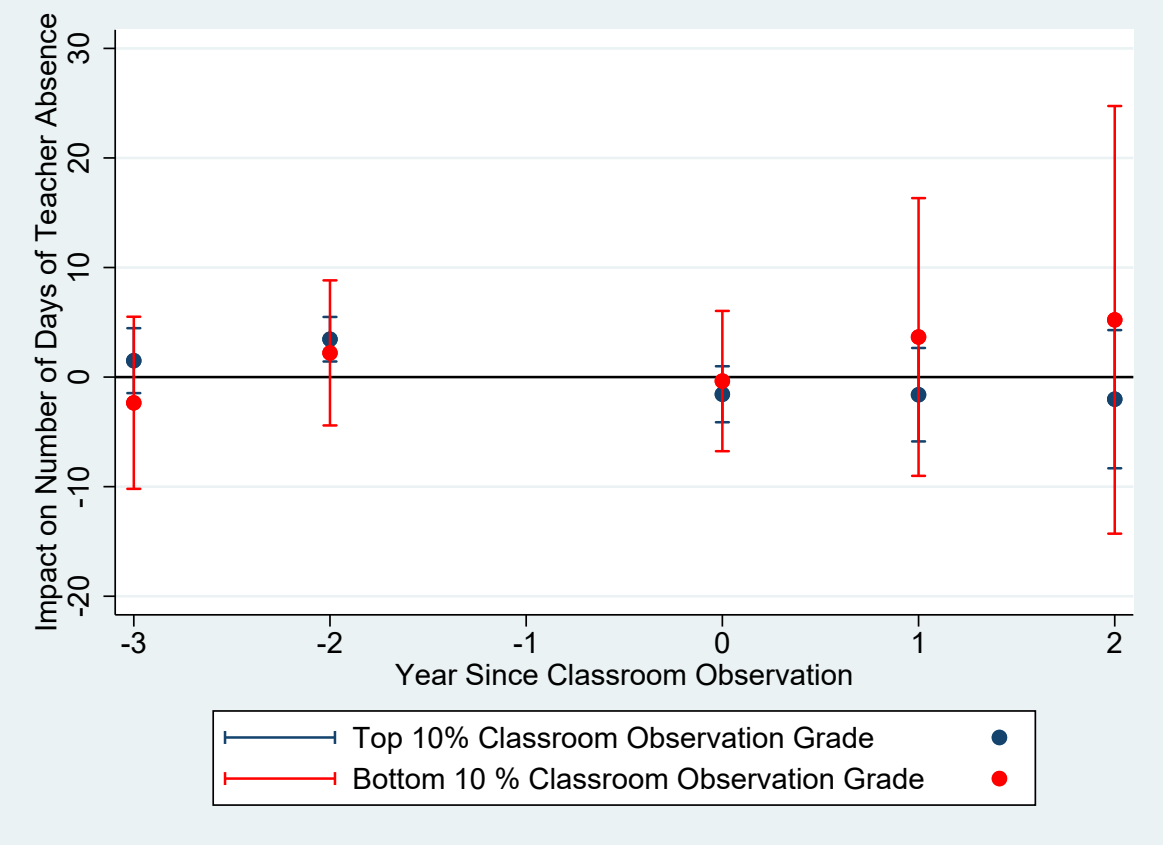
Notes : This figure plots the average share of *Agrégés*(ordered by percentile rank), the average percentile rank administrative, certification and classroom observation grades by the share of financial aid student per school (ordered by percentile rank). The sample includes all 12th grade teachers over the observed period (2004-2012).

Figure 1.13 – Impact of the Classroom Observation on Probability to Quit by Teachers' Performance at the Classroom Observation



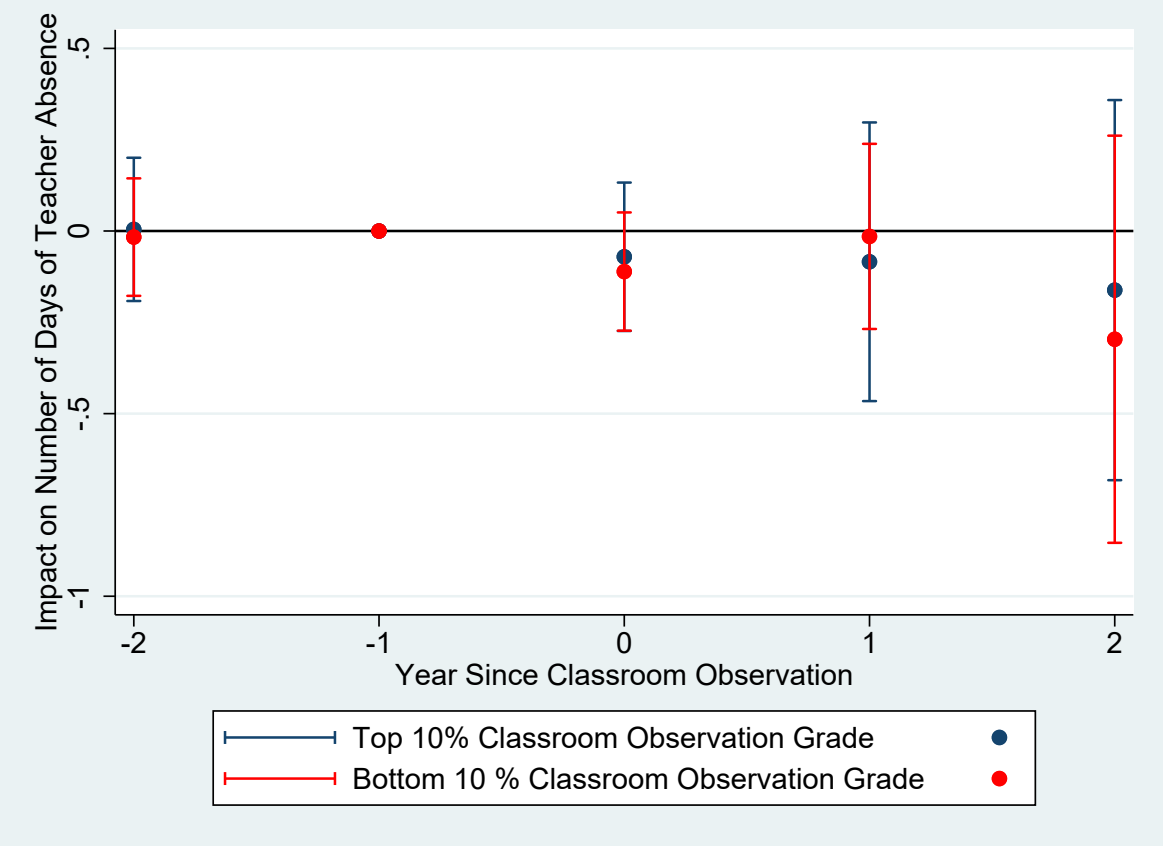
Notes : The specification includes teacher and classroom-year fixed effects. The sample includes all secondary teachers between 2006 and 2015. Standard errors are clustered by school.

Figure 1.14 – Impact of the Classroom Observation on Number of Days of Absence by Teachers' Performance at the Classroom Observation



Notes : The specification includes teacher and classroom-year fixed effects. The sample includes all secondary teachers between 2006 and 2015. Standard errors are clustered by school.

Figure 1.15 – Impact of the Classroom Observation on Student Test Scores by Teachers' Performance at the Classroom Observation



Notes : The specification includes teacher and classroom-year fixed effects. The sample includes all secondary teachers between 2006 and 2015. Standard errors are clustered by school.

1.10 Data Appendix

This study relies on administrative data provided by the Statistical Department of the French Ministry of Education. The set of data is composed of four main databases (also presented in Table 2.11) :

(i) individual data on certification examinations candidates including their name, their date of birth, their exam test scores and whether they passed or not. This database is extracted from the national OCEAN system. This data covers school years 2001-2002 to 2011-2012. However, the name variable is available only since the 2005-2006 school year.

(ii) individual data on teachers, school principals and inspectors including their national identification number, their name, their date of birth, their personal charac-

teristics. For teachers, the data includes their teaching subject(s), and, crucially, the identification number of the school and of the class in which they teach. All this information is mainly available in two databases, called *Annuaires* and *Relais*. These two databases cover school years 2001-2002 to 2014-2015. These two databases are merged with data on certification examinations based on the name, sex and date of birth variables.

(iii) individual data on students including socio-demographic characteristics such as gender and financial aid status [7] (*bourse sur critères sociaux*), an encrypted national identification number, their grades on the two national and externally grades examinations taken in the final year of 9th grade (the *Diplôme national du brevet* – hereafter DNB) and in the final year of 12th grade (*Baccalauréat*), the identification number of their school and of their class. These two latter variables enable us to match each teacher to her students. All this information is collected at the regional level (in databases called *Bases élève académique*) and gathered in a single national database by the Statistical department of the Ministry of Education. This database covers school years 2005-2006 to 2014-2015.

iv individual data on teacher absence spells for 9th grade teachers including the detailed dates of the absence spells. This datasets is mergeed with the other teacher data through teacher's individual identifier.

The construction of the final samples required numerous and sometimes delicate merges between the different databases. The main merging procedures and their outcomes are described in detail in the data appendix.

7. The financial aid status is not reliable in the student database commonly used in France (*Base centrale scolarité*). This is because the *Base centrale scolarité* is a beginning of the school year photography. At the beginning of the school year, the information on students' financial status is still incomplete. The database we are using here is an end of the school year of photography. At the end of the school year, the information on students' financial status is complete. Therefore, the financial aid status variable we are using is reliable.

Table 1.17 – Description of the data

Name	Observation level	Period covered
OCEAN (CAG)	candidate x year	2002-2012 without the name variables ; 2006-2012 with the name variables
ANNUAIRES (EPP)	teacher x year	2002-2012
RELAIS	teacher x class x year	2002-2012
FAERE	student x year	2006-2012

i) Merge between OCEAN (data on certification exam candidates) and EPP (data on teachers). Name of the matched database : CAGEPP

(a) Matching variables : family name, first name, date of birth, sex.

For the family name variable and the first name variable, we allow the Levenshtein distance to be equal to 1 or 2 [8]. More precisely, we conclude it is a match if two observations have the same date of birth and sex and if (a) the distance between the family names is equal to 0 or 1 and the distance between the first names is equal to 0,1 or 2. If two observations have the same date of birth and sex but the distance between surnames is equal to 1 and the distance between the first names is greater than 2, we look at the middle name (if there is one). Indeed, it happens that the first name in OCEAN (or in EPP) corresponds to the middle name in EPP (or in OCEAN). Therefore, if two observations have the same date of birth and sex but the distance between surnames is equal to 1, the distance between the first names is greater than 2 and the distance between the first name and the middle name is equal to 0 or 1, we conclude it is a match.

(b) Proportion of teachers for whom we observe a certification grade by school year :

- 2006-2007 : 9.2 %
- 2007-2008 : 12.4 %
- 2008-2009 : 15 %

8. We use a SAS function called COMPLEV.

- 2009-2010 : 17.6 %
- 2010-2011 : 19.9 %
- 2011-2012 : 21.6 %

ii) We clean CAGEPP mainly by suppressing duplicate observations.

These duplicates are mainly due to (a) teachers who took different exams the same year or (b) teachers who took different exams in different years. We only keep the observation corresponding to the teacher's actual certification level. For example, if (a) in a given year, a teacher passed both the CAPES and the *Agrégation* but is registered in EPP as an *Agrégé*, we only keep the observation corresponding to her certification grade at the *Agrégation* ; if (b) in 2007, a teacher passed the CAPES but, in 2008, passed the *Agrégation*, we keep, in 2007, the observation corresponding to her certification grade at the CAPES but, in 2008, we only keep the observation corresponding to her certification grade at the *Agrégation* ; if (c) in 2007, a teacher passed the CAPES but, in 2008, took the *Agrégation* and failed, we only keep, both in 2007 and 2008, the observation corresponding to her certification grade at the CAPES ; if (d) in 2007, a CAPES recipient took the *Agrégation* but failed, we suppress this observation ; if (e) a teacher passed both the CAPES of mathematics and the CAPES of physics but is registered in EPP as Math teacher, we only keep the observation corresponding to her certification grade at the CAPES of mathematics.

We also suppress observations corresponding to teachers without any certification status but teaching under a fixed-term contract (*enseignants contractuels*) who took and failed a certification examination.

Merge between CAGEPP and RELAIS (data on teachers with the identification number of their class(es))

1. Matching variable : teacher identification number
2. Proportion of teachers in CAGEPP for whom we observe the identification number of their class(es) by school year :
   - 2006-2007 : 93.9 %
   - 2007-2008 : 85.2 %
   - 2008-2009 : 81.2 %

- 2009-2010 : 82.3 %
- 2010-2011 : 79.6 %
- 2011-2012 : 80.7 %

The identification number of the class variable is missing in the FAERE database before the 2009-2010 school year. Therefore, from the 2006-2007 school year to the 2008-2009 school year, we merge the FAERE database with the *Scolarité* database, in which the identification number of the class variable is not missing.

1. Matching variables : date of birth, place of birth, school identification number, gender, socioeconomic background of her mother, socioeconomic background of her father, options and lunch status.
2. Proportion of students in FAERE before 2009-2010 for whom we observe the identification number of their class : 90.8 %

Match between Junior high school teachers and Junior high school students

1. Matching variables : class identification number, grade identification number, school identification number
2. Proportion of distinct Junior high school Math or French teachers in CAGEPP matched with their Junior high school students in FAERE by school year :
   - 2006-2007 : 97.2 %
   - 2007-2008 : 92.4 %
   - 2008-2009 : 91.1 %
   - 2009-2010 : 78.2 %
   - 2010-2011 : 83.2 %
   - 2011-2012 : 99.7 %

Match between Senior high school Math or French teachers and Senior high school students

1. Matching variables : class identification number, grade identification number, school identification number
2. Proportion of distinct Senior high school Math or French teachers in CAGEPP matched with their Senior high school students in FAERE by school year :
   - 2006-2007 : 60.7 %
   - 2007-2008 : 90.6 %

- 2008-2009 : 94.5 %
- 2009-2010 : 93.7 %
- 2010-2011 : 92.8 %
- 2011-2012 : 94.7 %

Our final samples cover teachers who have passed their certification examination between school years 2005-2006 and 2010-2011. In particular, they do not include teachers who passed their certification examination before 2005-2006 because the name variable– essential to our merging procedure– is not available for this period. Our samples cover students who have taken the DNB or the *Baccalauréat* between school years 2006-2007 and 2011-2012. More precisely, the two samples we analyse in this study are the following :

(i) ninth grade students (*élèves de troisième*) matched to their Math and French teachers. The sample is composed of students fulfilling the following conditions : we observe both their Math and French teachers, both their Math teacher and their French teacher passed the certification exam the same year (to control for differences in teachers cohort composition–which the "masterisation" reform is likely to make even more significant – and to make teachers' certification grades as comparable as possible), we observe both their Math and French teachers certification grade, classroom observation grade and school principal grade.

(ii) 12th grade Senior high school students (*élèves de terminale*) –hereafter Senior high school students – matched to their Math and French teachers [9]. The sample is composed of student fulfilling the same conditions as those required for Junior high students plus an additional one. This supplementary condition is that we observe not only the student's *Baccalauréat* test scores but also her DNB test scores. This condition is actually only strictly required for the value-added analysis we perform in section 5 but we also apply it for the sample on which is based the within student, across topics analysis in order to guarantee the comparability of the two approaches. The sample counts 8,295 students and 821 distinct teachers.

We focus on Math and French topics for three main reasons. The first reason is that Math and French are the only topics (with History-Geography) for which externally graded test scores are available and relatively comparable both for Junior and Senior high school. The

9. The French examination is actually taken in 11th grade (*classe de première*). Therefore, we match students to their 11th grade French teacher.

second reason is that it enables us to improve the comparability of our results with those of the literature – as most of the literature on teacher quality focuses on Math and English. The third reason is that Math and French are the two topics for which the threat of teacher spillover effects across topics seems the less plausible. Koedel (2009) for example suggests that teacher spillover effects between Math and English high school teachers are not statistically significant. The threat of teacher spillover effects seems however, *a priori*, more plausible for History-Geography for example, because students' History-Geography test scores also measure students' reading and writing skills taught by their French teacher. Students' Math test scores (French test scores) seem less likely to be contaminated by the effect of teachers teaching another topic than Math (French) to these students.

To facilitate the interpretation and the comparability of our results, we adopt several normalizations. First, we normalize students test scores by subject and by year. Second, we normalize the teacher certification grade by certification level, subject and year. Finally, we normalize teacher pedagogical and school principal grades by year, certification level and ranking on the wage scale, according the national grading tables presented in section 1 (Table 1.8 and Table 1.6). These normalizations imply that the estimated coefficients can be interpreted as fractions of a standard deviation of the distribution of individual scores.

Chapitre 2

Absence, Substitutability and Productivity : Evidence from Teachers

Worker absence is a frequent phenomenon but little is known on its effects on productivity nor on organizations' strategies to cope with this temporary disruptive event through substitute workers. Using a unique French administrative dataset matching, for each absence spell, each missing secondary school teacher to her substitute teacher, I find that the expected loss in daily productivity from non-replaced days is on par with replacing an average teacher with one at the 30^{th} percentile of the teacher value-added distribution. On average, substitute teachers are unable to mitigate this negative effect. There is substantial heterogeneity by substitute teacher quality : higher quality substitute teachers are able to compensate up to 25 % of this negative impact while lower quality substitute teachers do not have any statistically significant impact. **JEL** : I2, J2, M51. **Keywords** : absence, substitutability, productivity, teachers.

2.1 Introduction

Worker absence is frequent in many countries. For example, in the United Kingdom, the United States and France alike, every year, two to three percent of annual work time is lost due to worker absence (DARES, 2013 ; UK Office for National Statistics, 2014 ; US Bureau of Labor Statistics, 2016). Despite the importance of this phenomenon, empirical

evidence on the causal effect of worker absence on productivity is scarce.[1] Even much less is known on organizations' strategies to cope with this temporary disruptive event through worker substitution. When a worker is absent, how does it hurt her productivity ? How easily can organizations mitigate this effect with substitute workers ? Several major economic issues, from the impact of worker health and effort on productivity (Lazear and Oyer, 2012) to the analysis of specific human capital (Jacobson et al., 1993 ; Altonji and Williams, 2005 ; Gathmann and Schönberg, 2010) and its relationship with worker substitutability (Stole and Zwiebel, 1996), depend on the answer to these questions.

I offer an empirical answer to these questions using a comprehensive administrative French panel dataset covering the 2007-2015 period and matching, for each absence spell, each missing secondary school teacher to her substitute teacher. This paper estimates, for Math, French and History ninth grade teachers and their students : a) the effect of the number of days of non-replaced teacher absence on student test scores ; b) how this impact can be mitigated by the assignment of substitute teachers ; c) how the impact of substitute teachers depends on their quality, measured by their type (tenured vs contract teachers).

I implement a two-way fixed effect model with teacher and classroom-year fixed effects. This model exploits the longititudinal dimension of the data with teacher-school fixed effects. It also exploits the cross-sectional dimension of the data : in secondary school, teachers are subject-specific and students stay with the same peers in the same classroom, throughout the school year and for all subjects. This allows me to use variation within classroom-year, across subject. I perform several robustness checks to confirm that the results are not driven by a) reverse causality : teachers are more absent when assigned to low performing students and it is more difficult to find quality substitution for this type of students ; b) the fact that absences are only a reflection of poor on-the-job teacher productivity ; c) or the fact that replaced absence spells are not comparable to non-replaced ones.

Based on the analysis of more than 100,000 teachers and three millions students, I show that teacher absence has a statistically negative impact on student test scores : the expected loss in daily productivity from non-replaced days is on par with replacing an

1. To my best knowledge, there are only four papers covering this question : Miller et al (2008) ; Clotfelter et al. (2009) ; Duflo et al. (2012) ; Herrmann and Rockoff (2012)

average teacher with one at the 30th percentile of the teacher value-added distribution, which is consistent with the very few studies on this question (Herrmann and Rockoff, 2012). The fraction of replaced absence spell does not have any statistically significant compensating effect. However, when I make the distinction between the two type of substitute teachers, I find that one additional replaced day with a tenured substitute teacher (as opposed to a missed day at school) mitigates 26 % of the marginal impact of non-replaced days. The marginal impact of a replaced day with a contract teacher (as opposed to a missed day at school) is not statistically significant.

I also estimate heterogeneity by teacher and absence spell characteristics to provide suggestive evidence on the underlying mechanisms highlighted in a conceptual framework. I first investigate the role of the gap in general human capital between the regular and the substitute teachers. The main prediction from the conceptual framework is that the larger this gap, the smaller the mitigating effect of substitution. I use teacher experience as a measure of general human capital because the link between teacher experience and teacher productivity is well established in the literature (see Koedel et al., 2015 for a review). I find that the mitigating effect of tenured substitution is not significantly impacted by the experience gap. This suggests that the results cannot be entirely explained by this mechanism. I then investigate the role of the specific human capital gap : teaching requires specific human capital which can be acquired only through prolonged and repeated interactions with students. The role of this mechanism is supported by the heterogeneity analysis by month of the year : absence spells happening at the end of the school year have a larger impact than those happening at the beginning of the year, when the specific human capital gap between the substitute and the regular teachers is smaller.

This paper contributes to several strands of the literature. First, this paper contributes to an emerging empirical literature on worker substitutability. Hensvik and Rosenqvist (2016) show that worker sickness absence is lower in positions with few internal substitute and give evidence that firms try to keep absence low in positions with few internal substitute. Jäger (2016) analyzes the effect of unexpected worker deaths in the German private sector and shows these worker exits on average raise the remaining workers' wages and retention probabilities. While these papers use wage and retention as proxies for worker productivity, I measure it based on an actual and multidimensional output, student outcomes. I can rely on an important literature which consistently finds teachers to be the

most important determinant of student outcomes, both in the short and long run (Rockoff, 2004 ; Rivkin, Hanushek and Kain, 2005 ; Chetty, Friedman and Rockoff, 2014a ;b). Moreover, because teaching is a complex, multidimensional task, based on direct, personal and prolonged interactions with the "output" (students), it requires specific human capital (student-specific, grade-specific etc., see Ost, 2014), which makes it particularly well suited to the analysis of the relationship between human capital specificity and substitutability.

Second, it contributes to the very small literature on the effect of worker absence on productivity (Miller et al., 2008 ; Clotfelter et al., 2009 ; Duflo et al., 2012 ; Herrmann and Rockoff, 2012). This literature focuses on teachers and finds that the expected loss in daily productivity from teacher absence is on par with replacing a teacher of average productivity with one at the 10th-20th percentile of productivity. One of the most important limitation of this literature is that it does not provide any empirical evidence on the impact of substitute teachers and the channels through which teacher absence affects students. A forthcoming paper by Schiprowski (2020) provides evidence on the impact of absence in a different context, unemployment insurenace caseworkers, and finds that individuals who lose a meeting with their caseworker stay unemployed 5% longer. This paper does not discuss however the impact of non-replacement and substitution.

Third, this paper contributes to the small literature on contract teachers, which focuses on developing countries. The main paper on this question is Duflo et al.(2012), which shows that, in Kenyan primary schools, contract teachers are more efficient than regular teachers when their hiring is more closely monitored and they have higher incentives to exert effort. The French context analyzed in this paper is very different because the requirements to become a contract teacher are very low and contract teachers do not have higher incentives than regular teachers to exert effort.

Finally, this paper contributes to the literature on instruction time (Pischke, 2007 ; Lavy, 2015). This literature finds that longer instructional time has a positive impact on student test scores and one-time grade progression. While these papers focus on variations in planned instruction time defined by law, I go a step further and analyze the impact on student outcomes of variations in the actual amount of instruction hours, and of variations with whom they are actually spent (regular or substitute teacher).

The remainder of the paper is organized as follows. Section 2 describes the French

educational context, highlighting its relevance to the analysis of worker absence and substitutability. Section 3 presents a highly stylized conceptual framework to illustrate the mechanisms through which teacher absence and substitution affect student outcomes. Section 4 presents the data and some descriptive statistics. Section 5 exposes the empirical strategy, section 6 the baseline results and section 7 the robustness checks. Section 8 shows the hetergoneity analysis. Section 9 concludes.

2.2 Institutional Setting

To provide context for the empirical analysis, this section describes the main relevant features of the French educational system. It focuses more specifically on describing the different types of teachers and the teacher assignment system.

2.2.1 Secondary School Teachers in France

The public French educational system is highly centralized. Schools have little autonomy and they are in particular, all required to follow the same national curriculum. School principals cannot hire nor fire their teachers. The French territory [2] is decomposed in 25 large regions, called *académies* (hereafter regions).

Secondary school teachers are selected through a subject-specific national competitive examination, which is demanding academically and has low passing rates (between 15 and 30 %). There are two main certification levels : basic, called CAPES (*Certificat d'aptitude au professorat de l'enseignement du second degré*) and advanced, called *Agrégation*. Conditional on passing this examination, teachers become civil servants and are managed by the government. They have a permanent position and cannot be fired.

Certified teachers are assigned via a centralized point-based system (called SIAM, *Système d'information et d'aide aux mutations*) with two rounds : the inter-regional round and the regional round. Candidates submit a rank-ordered list of choices and are assigned according to a modified version of the school-proposing Deferred Acceptance mechanism (Combes, Tercieux and Terrier, 2016). Teachers' priorities are mostly determined by their number of years of experience. Every year, i) new teachers and tenured teachers who want to change region apply to the inter-regional mobility round ; ii) participants of the

2. This paper focuses on mainland France and does not analyse its overseas territories.

inter-regional mobility round, and tenured teachers who want to change school within their region, apply to the intra-regional mobility round.

Teachers' wage is set through a national wage scale based on teachers' number of years of experience and certification level (none, basic and advanced). For example, the gross wage of a teacher with the basic certification level and a year of experience is approximately 2,000 euros per month. Wages do not vary across schools and do not depend on output.

Secondary school teachers are subject-specific : each subject is taught by a different teacher. The legal working week is 15 hours for teachers with an advanced certification level and 18 hours for teachers with a basic certification level. Students are not tracked by major nor ability. Students stay in the same class, with the same peers throughout the school year and in all subjects. For ninth graders, a typical week consists in 29 school hours, distributed across 11 teachers– subjects, among which 4 hours of French, 3.30 hours of Mathematics, and 3.30 hours of History[3] . At the end of 9th grade, students take a national and externally graded examination called *Diplôme national du Brevet* in three subjects : French, Math and History. This exam takes place in the very last days of June/early days of July.

2.2.2 Teacher Absence Leave Regulation

Teachers are fully paid during the first three months of their absence leave for minor illness, and during the first to third year of their leave for serious illness. After this period, they receive half of their regular pay. Teachers are fully paid during their maternity leave, which can last from 16 to 46 weeks depending on the order of the birth. Paternity leaves are also fully paid and can last from 11 to 18 days. Teacher can also take fully paid leave for professional reasons such as training, meetings, participation to an examination board *etc.*. There is no limitation in the number of days of paid absence each teacher can take per year.

3. The rest of the hours are distributed between Foreign Languages (5h30), Science (4h30), Sport(3h) and Art (2h), see http ://www.education.gouv.fr/cid80/les-horaires-par-cycle-au-college.html

2.2.3 Teacher Substitution Procedure

Teacher absences are not systematically replaced in France. Overall, the probability of replacement depends on the length of the absence spell and the availability of substitute teachers. Absences are handled by the regional educational authority (*rectorat*). There are no official precise criteria : regional educational authorities are simply asked to give priority to long term absences (IGEN, 2011).

In practice, when a teacher is absent, she has to notify her school principal, who then notifies the region via an online form, whatever the length of the absence spell. Regional educational authorities assign substitute teachers manually.

2.2.4 Substitute Teachers

Tenured Substitute Teachers. Certified teachers can ask to become substitute teachers during the intra-regional mobility round of the centralized teacher assignment procedure but most tenured substitutes (*Titulaires sur zone de remplacement*) are teachers who participated to the inter-regional mobility round and failed to obtain one of their choices in the intra-regional mobility round (IGAENR, 2015). They are assigned to a reference school called *établissement de rattachement administratif* (RAD), and can be called to replace absent teachers in any school located in an geographical area called *zone de remplacement.*[4] There are around 250 *zones de remplacement* in France. Tenured substitute teachers' wages do not depend on the number of substitution they perform nor on the number of hours they work. Their wage is mainly fixed and equal the regular teachers' wage. As explained above, there is no clear rule for the assignment of tenured substitute teachers. Regional educational authorities, which are in charge of the assignment and do it manually, are simply given the general guideline to give priority to long absence spells (IGEN, 2011). Substitute teachers do not have the possibility to refuse an assignment.[5]

Contract Teachers. When there is a shortage of available tenured substitute teachers, regions hire contract teachers on the spot. Contract teachers are not hired via the same procedure as certified teachers. Candidates apply directly to regional educational authorities via an online platform.[6] To be eligible, they must hold a Bachelor's degree

4. Décret 99-823 du 17 septembre 1999
5. This is different in other countries such as the United States, see Gershenson (2012)
6. This online platform is called, depending on the region, either SIATEN (Système d'information

and have no criminal record. Candidates submit their resume, cover letter and, in some regions, their geographical preferences. The selection process is managed by regional professional inspectors. In general, professional inspectors are experienced teachers. They screen candidates based on their online application and conduct interviews. Successful candidates are hired on a short term contract (*Contrat à durée déterminée*) of maximum a year. Contract teachers' wage depends on their degree (High school degree, Bachelor's, Master's or more), their professional experience, and on their region. [7] For example, the gross wage of a contract teacher in Paris, with a Bachelor's degree and a year of experience is 1699 / month.

2.3 Conceptual Framework

This section presents the main intuitions and predictions of a highly stylized conceptual framework illustrating how teacher absences can impact teacher productivity and how this impact can be mitigated or exacerbated by substitute teachers. This detailed conceptual framework is presented in appendix (section 2.11).

This framework builds on the education production function framework. Teacher productivity depends on her ability, general human capital (including professional experience) and, importantly, student-specific human capital. The basic intuition of student-specific human capital is that the longer teachers spend time with the specific students they are assigned to, the better they are at teaching them. This may be because they get to know students and adjust to them, and also have more time to implement a long-term instructional strategy. Existing suggestive empirical evidence back this intuition. Duflo, Dupas and Kremer (2011) suggest teachers adjust the level at which they teach in response to changes in class composition. Herrmann and Rockoff (2012) find daily productivity losses from absence decline with the length of an absence spell, consistent with substitute teachers learning on the job.

The main predictions of this conceptual framework are the following. Teacher absence can impact teacher productivity through different channels, depending on whether the absent teacher is replaced, and on the quality of the substitute teacher :

des agents temporaires de l'Éducation nationale) or ACLOE (Application de gestion des candidatures en ligne)

7. http ://vocationenseignant.fr/devenir-enseignant-contractuel-ou-vacataire-mode-d-emploi

1. If the regular teacher is absent and no substitute teacher is assigned, teacher absence can impact productivity through the loss of instruction time and the amount of student-specific capital the regular teacher loses during her absence. The higher the regular teacher productivity, the bigger the impact of the loss of instruction time ;
2. If the regular teacher is absent and a substitute teacher is assigned, the main channels are :
   - the difference in ability and experience between the regular and the substitute teachers ;
   - how fast substitute teachers gain student-specific human capital ;
   - the amount of student-specific capital the regular teacher loses during her absence.

2.4 Data and Descriptive Statistics

This section presents the administrative data on regular teachers, substitute teachers and their students. Its main advantage is that it is a comprehensive panel data matching each teacher to her students, and each absent teacher to her substitute teacher for each absence spell. The main estimation sample is composed of all ninth grade students and their Math, French and History teachers from 2007 to 2015. This corresponds to 5,233 schools, 101,479 teachers and 3,259,290 students. This section also provides the descriptive statistics necessary to understand how absence and substitution spells are distributed across teachers and schools.

2.4.1 Data

This paper relies on administrative data from the French ministry of Education covering the whole country and school years 2005-2006 through 2014-2015. I focus on Math, French and History teachers matched to their ninth grade students. A precise description of the data is found in appendix (section **??**). I exploit four main set of data :

- individual data on students including an encrypted national identification number, gender, financial aid status, parents' occupation, the identification number of their school and of their class. A separate database also includes their test scores at the

end of 9th grade examination in French, Math and History, which I standardize by year and region.

- individual data on teachers including national identification number, date of birth, gender, number of year of teaching experience, teaching subject, identification number of their assignment, and the identification number of the school and of the class they teach. The two latter variables are used to match each teacher to her students. I take into account, throughout the paper, only open business days and remove holidays and weekends.
- data on teachers' absence spells : regional identification number of the absent teacher ; day, month and year of the absence spells ; detailed cause of absence (minor illness, maternity leave, training etc.) ; region identification number.
- data on teachers' assignment spells : region identification number of the substitute teacher, day, month and year of the assignment spells ; identification number of their assignment ; national identifying number of the school. The match between the absent and the substitute teachers is made on the identification number and dates of their respective assignment spells. As for absence spells, I take into account, throughout the paper, only open business days and remove from absence spells holidays and weekends.

2.4.2 Summary Statistics

Distribution of Absence Spells. Each year, 55 percent of teachers do not take any absence leave (Figure 2.1). Around half of teachers who are absent take only one absence spell. The majority of absence spells are health-related : 50 % for minor sickness, 10 % for long term illness, 3 % for maternity leave, 2 % for maternity leave extension (in case of a difficult pregnancy or childbirth) and 1 % for professional illness (Figure 2.8a).

Teachers are absent 13.14 days per year on average, which represents around 7 % of the yearly instructional time. Figure 2.3 shows the cumulative distribution of the number of instructional days of absence per absence spell. More than 36 % of absence spells last only one day. The distribution of absence spells is right-skewed, with 80 % of absence spells lasting less than 20 days.

Distribution of Substitution Spells. In 2015, the number of replaced days is equal to 10 days per year, which means that around 75 % of absent days are replaced (Figure

2.2). On average, 5 days per year are replaced by tenured substitute teachers. This means that on average in 2015, 3 % of annual instructional time is spent with tenured substitute teachers, against 6 % in 2007. Over the period, the share of replaced days by contract substitute teachers is more than four times higher in 2015 than in 2007 (from 10 % to around 45 %).

There are large variations in replacement rates by length of the absence spell (Figure 2.4). On average, only 0.4 % of absence spells lasting a single day and 6 % of absence spells lasting a week are replaced. The replacement rate rises quickly with the length of absence spells, and reaches 50 % for 20 days absence spells and 90 % for 100 days absence spells. Importantly, the share of replacement spells ensured by contract teachers increases with the length of the absence spells for absence spells lasting less than 20 days (which represent more than 80 % of the absence spells). The share of replacement spells done by contract substitute teachers is equal to 6 % for one day absence spells, against more than 17 % for absence spells lasting 20 days.

There are also large variations in replacement rates across regions (Figure 2.9). For example, in the Creteil region (disadvantaged Eastern suburb of Paris), only 6 % of absence spells are replaced whereas in the Nice region (French Riveria), almost 45 % of absence spells are replaced. The share of absence spells replaced by contract substitute teachers differs greatly between these two regions. In Creteil in 2015, 51 % of replacement spells are done by contract teachers, against 33 % of replacement spells in Nice the same year. This point is important as it shows social inequalities in students' exposition to contract teachers.

Substitute Teachers Characteristics. Table 2.1 shows summary statistics on teacher characteristics. Contract teachers are on average less experienced than regular and tenured substitute teachers : they have on average 4.6 years of experience, whereas tenured substitute teachers have 10 years of experience and regular teachers 14.1 years. 32 % of contract teachers have a year or less of experience, against 13 % of tenured substitute teachers and 2 % of regular teachers. Regular teachers and tenured substitute teachers have the same distribution by certification. For both regular and tenured substitute teachers, *Agrégation* recipients represent 5 % of the population and CAPES recipients approximately 75 %. By definition, contract teachers are not certified. I then focus on the subsample of contract teachers who take the same certification examinations as regular and tenured

substitute teachers (Table 2.5). Candidates who are contract teachers perform very badly both at *Agrégation* and CAPES. For example, only 16 % of them pass the CAPES against 33 % of candidates who are not contract teachers.

Relationship between teacher characteristics, and absences/substitution. Finally, I analyse the relationship between observable teacher, school and student characteristics, and absence/replacement (Table 2.6). This correlational analysis is also a first step towards understanding the potential sources of biases in a causal analysis of the impact of absence/replacement on student achievement. First, I am interested in the relationship between teacher experience and absences/replacements, other teacher and school observable characteristics kept equal. Estimates show that the number of absence days rises as teachers gain experience, both without and with teacher fixed effects (columns 1 and 2). This correlation is consistent with other studies on the determinants of teacher absence (DEPP, 2015 ; Ost and Schiman, forthcoming). As most absences are health-related, this relationship can be possibly due to the strong correlation between experience and age, older teachers having a more fragile health than younger ones. Furthermore, the fact that the correlation between experience and absences is steeper when teacher fixed effects are included (column 2) suggests a survival bias : the more dedicated teachers are less likely to be absent, and these teachers are over represented at later experience/age levels. The negative correlation between the share of replaced days and teacher experience is likely to reflect teacher sorting into schools by experience : inexperienced teachers are more likely to be assigned to schools which have less access to substitute teachers. Second, I analyse the role of teacher seniority, defined as the number of consecutive years spent in the same school, everything else kept equal. Whatever the specification, the number of days of absences decreases with seniority (columns 1 and 2). A possible explaination might be school-specific human capital : teachers find it difficult to adapt when they move to a new school as it may entail a higher workload. The fact that absent teachers with less seniority are more likely to be replaced (columns 2 and 3) might reflect school principal decision-making as they might want to provide more support to less senior teachers by assigning a substitute teacher to their students.

2.5 Empirical Strategy

This section describes the empirical strategy implemented to identify the impact of absence and substitution on student achievement. I implement a two-way fixed effect model with teacher-school and classroom fixed effects. I present the main empirical challenges and how they are addressed by this empirical strategy.

2.5.1 Empirical Strategy

The main empirical challenge raised by the estimation of the impact of teacher absence/substitution is the non-random teacher- student matching. As suggested by Table 2.6, absences and substitution can be correlated with observed and unobserved teachers' characteristics which can have a direct impact on student achievement. This table confirms results from the literature establishing the statistically significant relationship between teacher experience, her student socioeconomic background and her number of days of absence (e.g. Ost and Schiman, forthcoming). Futhermore, there is a statistically significant relationship between teacher substitution and her student socioeconomic background, experience and other teacher characteristics kept equal. Low quality teachers can be systematically assigned to low achieving students.

To deal with these issues, I implement a two way fixed effect model with teacher and classroom fixed effects. First, I exploit the longititudinal dimension of the data with teacher-school fixed effects, which control for both observed and unobserved teacher fixed characteristics (Miller et al., 2008 ; Herrmann and Rockoff, 2012). Therefore, I exploit within teacher, across years variations in the number of days of absence and in the number of replaced days. This source of variation has already been exploited in the previous studies on the impact of teacher absences on student achievement (Miller, 2008 ; Herrmann and Rockoff, 2012). However, a major concern for the validity of this strategy is unobserved variation in student ability, which can impact both teacher absences and replacement and student test scores. This is why I go a step further and take advantage of the fact that, in secondary school, teachers are subject-specific and that students stay with the same peers in the same classroom, throughout the school year and in every subject. This allows me to also exploit variation within classroom-year, across subjects. Formally, this model

writes :

$$Y_{c,s,j,t} = A_{j,t}\beta + R_{j,t}\gamma + \theta_s + \theta_c + \theta_j + \theta_t + e_{c,s,j,t} \tag{2.1}$$

where $Y_{c,s,j,t}$ is the outcome of teacher j 's students in year t in her subject s with the students of classroom c. $A_{j,t}$ is the number of work day absences of all the absence spells taken by teacher j in year t and $R_{j,t}$ the number of replaced work days of all the absence spells taken by teacher j in year t. Finally, θ_t year fixed-effect to control for common trends across years, and θ_j is the teacher-school fixed effects to control for fixed individual characteristics. Robust standard standard errors are clustered by school, which is the most conservative level of clusturisation.

2.5.2 Identification Assumption and Potential Threats to Identification

The parameters of interests $A_{j,t}$ and $R_{j,t}$ are identified under the assumption that variations within teacher, across year and within classrooom, across subject in the number of days of absence/ number of replaced days are not correlated with variations of unobserved determinants of student achievement. This would include i) within teacher variations in productivity, such as experience or motivation ; ii) student ability or iii) teachers' overall working conditions. First, table 2.6 shows that experience is strongly correlated with the number of days of absence and replacement. We also know from the literature that experience is an observable determinant of teacher quality. That is why I add experience and the square of experience as control variables. A source of unobservable variations in within teacher quality would be teacher motivation. If, for example, a teacher were burning out, then her absences would only be a symptom of poor on-the-job productivity. This point is discussed in the robustness checks with placebo tests in the number of days of absence and replacement. Second, low achieving students can discourage teachers and raise absences, i.e. there could be reverse causality. The classroom fixed effect addresses this issue under the assumption that, within classroom, there is no subject specific matching, i.e. that students relatively worse in one subject are not systematically assigned to relatively more absent/less replaced teachers. This issue of reverse causality is also further discussed in the robustness checks section, with a placebo test of the impact of absence/impact of a teacher in one subject on her students' test scores in another subject (i.e. with another teacher). Finally, in the heterogeneity analysis section, I distinguish between maternity

leaves and other type of absences. Indeed, maternity leave is the reason of absence most likely to be unrelated to within teacher variations in motivation or burning out, student ability or working conditions.

Another type of potential threat for identification is more specific to the replacement parameters. These parameters would not be identified if the type of absence spells that are replaced were not comparable to those who are not. For example, absences planned in advance may be more likely to be replaced than absences that are unexpected. In that case, the impact of replacement may be biased. Teachers who know in advance they are going to be missing a certain period of time can prepare their absence by giving guidelines to their substitute, specific homework to their students etc. In particular, the analysis of the impact of the assignment of tenured substitute teachers or contract substitute teachers would be biased if tenured substitute teachers where assigned to different type of absence spells, e.g. of different length, period of the year or reason, than contract substitute teachers. This is all the more relevant since the summary statistics (Figure 2.4) shows that, for absence spells lasting less than 20 days (more than 80 % of the absence spells), the share of replacement spells done by contract teachers increases with the length of the absence spell. I tackle this issue by performing several heterogeneity analyzes, in particular by length of absence spell and reason of absence. More specifically, distinguishing between maternity leaves and other types of absence can be fruitful because maternity leaves are the absences that are the most likely to be planned long in advance.

Finally, it is important to note that this identification strategy relies on across subject variations in the number of absent/replacement days. The estimated parameters give the average effect across subjects and rely on the assumption of a constant effect across subjects. I relax this assumption in the heterogeneity analysis by subject (section 8.2).

2.6 Baseline Results

The main results show one additional non-replaced day of absence reduces student test scores by 0.03 % of a standard deviation. On average, substitute teachers are unable to have any statistically significant mitigating effect. This average effects masks substantial heterogeneity : tenured substitute teachers are able to mitigate up to 25 % of this negative effect whereas contract teachers have no statistically significant mitigating effect.

2.6.1 Impact of the Number of Days Absence and Replacement

I begin by presenting estimates of the impact of the number of days of absence and the number of replaced days per teacher-year on their student test scores at the 9th grade examination (Table 2.2). Each column corresponds to a single regression. Results are reported in percentage of a standard deviation. All regressions include year x subject fixed effects. Column 1 reports naive estimates, without teacher-school fixed effect nor control variables. With this specification, an additional non-replaced day of absence is associated with a 0.13 % of a standard deviation decrease in student test scores. An additional replaced day (as compared to missing a day of school) is associated with a 0.06 % of a standard deviation increase of student test scores. In other words, replaced days compensate more than 45 % of the negative impact of absence. I now control for teacher-school fixed effects and time-varying teacher characteristics (teacher experience and seniority). The effect of absences is divided by three but remains statistically significant (column 2). The fact that the introduction of teacher-school fixed reduces the impact of absence is consistent with a negative correlation between teacher quality and absences. Furthermore, with this specification, the effect of replaced days becomes statistically insignificant. This suggests a positive sorting between absent teachers and substitute teachers : the best absent teachers seem to get the best substitute teachers.

Finally, with the preferred specification, which includes classroom fixed effects, the marginal impact of one additional non-replaced day of absence is to reduce student achievement by 0.03 % of a standard deviation. In other words, the expected loss in daily productivity from teacher absences is on par with replacing an average teacher with one at the 30^{th} percentile of the teacher value-added distribution. [8] This is comparable to the results of the literature. Herrmann and Rockoff (2012) for example find that the expected loss in daily productivity from teacher absences is on par with replacing an average teacher with one at the 10-20 percentile of the teacher value-added distribution. Furthermore, the coefficient associated with the number of replaced days remains statistically insignificant.

8. For the detail of the computation, see Herrmann and Rockoff, 2012

2.6.2 Impact of the Number of Days of Replacement by Type of Substitute Teachers

The above results seems to suggest that substitute teachers are, on average, unable to compensate the negative impact of teacher absences. Table 2.3 shows that, actually, the impact of replaced days largely depends on the type of substitute teachers. With the preferred specification (column 3), tenured substitute teachers are able to mitigate more than 25 % of the marginal impact of absences. On the other hand, the marginal impact of a replaced day with a contract teacher (as compared to missing a day of school) is not statistically significant.

This result suggests that substitute teacher quality plays an important role in the mitigating impact of substitution. This result is consistent with the conceptual framework showing that one of the main mechanisms underlying the impact of teacher absence is the human capital gap between the regular and the substitute teachers.

2.7 Robustness Checks

This section aims at adressing the main potential threats to identification. I discuss three main threats to identification : reverse causality, absence as a symptom of poor on-the-job teacher quality, non-comparability of replaced absences with non-replaced absences.

2.7.1 Threat I : Reverse Causality

Placebo test with students' teacher in another subject. A concern for the validity of the baseline results is that the bias caused by unobserved variations in student ability, which can impact both teacher absences and replacement and student test scores. To address this concern, we test whether absences and replacements of a teacher in one subject impact her students' test scores in another subject (i.e. with another teacher). If the baseline results were driven by student ability, then the absence days and replaced days of the Math teacher of student i would be significantly correlated with student test scores in French. Table 2.9 reports regression estimates of the effect of absence and replaced days of the "other subject" teacher of student i on student test scores in 9th grade. Each column-panel corresponds to a single regression. This table shows that Math absence and

replacement days are not significantly related to student achievement in French and in History. This is also true for French absence and replacement days on Math and History test scores ; and of History absence and replacement days on French and Math test scores. Thus, this placebo test gives strong evidence in favour of the robustness of the baseline results.

2.7.2 Threat II : Absence as a Symptom of Poor On-the-job Teacher Quality

Previous and Following Year Absences and Substitution. I also give evidence against the idea that the baseline results are driven by the fact that absences are only a symptom of poor on-the-job teacher quality. If, for example, the impact of absence were only capturing the fact that absent teacher were burning out, then previous and following absences would have a statistically significant impact. Table 2.10 reports a placebo test of the effect of absence and replacement of the previous year ($t-1$) and following year ($t+1$) of teacher j on student test scores in 9th grade with teacher j during the year t. Each column corresponds to a different regression. All regressions correspond to the preferred specification. This table shows absent days and replacement day of years $t-1$ and $t+1$ do not have any statistically significant impact on student achievement in year t. Therefore, it does not seem that the baseline result are biased by poor on-the-job teacher performance.

Absences During the Holidays. Teachers who fall sick or pregnant during the school holidays (days when they do not have class) or during summer time have the possibility to declare these days in order to have these absence days transferred during school time [9]. These absence spells represent around 1 % of the observations. Half of them are maternity leaves happening over the summer. Table 2.7 shows regression estimates of the marginal impact of one day of absence during holidays. It shows that these estimates are not statistically significant. Therefore, this suggests that the baseline estimates are not driven by that the baseline estimates are not driven by the fact that absence would be a symptom of poor on-the-job teacher quality.

9. Source : https ://www.service-public.fr/particuliers/vosdroits/F2481

2.7.3 Threat III : Replaced Absences are not Comparable to non-replaced Absences

Heterogeneity by Reason of Absence. Table 2.8 reports regression estimates by reason of absence. This table corresponds to a single regression. I make the distinction between absence spells for maternity leave and non maternity leave absence spells. As discussed in the empirical strategy, the reason for this distinction is that maternity leave absence spells are less likely to be determined by within teacher variations in teacher quality, student ability or working conditions. Furthermore, maternity leaves are more likely to be planned long in advance. We observe that the marginal impact of absence for maternity leave is to reduce student test scores by 0.05 % of a standard deviation. The impact of absence for non maternity leave absences is similar. The impact of replacement by a tenured substitute teacher, for both maternity leave and non maternity leave absences, is to mitigate 30 - 35 % of the negative impact of absence. The fact that estimates for maternity leave absence spells and non maternity absence spells are very similar gives strong support for the robustness of the baseline results.

2.8 Heterogeneity Analysis

Having established the impact of teacher absence and substitution on student achievement, I then estimate heterogeneity across teachers, absence spells and school characteristics. This heterogeneity analysis aims at shedding light on the mechanisms underlying the main results and giving suggestive evidence on the conceptual framework's predictions.

2.8.1 Heterogenity by Length of Absence

I start by analysing the marginal impact of one additional non-replaced day by length of absence spell. The idea is to test whether the disruptive impact of teacher absence, predicted by the conceptual framework, decreases with length of absence spell. Figure 2.5 reports regression estimates of the effect of absence and replaced days on student test scores in 9th grade by length of absence spell. The marginal impact of one additional day of absence decreases with the length of absence spells. The marginal impact of absence is to reduce student achievement by around 0.1 % of a standard deviation for absence spells lasting one day whereas it is equal to less than 0.05 % of a standard deviation for absence

spells lasting 10 days.

This decreasing marginal impact of non-replaced days may be due to alternative compensating strategies from students or their parents (private tutoring for example) as absence spells get longer.

2.8.2 Heterogeneity by Subject

According to the conceptual framework, the main channel through which non-replaced days impact student achievement is the loss of instructional time. In this framework, the higher the regular teacher productivity, the bigger the impact of loss of instructional time and thus the bigger the impact of non-replaced days.

I investigate this mechanism by leveraging the research design to estimate heterogeneity across teaching subject. It is well established in the literature that teacher productivity varies greatly by subject. In particular Math teachers value-added is higher than in other subjects (see Chetty et al., 2014 for the latest evidence). Therefore, according to the conceptual framework, the negative impact of non-replaced days in Math should be higher than in the other two subjects.

Figure 2.6 reports regression estimates by teaching subject. The marginal impact of one additional day of non-replaced absence in Math is to reduce student achievement by 0.08 % of a standard deviation. In French and History, this impact is equal to 0.04 % of a standard deviation. The fact that absences have a larger impact in Math than in other subjects is consistent with the literature (Miller et al., 2008 ; Herrmann and Rockoff, 2012). This result is consistent with the intuition that the higher the teacher value-added, the higher the impact of absence.

2.8.3 Heterogeneity by the Experience Gap between the Substitute and the Regular Teacher

Another major prediction of the conceptual framework is that the mitigating effect of substitution depends on the general human capital gap between the regular and the substitute teachers. I use teacher experience as a measure of general human capital because the link between teacher experience and teacher productivity is well established in the literature (see Koedel et al., 2015 for a review). According to the conceptual framework, the larger the experience gap between the regular and the substitute teacher, the smaller

the mitigitating impact of substitution.

Table 2.4 reports estimates from interacting the number replaced days by each type of substitute teachers and the experience gap between the regular and the substitute teachers. It mainly shows that the mitigating effect of tenured substitution is not significantly impacted by the experience gap, suggesting the existence of other mechanisms.

2.8.4 Heterogeneity by Month of the School Year

The last mechanism I explore is the role of the student-specific human capital gap between the regular and the substitute teachers. According to this framework, the larger this gap, the bigger the impact of absence. I analyse the impact of non-replaced days by month of absence spell to provide suggestive evidence on this mechanism. The intuition is that the student-specific human capital gap between the regular and substitute teachers is larger in the end of the school year than in the beginning : in September, both regular and substitute teachers have limited knowledge of students and the classroom dynamics, but as the regular teacher interacts more and more with her students, she gains more and more specific human capital.

Figure 2.7 reports estimates of the impact of the number of days/substitution by month of the beginning of the absence spell. The three graphs correspond to a single regression with the preferred specification. The graph 2.7a shows the seasonality of the marginal impact of absence (controlling for the number of replaced days with tenured substitute and contract substitute). The marginal impact of absence starting in September is not statistically significant at the five percent level. Between October and January, the marginal impact of absence on student test scores is equal to -0.06/- 0.08 percent of a standard deviation and is statistically significant at the five percent level. It then drops to -0.10/ - 0.11 percent of a standard deviation in February and March. The marginal impact of absence is the most negative in June when it reaches a -0.12 percent of a standard deviation. Thus, this graph shows a trend of the impact of non-replaced days getting larger as the school year goes by. The graph 2.7b, which shows the marginal impact of one replaced day with a tenured substitute teacher, confirms this trend.

Overall, these results are consistent with the the existence of a student-specific human capital gap mechanism.

2.9 Conclusion

Using a unique French administrative dataset matching, for each absence spell, each missing secondary school teacher to her substitute teacher, this paper (a) estimates the effect of teacher absence on student test achievement ; (b) studies how the effect of teacher absence can be mitigated through the assignment and quality of substitute teachers. I find that the expected loss in daily productivity from teacher absences on student test scores is on par with replacing an average teacher with one at the 30th percentile of the teacher value-added distribution. Tenured substitute teachers are able to compensate 25 % of this negative impact, while contract substitute teachers do not have a statistically significant impact. I also provide suggestive evidence on the possible channels, including the gap in general and specific human capital between the regular and the substitute teachers.

This paper has major implications for public policy. It shows that non-replaced absence do impact student performance. It also shows contract teachers are unable to significantly mitigate the negative impact of absence, whereas tenured substitute teachers seem to do a decent job. This is a source of inefficiency as contract teachers represent, overall, an ever growing share of the teaching workforce.

Discussion : Contribution to educational inequalities. These results also have implications for educational inequalities as non-replaced days are concentrated in disadvantaged areas. To quantify this phenomenon, I perform a back-of-the-envelope calculation of the cumulative contribution, throughout middle school, of non replaced absence days to educational inequalities between the two extreme regions of Nice and Creteil. Nice is the region where teacher absence is best covered (around 45 %) whereas Creteil is the region with the worst coverage (around 6 %). This calculation relies on the assumption that the impact of non-replaced days is constant across grades in middle school. The student 9th grade test scores gap between Nice and Creteil is equal, on average, to 0.11 SD over the period. On average, teachers are absent 6.87 days in Creteil and 8.10 days in Nice. This implies that the gap in non-replaced days between Creteil and Nice is equal to 2 days. As students generally spend four years in middle school, the cumulative average gap in non-replaced days at the end of middle school between students in Nice and students in Creteil is equal to 8 days. Therefore, as the effect of one non-replaced day is equal to 0.02 % of a SD, non-replaced days represent 0.0002*8/0.11=1.5 % of the achievement gap

between Creteil and Nice at the end of middle school.

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2.10 Tables and Figures

Table 2.1 – Substitute Teachers Characteristics

	Regular Teacher	**Tenured Sub.**	**Contract Teacher**
A. **Demographics**			
Male	0.36	0.39	0.43
	(0.48)	(0.49)	(0.50)
Age	43.8	39.0	37.9
	(10.3)	(10.5)	(8.9)
Average Experience (in years)	14.1	10.0	4.6
	(8.3)	(8.8)	(10.2)
A year or less of experience	0.02	0.13	0.32
	(0.12)	(0.34)	(0.47)
B. **Certification**			
Agrégation	0.05	0.05	–
	(0.23)	(0.22)	
CAPES	0.77	0.74	–
	(0.42)	(0.44)	
Other	0.17	0.21	–
	(0.38)	(0.41)	
C. **Evaluations**			
Classroom Observation Grade (/60)	46.82(5.99)	44.84 (6.39)	11.85 (9.59)
School Principal Grade (/100)	39.02(10.05)	39.15 (11.82)	13.86 (8.70)
Nb of teachers	193,766	67,541	23,035

Note : Standard deviation in parenthesis. On average, regular teachers have 14.1 years of experience whereas tenured substitute teachers have 10 years of experience and contract teachers only 4.6 years of experience.

Table 2.2 – Effect of Absence and Replaced Days on Student Test Scores in 9th Grade

in % of a SD	(1)	(2)	(3)
# days of absence	-0.130***	-0.044***	-0.028***
	(0.009)	(0.006)	(0.005)
# replaced days	0.056***	0.010*	0.010*
	(0.011)	(0.006)	(0.006)
Av. nb of days of abs.	[13.14]	[13.14]	[13.14]
Av. nb of replaced days	[10.06]	[10.06]	[10.06]
Teacher-School Fixed effect	No	Yes	Yes
Teacher experience & seniority*	No	Yes	Yes
Classroom Fixed Effects	No	No	Yes
Number of observations	32,290,084	32,290,084	32,290,084

* Quadratic function of teacher experience and of teacher seniority. Each column corresponds to a single regression. Results are reported in percentage of a standard deviation. All regressions include year x subject fixed effects. Robust standard errors clustered by school.

Note : With teacher-school fixed effects, teacher experience and seniority and student background as controls (column 3), the marginal impact of one day of absence is to reduce student test score by 0.04 % of a standard deviation. The coefficient is statistically significant at the 1 % level. The number of replaced days does not have any statistically significant impact on student test scores.

Table 2.3 – Effect of Absence and Replaced Days on Student Test Scores in 9th Grade by Type of Substitute Teacher

in % of a SD	(1)	(2)	(3)
# days of absence	-0.132***	-0.046***	-0.027***
	(0.010)	(0.005)	(0.005)
# replaced days x tenured sub.	0.072***	0.017***	0.007***
	(0.011)	(0.006)	(0.005)
# replaced days x contract sub.	0.024**	-0.010	-0.006
	(0.012)	(0.007)	(0.007)
Average # days of abs.	[13.14]	[13.14]	[13.14]
Average # replaced days tenured sub.	[7.73]	[7.73]	[7.73]
Average # replaced days contract sub.	[2.22]	[2.22]	[2.22]
Teacher - school fixed effect	No	Yes	Yes
Teacher experience & seniority*	No	Yes	Yes
Classroom Fixed Effect	No	No	Yes
Number of observations	32,290,084	32,290,084	32,290,084

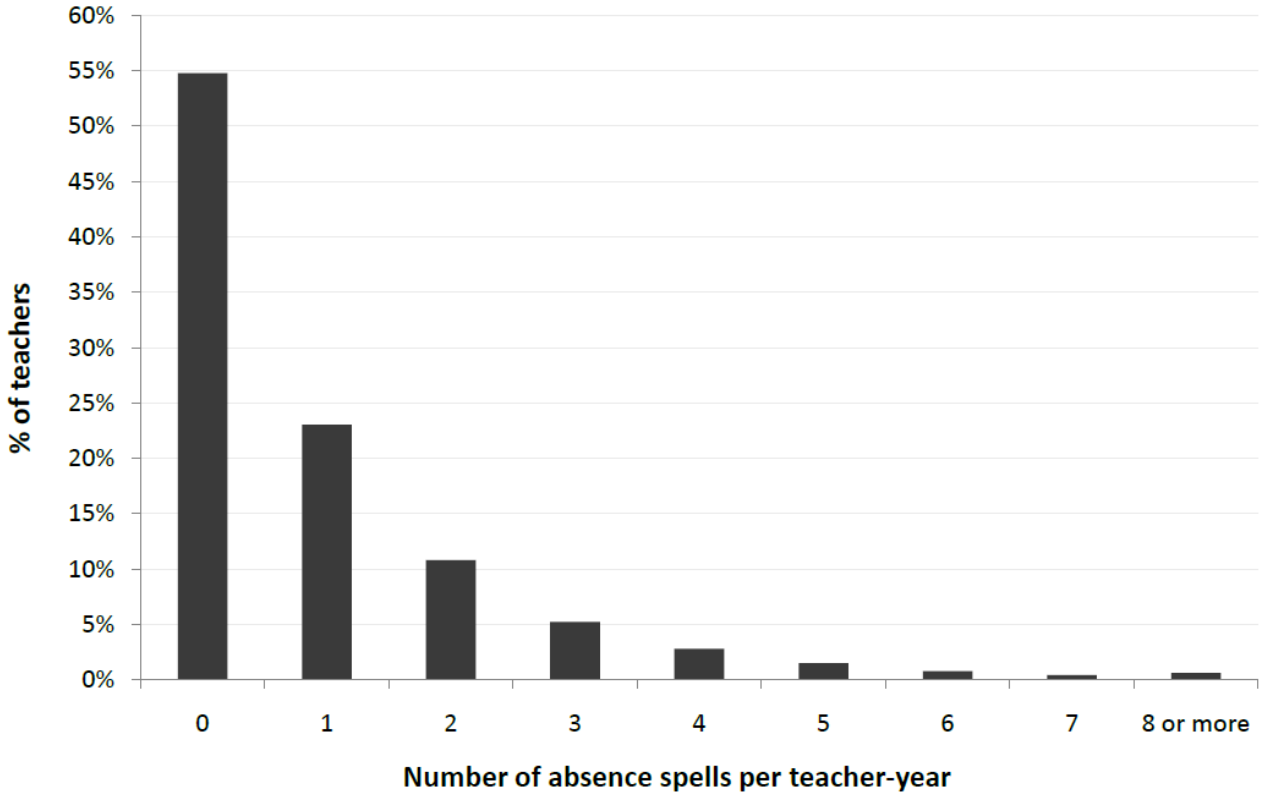
* Quadratic function of teacher experience and of teacher seniority. Each column corresponds to a single regression. Results are reported in percentage of a standard deviation. Robust standard errors clustered by school.
Note : With teacher fixed effects and teacher experience and seniority as controls (column 3), the marginal impact of one replaced day with a tenured substitute teacher is to increase student achievement by 0.016 % of a standard deviation. It corresponds to 30 % of the impact of teacher absence. The marginal impact of one replaced day with a contract substitute teacher is to decrease student achievement by 0.009 % of a standard deviation. It corresponds to 17 % of the impact of teacher absence.

Table 2.4 – Impact of days of absence/replacement in 9th Grade by Experience Gap between Regular and Substitute Teacher

in % of a SD of student test scores	
# days of absence	-0.039***
	(0.005)
# replaced days x tenured sub.	0.015**
	(0.008)
# replaced days x tenured sub. x exp. gap regular-tenured sub.	-0.000
	(0.000)
# replaced days x contract sub.	0.014
	(0.013)
# replaced days x contract sub. x exp. gap regular-contract sub.	- 0.001**
	(0.000)
Average # days of abs.	[13.14]
Average # replaced days tenured sub.	[7.73]
Average # replaced days contract sub.	[2.22]
Teacher - school and classroom fixed effect	Yes
Teacher experience & seniority	Yes
Student background	Yes
Number of observations	32,290,084

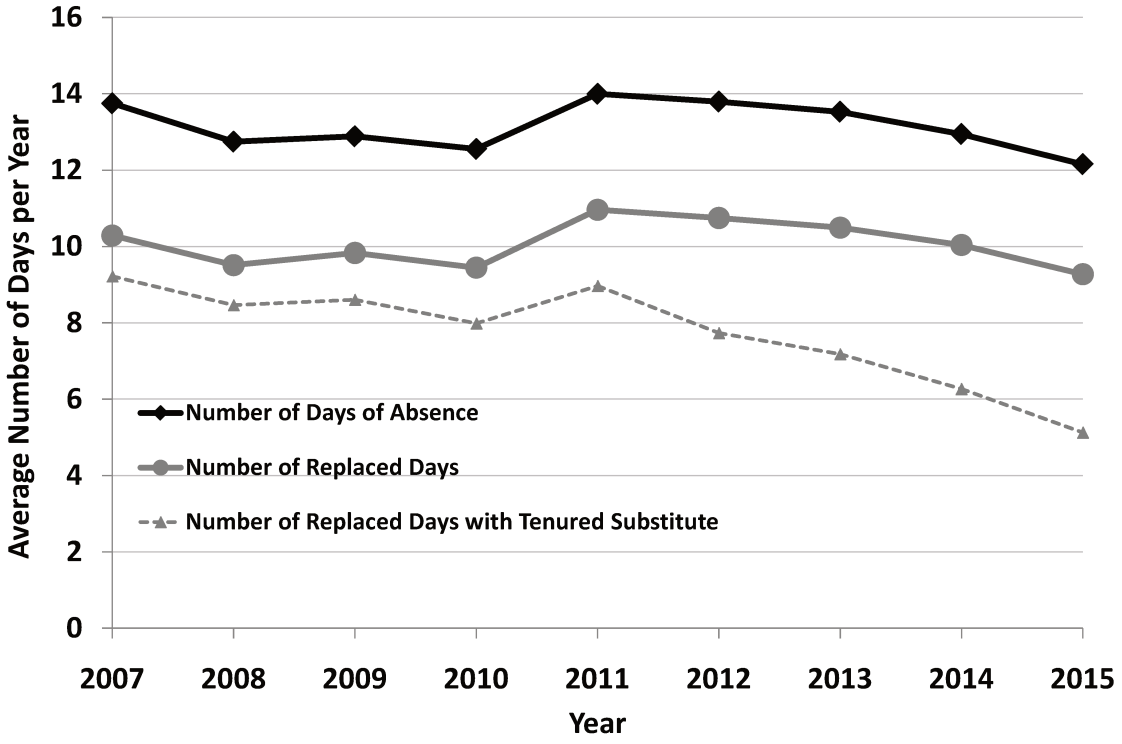
Robust standard errors clustered by school.

Figure 2.1 – Distribution of Absence Spells by Teacher-Year



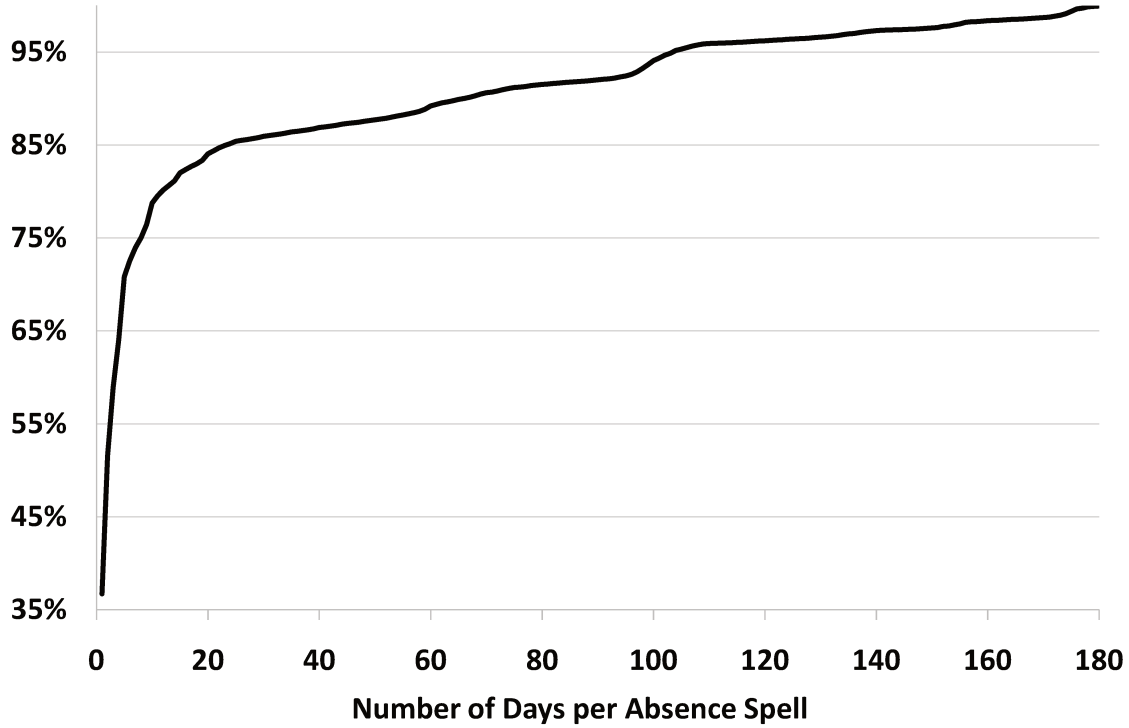
Note : 55 % of secondary teachers do not take any absence spell per year.

Figure 2.2 – Number of Days of Absence and Replacement per Year



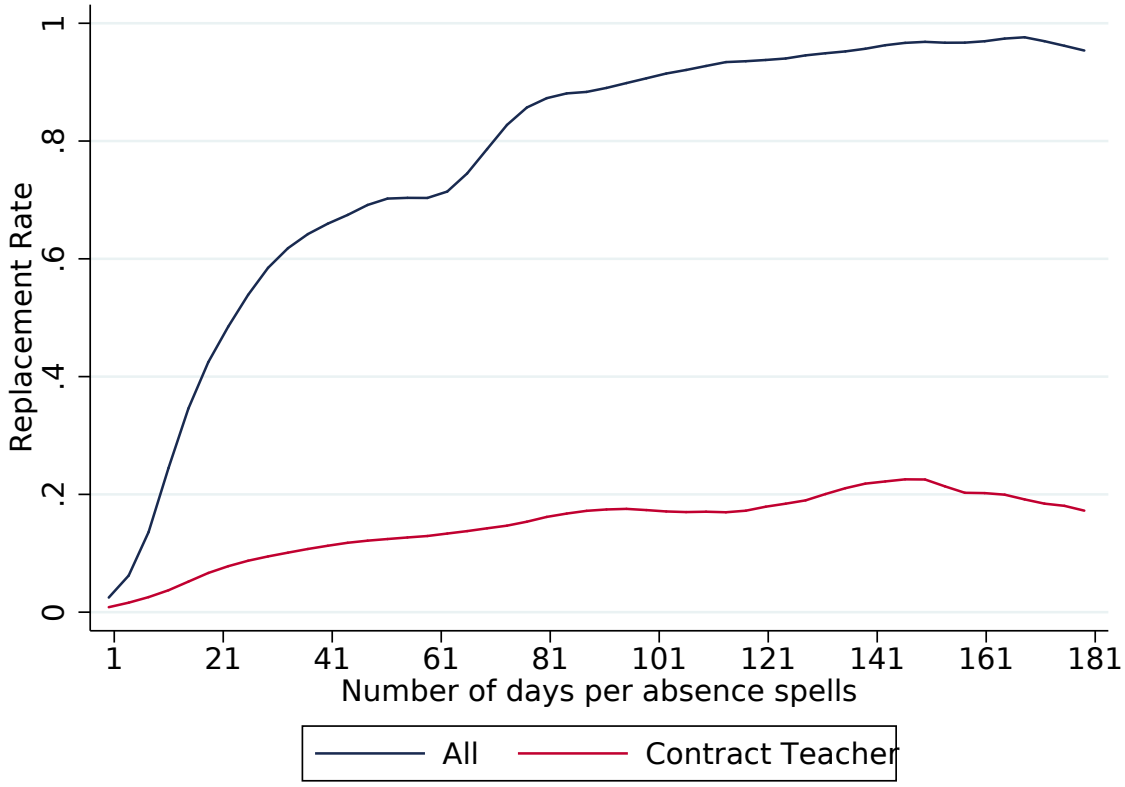
Notes : In 2015, middle school teachers were on average absent 12 days. On average, the number of replaced days in 2015 is 10 days, which means that 78 % of absent days are replaced. The average number of replaced days with a tenured substitute teacher is 5.55 days in 2015, which means that 55 % of replaced days are done by tenured substitute teachers.

Figure 2.3 – Cumulative Distribution of Absence Spells per Length



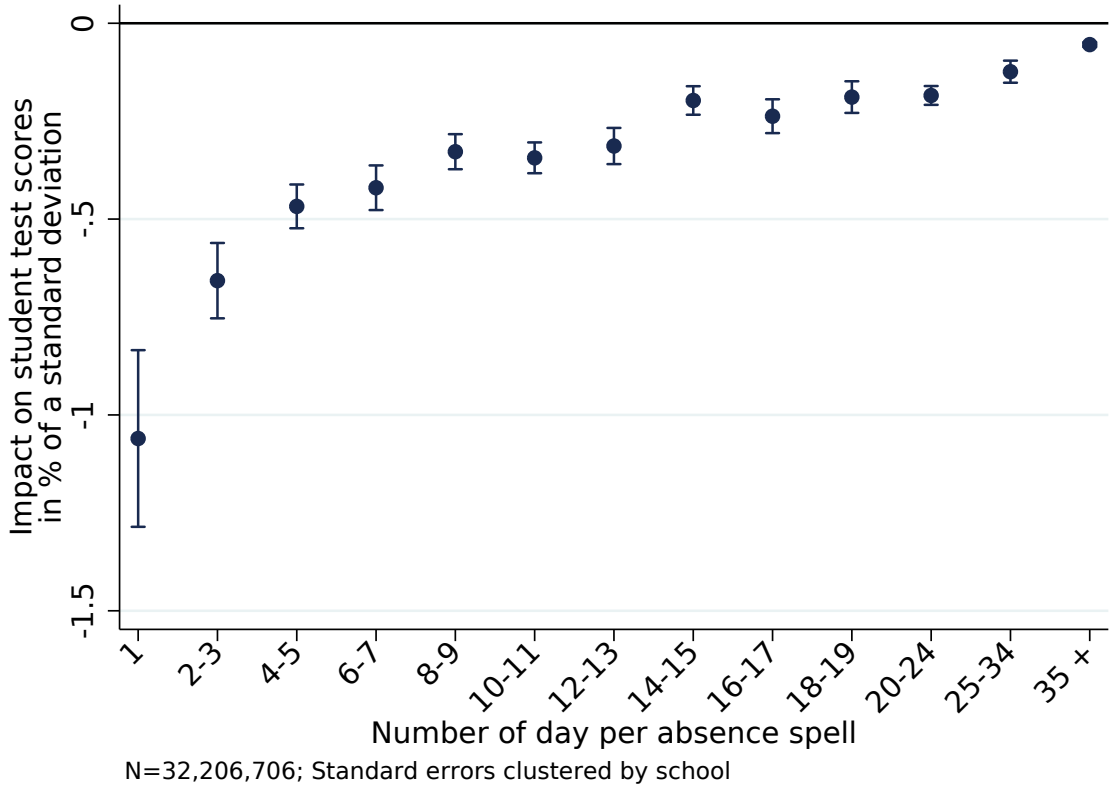
Notes : 36 % of absence spells taken by middle school teachers last only one day. 90 % of absence spells last less than 40 days.

Figure 2.4 – Replacement Rate per Length of Absence Spell



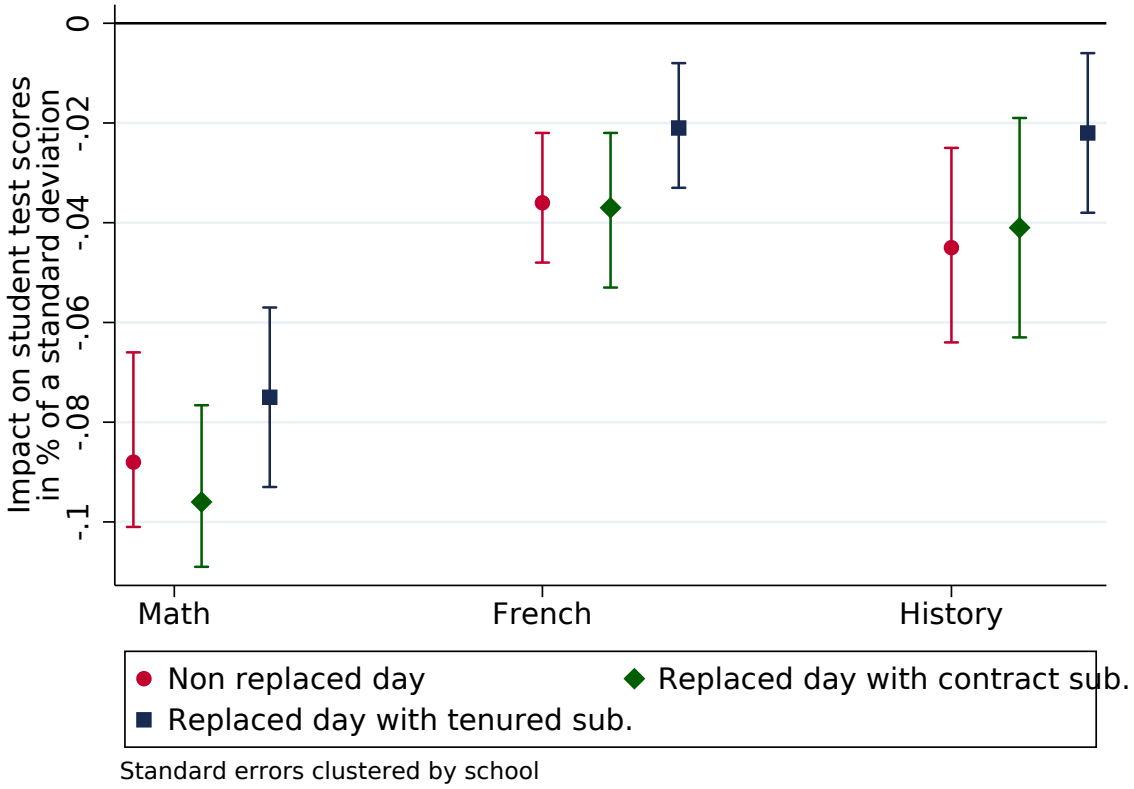
Notes : 70 % of absence spells lasting 40 days are replaced (black line). 10 % of absence spells lasting 40 days are replaced by a contract substitute teacher. This implies that 60 % of 40 days absence spells are replaced by a tenured substitute teacher.

Figure 2.5 – Marginal of non-replaced Day by Length of Absence Spell



Notes : All reported estimates correspond to a single regression with the preferred specification.

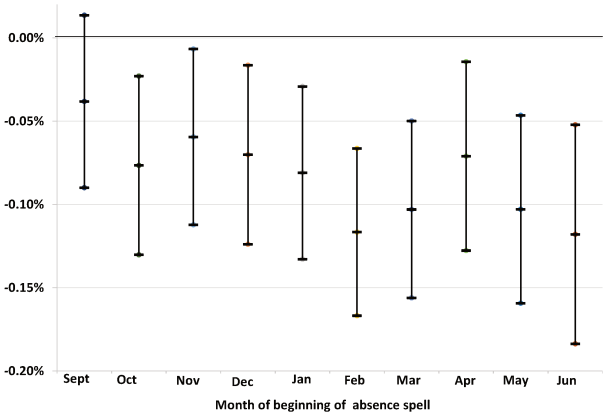
Figure 2.6 – Impact of Absence/Replacement by Teaching subject



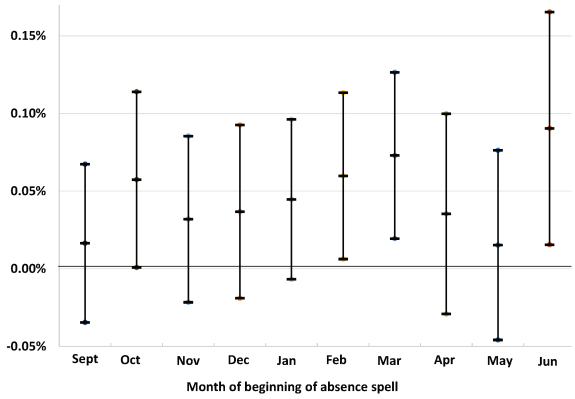
Notes : Estimates by subject are estimated through interaction terms. For each subject, the first reported estimates corresponds to the number of days of non-replaced absence, the second to the number of days with a contract teacher and the third to the number of days with a tenured substitute teacher. The marginal impact of one day of non-replaced absence of the Math teacher is to reduce student test scores by 0.86 % of a standard deviation. This impact is statistically significant at the five percent level.

Figure 2.7 – Impact of Absence/Replacement on 9th Grade Student Test Scores per Month of the Year

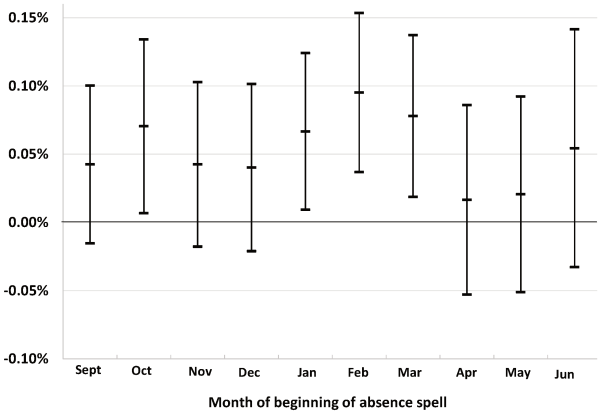
(a) Impact of absence



(b) Impact of tenured substitute



(c) Impact of contract teacher



Notes : These figures corresponds to a single regression, with the preferred specification. It reports the marginal impact of one day of absence/replacement with a tenured substitute/replacement with a contract teacher on 9th grade student test scores by month of beginning of the absence spell.

2.11 Detailed Conceptual Framework

I present a highly stylized conceptual framework aimed at understanding the intuitions of my empirical analysis. I essentially build on Herrmann and Rockoff (2012) and add to their framework the potential underlying mechanisms of the effect of absence and substitution on productivity.

Consider $q_{j,i,t}$ the productivity of a representative teacher j during a specific hour of teaching t with student i. The average hourly productivity of teacher j over her hours of teaching with student i, indexed from 1 to $T_{j,i}$ writes :

$$q_{j,i} = \frac{1}{T_{j,i}} \sum_{t=1}^{T_{j,i}} q_{j,i,t} \tag{2.2}$$

Crucially, I assume the average hourly productivity to be strictly increasing in the number of hours T_j teacher j spends instructing her student i :

$$q_{j,i} = q_j(T_{j,i}), \text{ with } \frac{\delta q_{j,i}(T_{j,i})}{\delta T_{j,i}} > 0 \tag{2.3}$$

The intuition is that teachers acquire, over their hours of teaching, student-specific human capital which contributes positively to their average productivity. Several suggestive empirical evidence back this intuition. Duflo, Dupas and Kremer (2011) suggest teachers adjust the level at which they teach in response to changes in class composition. Herrmann and Rockoff (2012) find daily productivity losses from absence decline with the length of an absence spell, consistent with substitute teachers learning on the job. Therefore, I assume the longer teachers teach the student they are assigned to, the better they are at teaching them. This may be because they get to know and adjust to their students, and also have more time to implement a long-term instructional strategy.

I write total productivity $Q_{T_{j,i}}$ over hours of teaching indexed from 1 to $T_{j,i}$ as a function of hourly productivity :

$$Q_{T_{j,i}} = f_{T_{j,i}}(q_{j,i,1}, q_{j,i,2}, ..., q_{j,i,T_{j,i}}), \text{ where } j = \begin{cases} r \text{ if the regular teacher is teaching} \\ s \text{ if the substitute teacher } s \text{ is teaching} \end{cases} \tag{2.4}$$

From the student i perspective, the total number of planned hours of instruction T_i

writes :

$$T_i = T_{i,r} + T_{i,s} + T_{i,a} \tag{2.5}$$

where $T_{i,a}$ is the number of instruction hours lost by student i when her regular teacher is absent and no substitute teacher is assigned. I write $Y_{i,T}$, student i output over T, as a function g_T of the sum of regular teacher r and potential substitute teacher s respective productivity, lost instruction time $T_{i,a}$ and an idiosyncratic error ϵ_{i,T_i} (other inputs) :

$$Y_{i,T_i} = g_T(f_{T_{i,r}} + f_{T_{i,s}}, T_{i,a}, \epsilon_{i,T_i}) \tag{2.6}$$

Following the standard education production function framework (Todd and Wolpin, 2003), I assume $f_{T_{i,j}}$ and g_T to be additive and separable :

$$Y_{i,T_i} = T_{i,r} q_r(T_{i,r}).\alpha + T_{i,s} q_s(T_{i,s}).\beta + T_{i,a}.\gamma + \epsilon_{i,T_i} \tag{2.7}$$

Empirically, we observe two main different cases : 1) The regular teacher is absent and no substitute teacher is assigned ; 2) The regular teacher is absent and a substitute teacher is assigned.

Case 1. It corresponds to $T_{i,s} = 0$, $T_{i,a} > 0$ and $T_{i,r} = T_i - T_{i,a}$. The marginal effect of teacher absence writes :

$$\frac{\delta Y_{i,T_i}}{\delta T_{i,a}} = -\alpha[\underbrace{q_r(T_i - T_{i,a})}_{(a)} + \underbrace{\frac{\delta q_r(T_i - T_{i,a})}{\delta T_{i,a}}(T_i - T_{i,a})]}_{(b)} + \underbrace{\gamma}_{(c)} \tag{2.8}$$

Each term of this equation can be interpreted as follows :

- Term (a) : The more productive the regular teacher is, the greater the output loss from her absence
- Term (b) : It can be interpreted as the disruptive effect of the regular teacher absence. It is the additional student-specific human capital that teacher r would have acquired during her absence. Intuitively, teacher r absence give her less time to know her students and also creates discontinuities in her long-term instructional strategy.
- Term (c) : This is the variation in student output caused directly by the fact

that students do not have class during teacher r absence. Its sign can depend on the quality of the regular teacher and on whether the absence was expected. For example, if the absence was expected and the regular teacher is forward-looking, she can give them extra homework : they have material to study during her absence, which can mitigate the negative impact of her absence. The sign of this term can also depend on the quality of the school environment outside the classroom. More precisely, it can depend on the amount and the quality of adult supervision outside the classroom, in the school and its premises. For example, if students are left without sufficient adult supervision during the hours teacher r is absent, they can adopt negative non-cognitive behavior (bullying, fighting, smoking drugs etc.), which can exacerbate the negative impact of teacher absence.

Overall, in case 1, the marginal effect of teacher absence will be negative unless $\gamma > \alpha[q_r(T_i - T_{i,a}) + \frac{\delta q_r(T_i - T_{i,a})}{\delta T_{i,a}}(T_i - T_{i,a})]$, i.e. unless students use their lost instruction hours so efficiently that these hours are more productive than the instruction hours they would have had with their missing regular teacher.

Case 2. It corresponds to $T_{i,s} > 0$, $T_{i,a} = 0$ and $T_{i,r} = T_i - T_{i,s}$. The marginal effect of teacher absence writes :

$$\frac{\delta Y_{i,T_i}}{\delta T_{i,s}} = -\alpha[\underbrace{q_r(T_i - T_{i,s})}_{(d)} + \underbrace{\frac{\delta q_r(T_i - T_{i,s})}{\delta T_{i,s}}(T_i - T_{i,s})]}_{(e)} + \beta[\underbrace{q_s(T_{i,s})}_{(f)} + \underbrace{T_{i,s}\frac{\delta q_s(T_{i,s})}{\delta T_{i,s}}}_{(g)}] \quad (2.9)$$

The terms (d) and (e) have similar interpretations as (a) and (b) in case 1, the other terms can be interpreted as follows :

- Term (f) : The more productive the substitute teacher, the smaller the negative effect of teacher r absence
- Term (g) : This is the additional student-specific human capital acquired by the substitute teacher.

Overall, in case 2, the marginal effect of teacher absence will be negative if and only

if :

$$\alpha[q_r(T_i - T_{i,s}) + \frac{\delta q_r(T_i - T_{i,s})}{\delta T_{i,s}}(T_i - T_{i,s})] > \beta[q_s(T_{i,s}) + T_{i,s}\frac{\delta q_s(T_{i,s})}{\delta T_{i,s}}] \tag{2.10}$$

In particular, equation (2.10) will be verified when the regular teacher is of higher quality than the substitute teacher ($q_r > q_s$) and/or when the regular teacher acquire student-specific human capital faster than the substitute teacher ($\delta q_r/\delta T_{i,r} > \delta q_s/\delta T_{i,s}$).

Table 2.5 – Performance at the Certification Exam of the Contract Teachers who take it

	Contract Teachers Candidates		**Other Candidates**	
	Agreg.	CAPES	Agreg.	CAPES
A. Demographics				
Age (in years)	37.72	35.17	31.05	28.18
	(7.75)	(7.68)	(8.32)	(6.65)
Male	0.53	0.39	0.46	0.35
	(0.50)	(0.48)	(0.49)	(0.48)
B. Performance				
Passing Rate	0.03	0.16	0.15	0.33
	(0.18)	(0.37)	(0.36)	(0.47)
Written Part Grade (/20)	3.91	5.67	6.25	7.30
	(2.52)	(3.14)	(3.61)	(3.69)
Oral Part Grade (/20)	7.00	7.30	8.09	8.50
	(3.78)	(4.17)	(3.83)	(4.58)
Nb of obs	286	1,232	8,037	11,779

Note : Standard deviation in parenthesis. On average, the passing rate of contract teachers at the CAPES examination is 16 %. The average passing rate of other candidates is 33 %.

Table 2.6 – Regression Estimates of the Relationship between Absence/Replacement and Teacher Characteristics

	# Abs. Days		Share Replaced Days		Share Replaced x Contr.		Share Replaced x Tenured Sub.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Experience (Ref : 6 + years)								
One year or less of experience	-4.976***	-4.099	-0.043***	-0.056***	-0.012**	-0.014	-0.031***	-0.045***
	(1.255)	(2.479)	(0.008)	(0.016)	(0.005)	(0.009)	(0.006)	(0.011)
Two years of experience	-4.854***	-5.415***	-0.026***	-0.0382***	-0.008**	-0.017***	-0.018***	-0.020**
	(0.613)	(1.061)	(0.005)	(0.008)	(0.002)	(0.005)	(0.004)	(0.007)
Three years of experience	-3.475***	-4.059***	-0.019***	-0.025***	-0.005*	-0.011***	-0.013***	-0.0138**
	(0.455)	(0.658)	(0.004)	(0.006)	(0.002)	(0.003)	(0.003)	(0.005)
Four years of experience	-1.706***	-2.711***	-0.006*	-0.012**	-0.000	-0.006*	-0.006*	-0.007
	(0.377)	(0.532)	(0.003)	(0.004)	(0.002)	(0.003)	(0.002)	(0.004)
Five years of experience	0.637	-0.681	0.008**	0.000	0.007***	0.000	0.001	0.000
	(0.350)	(0.449)	(0.002)	(0.003)	(0.001)	(0.002)	(0.002)	(0.003)
Seniority (Ref. : 6 + years)								
One year of seniority	5.320	22.930	0.498**	0.649**	0.332	0.294	0.167	0.356
	(10.26)	(13.150)	(0.210)	(0.257)	(0.200)	(0.263)	(0.177)	(0.319)
Two years of seniority	3.084***	0.004	0.018***	0.004	0.007***	-0.002	0.012***	0.006*
	(0.268)	(0.437)	(0.001)	(0.003)	(0.001)	(0.002)	(0.001)	(0.003)
Three years of seniority	1.545***	1.001**	0.012***	0.0111***	0.005***	0.002	0.008***	0.009***
	(0.223)	(0.365)	(0.00171)	(0.002)	(0.000)	(0.001)	(0.001)	(0.002)
Four years of seniority	1.368***	1.112***	0.011***	0.0101***	0.005***	0.002	0.006***	0.007***
	(0.222)	(0.315)	(0.001)	(0.002)	(0.000)	(0.001)	(0.001)	(0.002)
Five years of seniority	0.695***	0.374	0.007***	0.004**	0.004***	0.001	0.003***	0.003
	(0.205)	(0.275)	(0.001)	(0.002)	(0.000)	(0.001)	(0.001)	(0.001)
Evaluations								
Classrom Obs. Eval.	-0.266***	0.0115	-0.001***	0.000	-0.000	-0.000	-0.000	0.000
	(0.0170)	(0.0371)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
School Principal Eval.	-0.532***	-0.222***	-0.004***	-0.002***	-0.001***	-0.000	-0.003***	-0.002**
	(0.065)	(0.075)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Student Composition								
Prop. of financial aid students	-0.492*	0.901*	-0.007***	0.002	0.003***	0.001	-0.009***	0.001
	(0.339)	(0.530)	(0.002)	(0.006)	(0.001)	(0.002)	(0.001)	(0.005)
Gender								
Male	-4.688***		-0.029***		-0.013***		-0.017***	
	(0.124)		(0.000)		(0.000)		(0.000)	
Certification Level (Ref : Capes)								
Agrégation	0.383		0.003		0.002*		0.001	
	(0.219)		(0.002)		(0.000)		(0.001)	
Teaching subject (Ref. : History)								
French	0.855***		-0.002*		0.002***		-0.003***	
	(0.158)		(0.001)		(0.0005)		(0.002)	
Math	-0.851***		-0.002**		0.007***		-0.010***	
	(0.144)		(0.001)		(0.000)		(0.000)	
Teacher - school fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Nb. of obs.	282,001	282,001	282,001	282,001	282,001	282,001	282,001	282,001

* Each column corresponds to a single regression. Results are reported in percentage of a standard deviation. All regressions include year fixed effects. Robust standard errors clustered by teacher-school.

Note : With teacher-school fixed effects, the relationship between the share of financial aid students assigned to a teacher and her share of replaced absent days is negative and statistically significant at the 1 % level.

Table 2.8 – Impact of Absence and Replacement by Type of Absence (Maternity leave vs. others) on Student Test Scores

N = 32,290,084 in % of a SD	# Days of Abs. (1)	# Replaced Days x Tenured Sub. (2)	# Replaced Days x Contract. Sub. (3)
Maternity Leave	-0.036***	0.015***	0.002
	(0.007)	(0.008)	(0.009)
	[53.67]	[21.67]	[12.14]
Non Maternity Leave	-0.056***	0.021***	-0.060*
(same length)	(0.007)	(0.008)	(0.030)
	[49.30]	[16.69]	[8.42]

Note : Estimates corresponds to a single regression with the preferred specification. Results are reported in percentage of a standard deviation of student test scores.

Table 2.7 – Robustness Effect of Teacher Absence Spells During Holidays on Student Test Scores in 9th Grade

in % of a SD	(1)	(2)
# days of holiday absence	0.029	0.027
	(0.035)	(0.024)
Teacher-School Fixed effect	No	Yes
Teacher experience & seniority*	No	Yes
Student background**	No	Yes
Number of observations	32,290,084	32,290,084

* Quadratic function of teacher experience and of teacher seniority. ** Student background : parents' occupation and financial aid status. Each column corresponds to a single regression. Results are reported in percentage of a standard deviation. All regressions include year x subject fixed effects. Robust standard errors clustered by school.

Table 2.9 – Robustness Check : Placebo Test of the Effect of Absence and Replaced Days of "Other subject" Teacher on Student Test Scores in 9th Grade

	Math Exam		French Exam		History Exam	
	(1)	(2)	(3)	(4)	(5)	(6)
A. Math Teacher						
# Days of Absence	-0.081***	-0.078***	-0.00	0.004	-0.009	-0.002
	(0.009)	(0.009)	(0.00)	(0.009)	(0.010)	(0.010)
# Replaced Days	0.001		-0.00		0.000	
	(0.001)		(0.00)		(0.000)	
# Replaced Days x Tenured Sub.		0.007		-0.007		-0.002
		(0.011)		(0.010)		(0.011)
# Replaced Days x Contract Sub.		-0.012		-0.004		0.003
		(0.011)		(0.010)		(0.011)
Math Teacher - School Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
B. French Teacher						
(with French Teacher -school fixed effects)						
# Days of Absence	-0.011	-0.007	-0.044***	-0.035***	-0.020	-0.016
	(0.007)	(0.007)	(0.007)	(0.005)	(0.013)	(0.10)
# Replaced Days	-0.002		0.013		0.013	
	(0.009)		(0.009)		(0.009)	
# Replaced Days x Tenured Sub.		0.004		0.016**		0.017
		(0.008)		(0.008)		(0.010)
# Replaced Days x Contract Sub.		-0.012		-0.005		0.007
		(0.010)		(0.010)		(0.010
French Teacher - School Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
C.History Teacher						
# Days of Absence	-0.004	-0.000	-0.005	-.001	-0.038***	- 0.035***
	(0.099)	(0.010)	(0.009)	(0.010)	(0.010)	(0.011)
# Replaced Days	-0.013		-0.003		0.013	
	(0.011)		(0.011)		(0.012)	
# Replaced Days x Tenured Sub.		-0.014		-0.001		0.013
		(0.011)		(0.011)		(0.013)
# Replaced Days x Contract Sub.		-0.025		-0.013		-0.002
		(0.020)		(0.011)		(0.014)
History Teacher - School Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes

Each column corresponds to a single regression. The dependent variable is student test scores in 9th grade. All regressions include subject fixed effects, year fixed effects, subject x year fixed effects. Robust standard errors clustered by school.
Notes : With the Math exam test scores as the dependent variable (panel A, columns 1 to 6)

Table 2.10 – Robustness Check : Placebo Test of the Effect of Absence and Replaced Days of Previous and Following Year on Student Test Scores in 9th Grade

	Previous year		Following year	
	(1)	(2)	(3)	(4)
# Days of Absence	0.004	0.003	0.002	0.000
	(0.019)	(0.020)	(0.013)	(0.013)
# Replaced Days	0.015		0.004	
	(0.023)		(0.018)	
# Replaced Days x Tenured Sub.		0.023		0.003
		(0.027)		(0.020)
# Replaced Days x Contract Sub.		0.008		0.018
		(0.029)		(0.027)
Teacher - school fixed effect	No	No	Yes	Yes
Teacher experience & seniority*	Yes	Yes	Yes	Yes
Classroom Fixed Effect	Yes	Yes	Yes	Yes
Number of observations	31,643,528	31,643,528	31,643,528	31,643,528

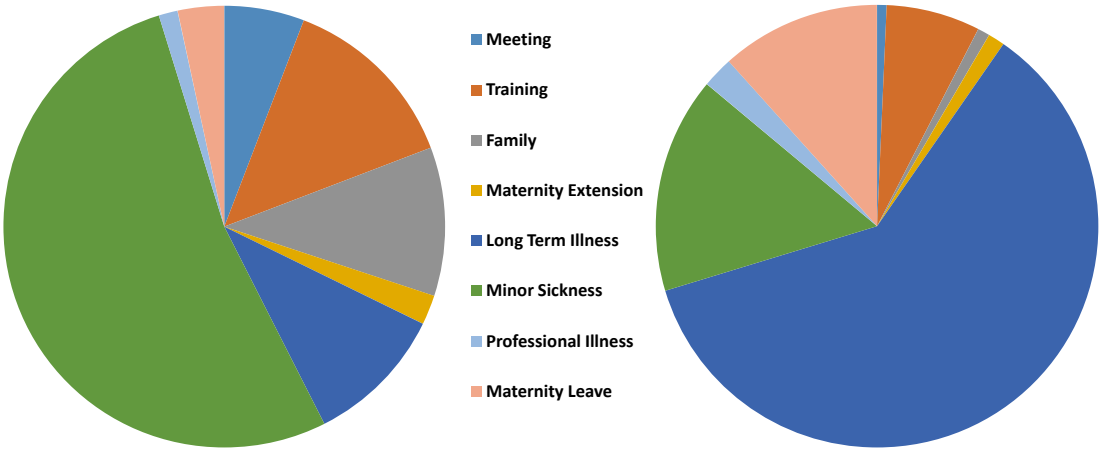
* Quadratic function of teacher experience and of teacher seniority. ** Student background : parents' occupation and financial aid status. Each column corresponds to a single regression. Results are reported in percentage of a standard deviation. The level of observation is teacher/topic x student x year. All regressions include year x subject fixed effects. Robust standard errors clustered by teacher-school. Robust standard errors clustered by school.

Notes : In columns 1 and 2, the number of days of absence, number of replaced days and number of replaced days with the two types of substitute teachers of the previous year are used as independent variables. Column 1 shows that the marginal impact of one additional day of absence and replacement of the teacher in the year $n-1$ does not have any statistically significant impact on her student test scores, assigned to her during the year n.

Figure 2.8 – Distribution of Absence Spells and Days per Type of Absence

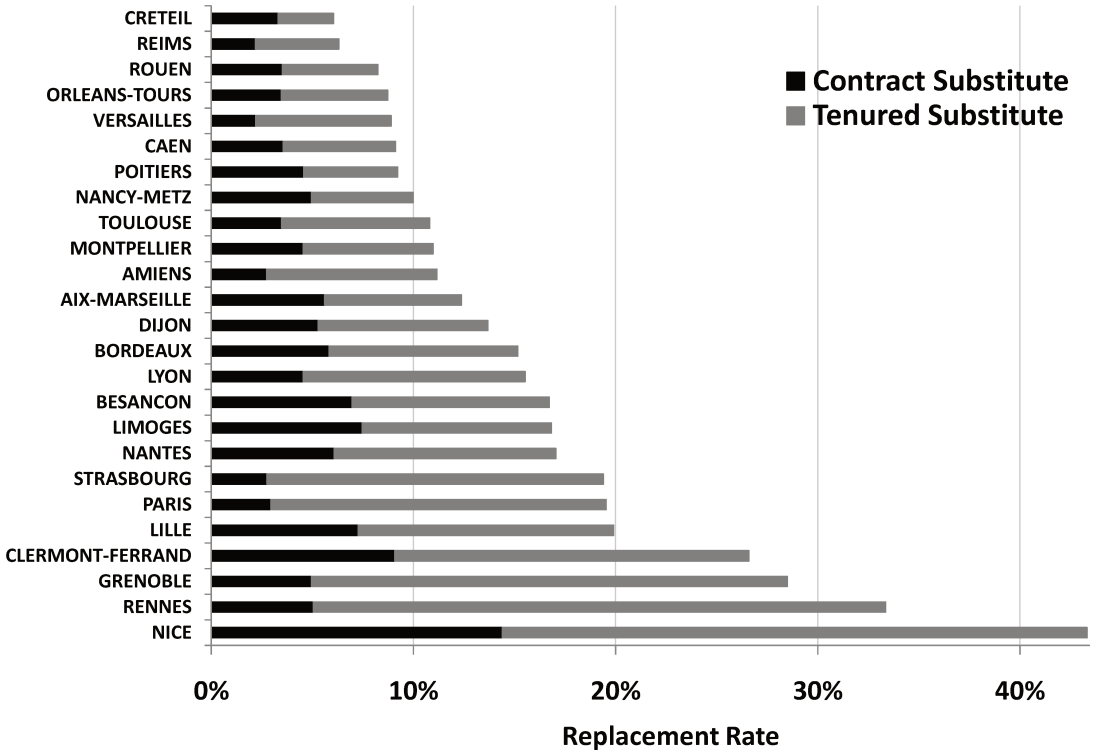
(a) Distribution of the Number of Absence Spells per Type of Absence

(b) Distribution of the Number of Absence Days per Type of Absence



Notes : Figure 2.8a plots the distribution of the number of absence spells (2006-2015) per type of absence. Absence spells for minor sickness account for 50 % of absence spells. Maternity leaves account for 3 % of absence spells. Figure 2.8b plots the distribution of the number of absence days per type of absence. Absences for minor sickness account for 16 % of the total of absence days per year. Maternity leaves account for 12 % of the total of absence days per year.

Figure 2.9 – Replacement Rate per Region



Notes : In the Creteil region (Eastern Parisian suburb), 6% of absence spells are replaced in 2015. 45 % of replacement spells are made by tenured substitute teachers in the Creteil region in 2015. In the Nice region (French Riviera), 44 % of absence spells are replaced in 2015. 70 % of replacement spells are made by tenured substitute teachers in the Nice region.

2.12 Data Appendix

Table 2.11 – Main Datasets

Name	Observation level	Period covered
OCC	teacher x assignment spell	2001 - 2015
CONG	teacher x absence spell	2001 - 2015
RELAIS	teacher x class x year	2004-2015
FAERE	student x year	2006-2015

The OCC and CONG datasets are raw administrative datasets which are not previously cleaned by the Statistical Department of the Ministry of Education. I do not use the cleaned version of these datasets because they are not exhaustive :

1. The cleaned version of the OCC datasets does not include all teacher assignment spells but only the assignment spells which are ongoing at the time of the extraction by the Statistical Department (in December of each year). This is highly problematic for the purpose of this study because I need to observe all teacher assignments through the school year in order to know, for each absence spell, whether a substitute teacher has been assigned, and the identity of this substitute teacher.
2. The cleaned version of the CONG datasets does not include all teacher absence spells but only absence for heath reasons : minor sickness, maternity leave, long term illness and professional illness. This is highly problematic because, as shown in figure 2.8b, non health related absences (meetings, training, family) represent around 30 % of absence spells.

Chapitre 3

Stay a Little Longer ? Teacher Turnover, Retention and Quality in Disadvantaged Schools

Using French administrative data on secondary school teachers, we analyze a non-pecuniary, "career-path oriented" centralized incentive scheme designed to attract and retain teachers in French disadvantaged schools. We rely on a major reform of the structure of this incentive scheme to identify its effect on teacher turnover, retention, and quality in disadvantaged schools. We find this incentive scheme has a statistically significant positive effect on the number of consecutive years teachers stay in disadvantaged schools and decreases the probability of inexperienced teachers in disadvantaged schools to leave the profession. However, we find no statistically significant effect on the teacher experience gap nor the student achievement gap between disadvantaged and non disadvantaged schools.

Keywords : teachers, teacher mobility, teacher retention, educational inequalities, education prioritaire. JEL : I21, I22, J20.

3.1 Introduction

In many countries, disadvantaged students are more likely to be assigned to lower quality teachers (OECD, 2005). In the United States for example, disadvantaged students are 10 percent more likely to be taught by teachers in the bottom 10 percent of the

teacher quality distribution than non disadvantaged students (Goldhaber et al., 2015). The magnitude of this teacher quality gap in the US is equivalent to 20 percent of the student achievement gap (Darling-Hammond, 2015). There is a large literature showing that teacher quality matters for student outcomes (Rockoff, 2004 ; Chetty et al., 2014). Reducing the teacher quality gap is therefore a major policy issue in order to provide more equal educational opportunity.

There are very few papers analysing policies aiming at reducing the teacher quality gap. The main type of policies studied are financial bonus schemes for teachers working in disadvantaged schools. This literature remains inconclusive (Clotfelter et al., 2008 ; Prost, 2013). Furthermore, there is strong evidence showing that teachers do care about non-pecuniary factors (Hanushek et al., 2004).

This paper analyzes a "career-path oriented" centralized incentive scheme designed to reduce the teacher quality gap between disadvantaged and non-disadvanged public middle schools in France. To our best knowledge, there is no existing empirical evidence on the impact of teachers' non-pecuniary incentives on the teacher quality gap.

In France, teachers are assigned according to a centralized point-based assignment system. Teachers submit a ranked-ordered list of choices and are assigned according to a modified version of the deferred acceptance mechanism. The main assignment criteria are i) experience, defined as the number of years since entering the teaching profession ; ii) seniority, defined as the number of consecutive years spent in the current school ; iii) seniority in the same disadvantaged school.

This paper evaluates the last criteria : how effective is the disadvantaged school seniority bonus at attracting and retaining quality teachers in disadvantaged schools ? What is its effect on the student achievement gap in middle school ? In order to assess this scheme, we exploit a major reform in 2005 which changed i) the set of disadvantaged schools benefiting from this extra seniority bonus ; ii) the structure of this bonus. This change in structure aims at giving teachers the incentives to stay at least five consecutive years in the same disadvantaged school, instead of three consecutive years before the reform. This paper relies on comprehensive administrative data on middle school teachers and students from 2002 to 2014 to perform a difference-in-difference comparing the evolution of the disadvantaged schools receiving the bonus to the other schools before/after the 2005 reform. Disadvantaged schools benefitting from extra seniority points before the

reform are part of the Zone d'Education Prioritaire, violent schools or sensitive schools programs (19 % of middle schools), hereafter called ZEP schools for simplicity. Disadvantaged schools benefiting from extra seniority points (13 % of middle schools) after the reform are called Affectation prioritaire a valoriser, hereafter APV. We analyze the impact of the 2005 reform on several outcomes at the school level : teacher turnover, measured by teacher mobility rate and seniority ; teacher quality, measured by teacher experience ; student achievement, measured by their test scores at the national standardized exam Diplome national du brevet (DNB) taken in 9th grade.

We find that the reform has a positive impact on teacher seniority in APV schools. The reform provokes a progressive decrease in the seniority gap between APV and non-APV schools reaching 20 % (0.3 years) at the end of the period. We also find that the reform decreases the probability of inexperienced teachers (i.e. with less than 10 years of teaching experience) in APV school to leave the teaching profession. Finally, we find that the reform has no statistically significant impact on the quality of teachers moving to APV schools, as measured by their number of years of experience, nor on the student achievement gap between APV and non-APV schools.

3.2 Institutional Setting

We present the main features of the French educational system as well as the 2005 reform of the disadvantaged school mobility bonus.

3.2.1 Overview of the French Educational System

The public French educational system is highly centralized. Contrary to the United States for example, schools have little autonomy and school principals cannot hire nor fire their teachers. The French territory is composed of 25 large administrative school districts, called academies (hereafter regions). Secondary school teachers are selected through a subject-specific national competitive examination, which is demanding academically and has low passing rates (between 15 and 30 %). There are two main certification levels : basic, called CAPES (Certificat d'aptitude au professorat de l'enseignement du second degre) and advanced, called Agregation. Conditional on passing this examination, teachers become civil servants managed by their region.

Teachers's salary is set through a national wage scale based on teachers' number of years of experience and certification level (none, basic and advanced). For example, the gross wage of a teacher with the basic certification level and a year of experience is approximately 2,000 euros per month. Contrary to other countries such as the United States for example, wages do not vary across schools.

Teachers can however receive a small financial compensation for teaching in the disadvantaged schools that are part of the Zone d'education prioritaire (ZEP) program (Prost, 2013). The ZEP program, established in 1982, is a compensatory education policy giving additional resources (smaller class size, etc.) to a selected set of disadvantaged schools. ZEP schools are selected by the central government according to the socioeconomic background of their students. The ZEP financial compensation was introduced in 1990 at 300 euros per year, and was continuously increased to reach 1,156 euros per year in 2010.

Secondary school teachers are subject-specific : each subject is taught by a different teacher. In middle school (from grade 6 to grade 9), students are not tracked by major nor ability. Contrary to many countries such as the United States where students' peers depend on the teaching subject, in France, students stay in the same class, with the same peers throughout the school year and in every subject. At the end of 9th grade, students take a national and externally graded examination called Diplome national du Brevet in three topics : French, Math and History.

3.2.2 Certified Teacher Assignment and the 2005 Reform

Certified Secondary School Teacher Assignment. In many countries such as the United States for example, teachers are hired directly by schools. In France, secondary school certified teachers are assigned via a centralized point-based system (called SIAM, Systeme d'information et d'aide aux mutations) with two rounds : the inter-regional round and the regional round. Candidates submit a rank-ordered list of choices and are assigned according to a modified version of the school-proposing Deferred Acceptance mechanism (Combes, Tercieux and Terrier, 2017). Every year, i) new teachers and tenured teachers who want to change region apply to the inter-regional mobility round ; ii) participants of the inter-regional mobility round, and tenured teachers who want to change school within their region, apply to the intra-regional mobility round.

Both at the inter and intra regional level, the main assignment criterias are teacher

experience (defined as the number of years since entering the teaching profession), seniority (defined as the number of consecutive years spent teaching in the same school) and seniority in a disadvantaged school.

The 2005 Reform. This reform changed the set of schools benefitting from the extra seniority bonus. Before 2005, all the schools labelled ZEP benefitted from the additional seniority bonus. After 2005, a new list of schools, labelled APV (Affectation Prioritaire justifiant une Valorisation schools) was established. APV schools were selected based on their lack of attractivity as measured by their teacher turnover rate . The set of APV schools did not change after 2005. As shown in Table 3.1, most of ZEP schools became APV schools. However, many ZEP schools did not become APV schools. Therefore, we create four distinct groups of schools :

- non ZEP and non APV schools (3,920 schools) : the status of these schools did not change throughout the period
- ZEP and non APV schools (392 schools) : these schools benefitted from the disadvantaged school seniority bonus before the reform but not after the reform
- non ZEP an APV schools (140 schools) : these schools did not benefit from the disadvantanged school seniority bonus before the reform but benefitted from it after the reform
- ZEP and APV schools (572 schools) : the status of these schools did not change throughout the period

The 2005 reform also changed the structure of the seniority bonus. Before the 2005 reform, certified teachers got 10 points per year of seniority and 25 additional points every five years (table 3.3). This seniority bonus does not depend on the status of the school (ZEP school or not). Teachers assigned to ZEP schools got additional seniority points depending on their number of years of seniority : 50 additional points for 3 years of seniority ; 65 points for four years ; 85 points for five years or more.

After the 2005 reform, the structure of the standard seniority bonus changed. Teachers still get 10 points every year but now they get the additional 25 points every four years instead of every five years. The structure of the disadvantaged school seniority bonus also changed. The seniority bonuses at three and four years of seniority were suppressed. Teachers in APV schools get 300 additional points if they have five to seven years of seniority, and 400 points if they have 8 years or more of seniority.

Figure 3.1 plots the value of the seniority bonus by number of years of seniority, depending on the status of the school and the period (before or after the 2005 reform). The reform has a major impact on the disadvantaged school seniority bonus. For example, before the reform, a certified teacher with five years of seniority in a ZEP school got $4 \times 10 + 85 + 25 = 160$ points. After the reform, a similar teacher with five years of seniority in an APV school gets $4 \times 10 + 25 + 300 = 375$ points.

The population affected by the reform is composed of teachers assigned to APV schools from the 2005 onwards but also of teachers who were assigned to ZEP schools before the reform. A transitory bonus scale was implemented after the reform for teachers who were assigned to ZEP schools. Table 3.2 shows the transitory scale for the disadvantaged school seniority bonus. It distinguishes between two types of ZEP schools : ZEP schools which did not become APV, i.e. schools which stopped benefitting from the extra seniority bonus after 2005, and ZEP schools that became APV, i.e. schools which continued to benefit from the bonus after 2005. In both type of schools, the population benefitting from the transitory scale are teachers assigned to ZEP schools before the 2005 reform. In ZEP & APV schools, the transitory scale was implemented only in 2005 whereas in ZEP non APV schools, it was implemented in 2005, 2006 and 2007.

The main motivation of this reform, as stated by the Ministry of Education, is to make APV schools more attractive for teachers and to reduce teacher turnover. More specifically, the objective is "to give teachers the incentive to be commited to their assigned APV schools for at least five years ".

3.3 Data and Descriptive Evidence

In this section, we briefly present the main characteristics of the data as well descriptive evidence on the impact of the reform on teacher mobility, seniority and experience in disadvantaged schools.

3.3.1 Data

This paper relies on comprehensive administrative panel data on teachers, middle schools and students from the French Ministry of Education :

- Data on teachers and their assignments (2001 - 2014) : this datasets provide in-

dividual information on teacher such as their national identifier, their year of assignment, their type of assignment (permanent vs. temporary), school identifier, classroom identifier, number of years of experience, teaching subject

- Data on public secondary schools (2001 - 2014) : national identifier, classification (ZEP, violent, sensitive), type (middle vs. high schools)
- Secondary school students (2004 - 2014) : encrypted identifier, socio-demographic characteristics (financial aid status, profession of both parents), classroom identifier, test scores at the national and externally graded examination taken in 9th grade (Diplome national du Brevet)

We did not have access to the dataset from the Ministry of Education listing APV schools. Thus, we constructed the list of APV schools from the publicly available administrative documents on the regions' official websites.

We are able to match each individual teacher to all her students thanks to the school and classroom identifiers. Our sample focuses on teachers with a permanent assignment (78 % of observations) because temporary teachers are reassigned every year and do not benefit from the APV bonus. We also focus on public middle schools because there are almost no APV high schools.

We define the following outcome variables :

- teacher number of years of seniority : number of consecutive years a teacher teaches in the same school ;
- teacher mobility rate : proportion of teachers leaving their current school for another schools. This mobility rate does not include teachers who are leaving the teaching profession
- teacher exit rate : proportion of teachers who interrupt their teacher career, temporarily (being on a long sabbatical) or permanently (quitting or retiring) . We use the share of teachers who leave the teacher database as a proxy [1]. Each year, between three and six percent of teachers leave the teaching profession (Figure 3.15). This exit rate can have many causes that we do not observe directly in the data. We have however access to individual teacher retirement data, from 2007 to 2013. We observe that over this period, teachers in non disasvantaged schools are more

1. As we are using comprehensive administrative datasets, the probability of data collection related attrition is negligible

likely to retire than other teachers, which is consistent with the difference in the teacher experience structure between these two types of schools (Figure 3.13). In 2007 for example, almost 5% of teachers in non APV and non ZEP schools retired, against around 2% in APV and ZEP schools. This numbers are consistent with the descriptive statistics from the Ministry of Education (DEPP, 2014). This suggests that, in non APV – non ZEP schools, over the 2007-2013, more than 85 % of exits are due to retirement against less than 50 % in APV and ZEP schools.

Given the objectives of the APV program, we would like to know whether it provides big enough incentives to deter teachers from quitting the teaching profession. An established result in the literature in that inexperienced teachers in disadvantaged schools are the population the most at risk of quitting (Boyd et al., 2008 ; Allen et al. 2015). This is why we focus the exit rate analysis to inexperienced teachers, for which the main cause of the exit rate is most likely to be quitting rather than retiring. To find the specific experience threshold, we plot the retirement rate by number of years of experience (Figure 3.14) and we observe than teachers with less than 10 years of experience have a probability close to zero. In the remaining of the paper, we therefore define inexperienced teachers as having less than ten years of teaching experience.

- teacher experience : number of years since the teacher entered the teaching profession

3.3.2 Descriptive Evidence

We provide descriptive evidence on the evolution of teacher mobility, seniority and experience in the different groups of schools from 2002 to 2015.

Evolution of the Outcome Variables per Year. We first analyse the evolution of the average teacher mobility rate by school year from 2002 to 2014 (Figure 3.2). The mobility rate is much lower in non disadvantaged schools (non ZEP - non APV schools) than in disadvantaged schools throught the period. The teacher mobility rate in non disadvantaged schools is around 5 % throughout the period against around 10 % in APV and ZEP schools. Yet, we do not observe any impact of the reform on the mobility rate of the different categories of schools.

We now turn to the evolution of the average exit rate of inexperienced teachers (Figure

3.3). Overall, the exit rate is slightly lower for inexperienced teachers in non disadvantaged schools (non ZEP - non APV schools) than in disadvantaged schools, especially APV-ZEP schools before the reform. This graph seems to suggest that the reform has a negative impact on the exit rate gap between APV and non APV schools, even though it does not provide clear causal evidence.

There are also major variations in teacher seniority and experience across the different groups of schools (Figure 3.4 and Figure 3.5). Teachers in schools both labelled APV and ZEP have on average, around 8 years of seniority. Teachers in non ZEP - APV schools have around 9 years of seniority in the begining of the period. However, starting from 2009, their average level of seniority decreases to 8 years, converging with the level of seniority of teachers in ZEP-APV schools. Teachers in non- disadvantaged schools (non ZEP - non APV) have on average around 2 more years of seniority, around 10 years of seniority. Regarding teaching experience, we observe a large gap between disadvantaged schools (APV- ZEP, or non ZEP - APV) and non disadvantaged schools (non ZEP - non APV schools).

Mobility Rate by Number of Years of Seniority. We analyse teacher mobility by number of years of seniority. We distinguish four periods : i) before the reform : 2002 - 2004 (Figure 3.6) ; ii) year of the reform : 2005 (Figure 3.7) ; iii) transition years : 2006-2007 (Figure 3.8) ; iv) after the reform : 2008-2014 (Figure 3.9). Vertical lines correspond to seniority bonuses : black lines indicate seniority bonuses that apply to all types of schools ; red lines indicate bonuses that apply to ZEP schools before 2005, and to APV schools after 2005.

Before the reform (2002 - 2004), we observe a spike in the mobility rate at 5 years of seniority for all types of schools. This spike corresponds to the additional 25 seniority bonus when teachers reach five years of seniority. For non ZEP- APV schools, the mobility rate goes from 10 % at four years of seniority to 24 % at five years of seniority. Interestingly, this is larger than the spike for ZEP schools, which benefit from the extra bonus at 5 years of seniority (whereas non ZEP - APV schools do not).

In ZEP - APV schools, the mobility rate increases from 3 years of seniority, when teachers get the 50 points seniority bonus : the mobility rate goes from 8 % at 2 years of seniority to almost 16 % at 3 years of seniority. This mobility rate remains constant at 4 years of seniority, when teachers benefit from a 65 points seniority bonus. Finally, it

increases slightly at 5 years of seniority to around 18 %.

The year of the reform (2005), both teachers already in ZEP - APV schools and teachers already in ZEP - non APV schools benefit from a transitory bonus scale (see table 3.2). Additionally, teachers moving to APV schools benefit from the new scale, i.e. from the 300 points bonus at 5 years of seniority. In ZEP- non APV schools, mobility rate levels at 3,4, and 5 years of seniority remain comparable to those before the reform, i.e. between 8 and 12 %. In ZEP - APV schools, the 5 years spike does not seem to be affected by the reform, and is constant around 16 %. However, mobility rate levels at 3 and 4 years of seniority have fallen sharply compared to before the reform : from around 16 % before to around 9 % after the reform.

During the transition years (2006-2007), ZEP - APV schools do not benefit from the transitory bonus scale anymore (see table 3.2). However, ZEP - non APV schools still benefit from the transitory bonus scale. In ZEP - non APV schools, there is no spike at 5 years of seniority anymore. From the second year of seniority to the fifth year, the mobility rate is constant around 8 %. In ZEP and APV schools, the structure of the mobility rate by seniority is similar to the transition period.

After the end of the transition period (2008-2014), we observe that the structure of the mobility in ZEP - non APV schools and in non ZEP- non APV schools is now extremely similar. There is no spike at five years of seniority for both types of schools, but small spikes every four years, corresponding to the additional 25 points all schools get every four years. The structure of the mobility in non ZEP - APV schools and in ZEP- APV schools is also now very similar. In both types of schools, there is a big spike in mobility at five years, and a smaller spike at 8 years, corresponding to the extra seniority bonuses these schools get.

Overall, this descriptive analysis of the evolution of the mobility rate by seniority provides strong evidence of the impact of the 2005 reform on the structure of teacher mobility. Whatever the status of the school, we observe that the evolution of the structure of teacher mobility is closely correlated with the structure of the disadvantaged school seniority bonus.

Quality Gap between Previous School and New School for Movers. We then investigate the relationship between the 2005 reform and movers' new schools. The reform considerably increased the APV bonus at five years of seniority, going from 85 points to

300 points. This raises the question : does this 70 % increase in the APV bonus changed the type of schools teachers move to ? After the reform, do teachers with five years of seniority move to considerably better schools ? To answer these questions, I plot, for movers, the quality gap between their previous school and the school they move to, by movers' number of years of seniority when they move. I use the average standardised test scores of 9th grade students over the period as a proxy for school quality. Figure 3.12 plots the average 9th grade test scores gap for movers between the school they leave and the school they join (hereafter called the school quality gap), by number of years of seniority when they move. First, it shows that the school quality gap is much larger for APV schools than for non-APV schools. At one year of seniority for example, the school quality gap is close to zero in non-APV schools whereas it is equal to 0.8 SD in APV schools. Second, the reform does not seem to have a large impact on the school quality gap for APV movers. However, the reforms seems to have slightly changed the structure of the school quality gap in the first five years of seniority. Before the reform, for APV movers, the school quality gap starts to increase from the third year of seniority, whereas it starts to increase only from the fourth year after the reform. This suggests that before the reform, the 50 points APV bonus at three years of seniority is already enough to give APV teachers access to slightly better schools. Surprisingly however, the big increase in the 5 years of seniority APV bonus does not seem to translate into a higher school quality gap, as this gap is very similar before and after the reform. This may be because the reform did not change the type of schools APV movers apply to. Lastly, we do not observe any impact of the reform on the school quality gap in non APV schools, suggesting that no negative spillovers are taking place.

Exit Rate of Inexperienced Teachers by Number of Years of Seniority. Finally, we turn to the analysis of the exit rate of inexperienced teachers (i.e. teachers with less than ten years of experience). We distinguish two periods : before and after the 2005 reform. We mainly observe that the exit rate decreases faster with seniority after the reform than before, especially in APV schools. For example, both before and after the reform, the exit rate of inexperienced teachers after one year of seniority in an APV-ZEP school is equal to 4 %. Before the reform, the exit rate at 4 years of seniority is also equal to 4 % in APV-ZEP schools, against 2.5 % in those schools. Furthermore, we also observe that the exit rate gap between APV and non APV schools is smaller after the reform than

before, whatever the level of seniority. Overall, this descriptive analysis suggests that the reform is correlated with a decrease in the exit rate gap between APV and non-APV schools.

3.4 Empirical Strategy

Our aim is to assess the impact of the 2005 reform on teacher mobility, exit, seniority, experience, and student achievement. The first basic intuition of the empirical strategy is to implement a difference-in-differences and to compare the evolution of APV schools to the evolution of non APV schools before and after the 2005 reform.

A difficulty is that the 2005 reform is likely to have different short-run and long-run effects because of the stock-flow dynamics. For example, ex ante, the impact of the 2005 reform on teacher seniority is ambiguous. In the short run, the average seniority of teachers in APV schools is likely to decrease because of a transitory "opportunity effect" for teachers who were assigned to APV schools before 2005. These teachers have strong incentives to leave because they now benefit both from the new bonus scale and the transitory scale. In the long run, this "opportunity effect" fades out as teachers already in APV schools in 2005 leave and the transitory bonus scale expires. To benefit from the new bonus, teachers who entered APV in 2005 have to accumulate at least five years of seniority in the same APV school. Before the reform, they had to accumulate at three years of seniority. Thus, the reform will start to have an impact the entering teachers three years after its implementation, i.e. in 2008. From 2008 onwards, the reform can have several potentially competing effects :

- it replaces the incentives to exit at 3 or 4 years of seniority by strong incentives to stay at least five years. Therefore, it can have a positive effect on the average number of years of seniority in APV schools
- the reform marginally increases the incentives to stay 5 to 8 years in the same APV school. Therefore, it can also have a positive impact on the average seniority in APV schools
- the reform decreases the incentives to stay more than 8 years. Thus, it can a negative impact on the average seniority in APV schools.

Because of these complex and competing dynamic effects of the reform, the stan-

dard difference-in-differences approach may yield misleading results : as shown by Wolfers (2006), the standard difference-in-differences estimates confound these complex dynamics with panel-specific trends. We follow Wolfers (2006) dynamic difference-in-differences specification which imposes very little structure on the response dynamics, including dummy variables for the first two years, for the next years, and so on. These dummy variables allow a time variable to identify preexisting trends. Thus, we estimate the following specification :

$$y_{j,apv,t} = \sum_t \alpha_t.1_t + \delta_{apv}.1_{apv} + \sum_{t \geq 2005} \beta_{apv,t}(1_{apv}.1_t) + \gamma 1_{apv}.year + \epsilon_{j,apv,t}$$

where :

- $y_{j,apv,t}$: average outcome variable in school j, school category apv and year t
- 1_t : year dummy
- 1_{apv} : APV dummy

We focus on the following outcomes at the school-year level : average number of years of seniority, exit rate, number of years of experience, and standardized student test scores. Standard errors are robust and clustered by school.

3.5 Results

Impact on Teacher Seniority. We start by analysing the impact of the reform in teacher seniority. Table 3.4 shows the impact of the 2005 reform on teachers' number of years of seniority in APV schools. Each column corresponds to a single regresssion. We also control for the ZEP status of the schools. The first column reports the impact of the reform on the average teacher seniority gap between APV and non-APV schools. To analyse more closely the dynamic impact of the reform, columns 2 to 5 show the impact of the reform on the share of teachers with i) less than three years of seniority (column 2) ; ii) between 4 and 5 years of seniority (column 3) ; iii) between 6 and 8 years of seniority (column 4) ; iv) 8 years of seniority or more (column 5). We observe that, on average, before the reform, the seniority gap between teachers in APV schools and others is equal to 1.42 year (column 1). In its first two years, the reform has a negative impact on the average teacher seniority in APV schools, which is consistent with an "opportunity effect"

for teachers who were already in APV schools before the reform. The reform starts to have a positive impact from year 3. This positive impact becomes statistically significant from year 5. At the end of the period, the average seniority gap between APV and non APV schools is reduced by 0.26 year compared to before the reform. In other words, the pre-reform seniority gap between APV and non APV schools is reduced by 18 % at the end of the period. This decrease in the seniority gap is driven by an decrease in the share of teachers with less than three years of seniority (column 2) and an increase in the share of teachers with a number of years of seniority between 4 and 8 years. This positive impact of the reform on seniority is mitigated by its negative impact on the share of teachers with 8 years or more of seniority (column 5).

Impact on Teacher Mobility Rate. We turn to the impact of the reform of teacher mobility rate in APV schools. On average, before the reform, the mobility rate is 4 percentage points higher in APV schools than in other schools (Table 3.5). As expected, the reform increased the mobility rate of teachers with 5 years of seniority (column 3) and decreased the mobility rate of teachers with less than 5 years of seniority.

Impact on Teacher Exit Rate. We then focus on the impact on the reform on the exit rate of inexperienced teachers (i.e. with less than 10 years of experience). First, as suggested by the descriptive analysis, the baseline exit rate in APV schools is higher than in non APV schools : on average, before the reform, the exit rate of inexperienced teachers in APV schools is 0.8 percentage points higher than in other schools (Table 3.8). The reform starts to have a statistically significant negative impact on the exit rate gap from years 5- 6, i.e. when the first cohort reaches five years of seniority. At the end of the period, it seems that the reform closed the exit rate gap as it has decreased by 0.8 percentage points.

Impact on Teacher Experience. On average, before the reform, the experience gap between APV and non APV schools is equal to 2.78 years (table 3.7). We observe a decrease in teacher experience in the first four years of the reform, which is likely due to the "opportunity effect" of experienced teachers taking advantage of the reform to leave disadvantaged schools. Overall, the reform does not have a statistically significant long term impact on the average teacher experience in APV schools (column 1). However, it seems to have a negative impact on the average experience of entering and exiting teachers at the end of the period. This suggests that the reform is likely to have attracted

less experienced teachers, i.e. those who need the APV bonus the most, in APV schools.

Impact on Student Test scores. Finally, we analyse the impact of the reform on the student test score gap. On average, before the reform, the student test scores gap between APV and non APV schools is equal to 15 %. Overall, the reform does not have any statistically significant impact on the student test scores gap between APV and non APV schools.

This result has several possible interpretations. It may be because the positive impact of the reform on teacher seniority is too small to have any statistically significant consequence on student achievement. It may also be that the effect on seniority is mitigated by the negative impact of the reform on the quality of teachers entering APV schools. This mechanism would be consistent with a decrease in the experience of teachers entering APV schools at the end of the period.

3.6 Conclusion

Most of the literature on teacher retention policies focuses on financial incentive schemes and remains unconclusive. The present paper shifts the focus from financial to non-pecuniary, career-oriented incentives. We analyse the impact of the disadvantaged seniority bonus giving teachers in disadvantaged schools an extra mobility bonus once they reach a certain level of seniority. We exploit as a natural experiment the 2005 reform which both changed the set of disadvantaged schools benefitting from this extra seniority bonus and the structure of this bonus.

We find that the reform has a positive impact on teacher seniority in APV schools. The reform provokes a progressive decrease in the seniority gap between APV and non-APV schools up to 20 % (0.44 years). We also find that the reform decreases the probability of inexperienced teachers (i.e. with less than 10 years of teaching experience) in APV school to leave the teaching profession. Finally, we find that the reform has no statistically significant impact on the quality of teachers moving to APV schools, as measured by their number of years of experience, nor on the student achievement gap between APV and non-APV schools.

Further research. Further research will explore the underlying mechanisms underpining these results. First, we will try to understand why the average increase in teacher

seniority in APV schools does not have any statistical significant impact on the average student achievement gap between APV and non-APV schools. A possible interpretation is that the reform attracted lower quality teachers into APV schools. We will therefore measure the evolution over time of the fixed effect of teachers entering APV schools.

Second, we will analyse the impact of the reform on teacher mobility applications. Does the reform make APV schools more attractive ? We will therefore exploit data on teacher applications to analyse the impact of the reform on the number of applications to APV schools and on the characteristics of the applicants. This can also help us understand the impact of the reform on inexperienced teachers exits from the teaching profession as the reform may have given better school options to those vulnerable teachers.

3.7 References

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3.8 Tables and Figures

Figure 3.1 – Number of Seniority Points per Number of Years of Seniority

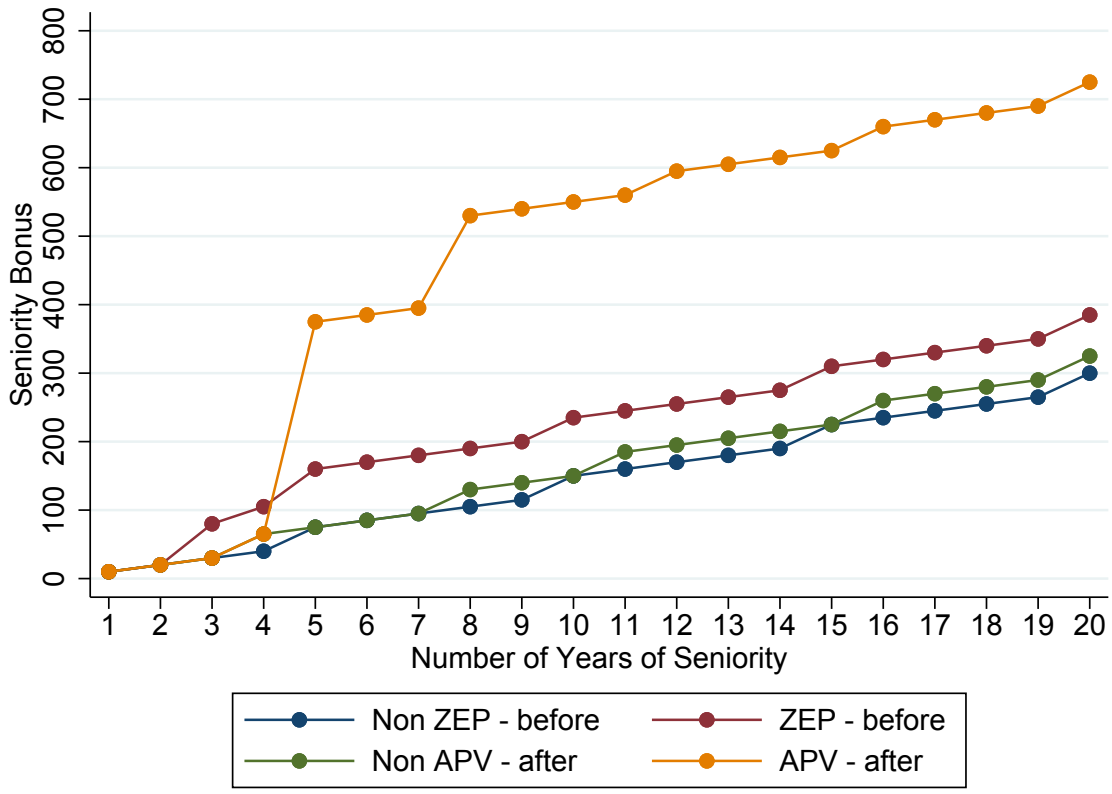


Table 3.1 – Correlation Table between ZEP schools and APV schools

	APV schools	**Non APV schools**	**Total**
ZEP schools	572	392	964
Non ZEP schools	140	3,920	4,060
Total	712	4,312	5,024

Table 3.2 – Transitory Bonus Scale

	ZEP & APV	**ZEP non APV**
Years of transition	2005	2005, 2006, 2007
Population	Teachers assigned before 2005	
Transitory scale	1 or 2 yrs : 30 pts 3 yrs : 65 pts 4 yrs : 80 pts 5 yrs or more : 100 pts	

Table 3.3 – Teacher Assignment Bonus Scale

	Before the 2005 Reform	**After the 2005 Reform**
Experience	First three years : 21 pts + 7 pts/year from the 4th year	
Seniority	10 pts/yrs + 25 pts/ five yrs	10 pts/yrs + 25 pts / four yrs
Seniority in disadvantaged schools	3 yrs : 50 pts 4 yrs : 65 pts 5 yrs or more : 85 pts	5 to 7 yrs : 300 pts 8 yrs or more : 400 pts

Table 3.4 – Impact of the 2005 Reform on Teachers Number of Years of Seniority in APV Schools (2002 - 2015)

	Average Seniority	Share with Seniority...			
		$\leq$ 3 yrs	4 - 5 yrs	6 - 8 yrs	8 yrs or +
	(1)	(2)	(3)	(4)	(5)
APV	-1.42***	0.07***	0.01**	0.00	-0.08***
	(0.15)	(0.00)	(0.00)	(0.00)	(0.00)
ZEP	-0.65***	0.04***	0.01**	-0.01*	-0.04***
	(0.13)	(0.00)	(0.00)	(0.00)	(0.00)
APV x Years 1 - 2	-0.21*	0.03***	0.02**	-0.04***	-0.00
	(0.12)	(0.01)	(0.00)	(0.01)	(0.00)
x Years 3 - 4	0.04	0.00	0.03***	-0.02**	-0.02***
	(0.14)	(0.01)	(0.00)	(0.00)	(0.00)
x Years 5 - 6	0.24*	-0.02*	0.05***	-0.00	-0.02**
	(0.14)	(0.00)	(0.00)	(0.00)	(0.00
x Years 7 - 8	0.31**	-0.02***	0.03***	0.01*	-0.02**
	(0.15)	(0.00)	(0.00)	(0.00)	(0.00)
x Years 9 - 10	0.26*	-0.02*	0.02***	0.01*	-0.02**
	(0.16)	(0.00)	(0.00)	(0.00)	(0.01)
ZEP x Years 1 - 2	-0.06	-0.00	0.00	0.00	-0.00
	(0.11)	(0.00)	(0.00)	(0.00)	(0.00)
x Years 3 - 4	-0.10	-0.00	0.01*	0.00	-0.00
	(0.12)	(0.00)	(0.00)	(0.00)	(0.00)
x Years 5 - 6	0.00	-0.01**	0.00	0.01**	-0.00
	(0.13)	(0.00)	(0.00)	(0.00)	(0.00)
x Years 7 - 8	0.19	-0.02**	-0.00	0.02***	0.01
	(0.14)	(0.00)	(0.00)	(0.00)	(0.01)
x Years 9 - 10	0.15	-0.01	-0.00	0.00	0.01
	(0.14)	(0.01)	(0.00)	(0.00)	(0.01)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes
APV pre-trend	Yes	Yes	Yes	Yes	Yes
ZEP pre-trend	Yes	Yes	Yes	Yes	Yes
Nb of obs.	63,915	63.915	63,915	63,915	63,915

Note : Robust standard errors clustered by school. Each column corresponds to a single regression. *** : 1 % level ; ** : 5 % level ; * : 10 % level.

Table 3.5 – Impact of the 2005 Reform on Teachers Mobility Rate in APV schools (2002-2015)

	Average mobility rate	Mobility Rate at...		
		$\leq$ 5 yrs	5 yrs	$\geq$ 5 yrs
	(1)	(2)	(3)	(4)
APV	0.04***	0.03***	0.01**	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
ZEP	0.03***	0.02***	0.01**	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
APV x Year 1	-0.00	-0.01*	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
x Years 2 - 3	-0.01***	-0.02***	0.01***	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
x Years 4 - 5	-0.00	-0.01***	0.01***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
x Years 6 - 7	-0.00	-0.02***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
x Years 8 - 10	-0.01*	-0.02***	0.01***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
ZEP x Year 1	-0.00	-0.01**	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
x Years 2 - 3	0.00	-0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
x Years 4 - 5	0.00	-0.01**	0.00	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
x Years 6 - 7	-0.01*	-0.01**	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
x Years 8 - 10	-0.01**	-0.01***	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Year Fixed Effect	Yes	Yes	Yes	Yes
APV Pre-trend	Yes	Yes	Yes	Yes
ZEP Pre-trend	Yes	Yes	Yes	Yes
Nb d'obs.	63,915	63,915	63,915	63,915

Note : Robust standard errors clustered by school. Each column corresponds to a single regression. *** : 1 % level ; ** : 5 % level ; * : 10 % level.

Table 3.6 – Impact of the 2005 Reform on Teachers Average Number of Years of Experience in APV schools (2002-2015)

	Average experience	Average experience of teachers... entering	exiting
	(1)	(2)	(3)
APV	-2.78***	-2.26***	-1.45***
	(0.15)	(0.20)	(0.30)
ZEP	-1.04***	-1.23***	-0.77***
	(0.13)	(0.20)	(0.29)
APV x Years 1 - 2	-0.48***	-0.17	0.02
	(0.12)	(0.30)	(0.38)
x Years 3 - 4	-0.24***	-0.03	0.10
	(0.12)	(0.28)	(0.37)
x Years 5 - 6	-0.15	-0.47*	-0.46
	(0.13)	(0.27)	(0.38)
x Years 7 - 8	-0.15	-0.29	-0.85**
	(0.13)	(0.29)	(0.39)
x Years 9 - 10	-0.13	-0.99***	-1.19***
	(0.15)	(0.32)	(0.40)
ZEP x Years 1 - 2	-0.30***	0.07	0.13
	(0.10)	(0.29)	(0.37)
x Years 3 - 4	-0.49***	-0.54**	-0.52
	(0.11)	(0.26)	(0.36)
x Years 5 - 6	-0.44***	0.17	0.16
	(0.13)	(0.27)	(0.37)
x Years 7 - 8	-0.31**	-0.01	0.30
	(0.13)	(0.28)	(0.38)
x Years 9 - 10	-0.46***	0.05	0.34
	(0.14)	(0.30)	(0.39)
Year Fixed Effect	Yes	Yes	Yes
APV Pre-trend	Yes	Yes	Yes
ZEP Pre-trend	Yes	Yes	Yes
Nb d'obs.	63,915	63,915	63,915

Note : Robust standard errors clustered by school. Each column corresponds to a single regression. *** : 1 % level ; ** : 5 % level ; * : 10 % level.

Table 3.7 – Impact of the 2005 Reform on Student Test Scores in APV schools (2002-2015)

Standardised test score in the 9th grade exam	
APV	-0.15***
	(0.01)
ZEP	-0.32***
	(0.01)
APV x Years 1 - 2	-0.00
	(0.02)
x Years 3 - 4	-0.02
	(0.02)
x Years 5 - 6	-0.03*
	(0.02)
x Years 7 - 8	-0.03*
	(0.02)
x Years 9 - 10	-0.02
	(0.02)
ZEP x Years 1 - 2	-0.00
	(0.01)
x Years 3 - 4	-0.01
	(0.01)
x Years 5 - 6	-0.03**
	(0.01)
x Years 7 - 8	-0.03**
	(0.01)
x Years 9 - 10	-0.02
	(0.02)
Year Fixed Effect	Yes
APV Pre-trend	Yes
ZEP Pre-trend	Yes
Nb d'obs.	59,481

Note : Robust standard errors clustered by school. Each column corresponds to a single regression. *** : 1 % level ; ** : 5 % level ; * : 10 % level.

Table 3.8 – Impact of the 2005 Reform on Inexperienced Teachers Exits (2002-2015)

Exit Rate (Teachers with less than 10 yrs of exp)	
APV	0.0081***
	(0.0030)
ZEP	0.0002
	(0.0022)
APV x Years 1 - 2	- 0.0051
	(0.0034)
x Years 3 - 4	-0.0058
	(0.0033)
x Years 5 - 6	-0.0092***
	(0.0035)
x Years 7 - 8	-0.0082**
	(0.0034)
x Years 9 - 11	-0.0080**
	(0.0033)
ZEP x Years 1 - 2	0.0012
	(0.0030)
x Years 3 - 4	-0.002
	(0.0030)
x Years 5 - 6	0.0039
	(0.0030)
x Years 7 - 8	0.0020
	(0.0030)
x Years 9 - 10	-0.0020
	(0.0030)
Year Fixed Effect	Yes
APV Pre-trend	Yes
ZEP Pre-trend	Yes
Nb d'obs.	63,915

Note : Robust standard errors clustered by school. Each column corresponds to a single regression. *** : 1 % level ; ** : 5 % level ; * : 10 % level.

Figure 3.2 – Average Teacher Mobility Rate by School Year

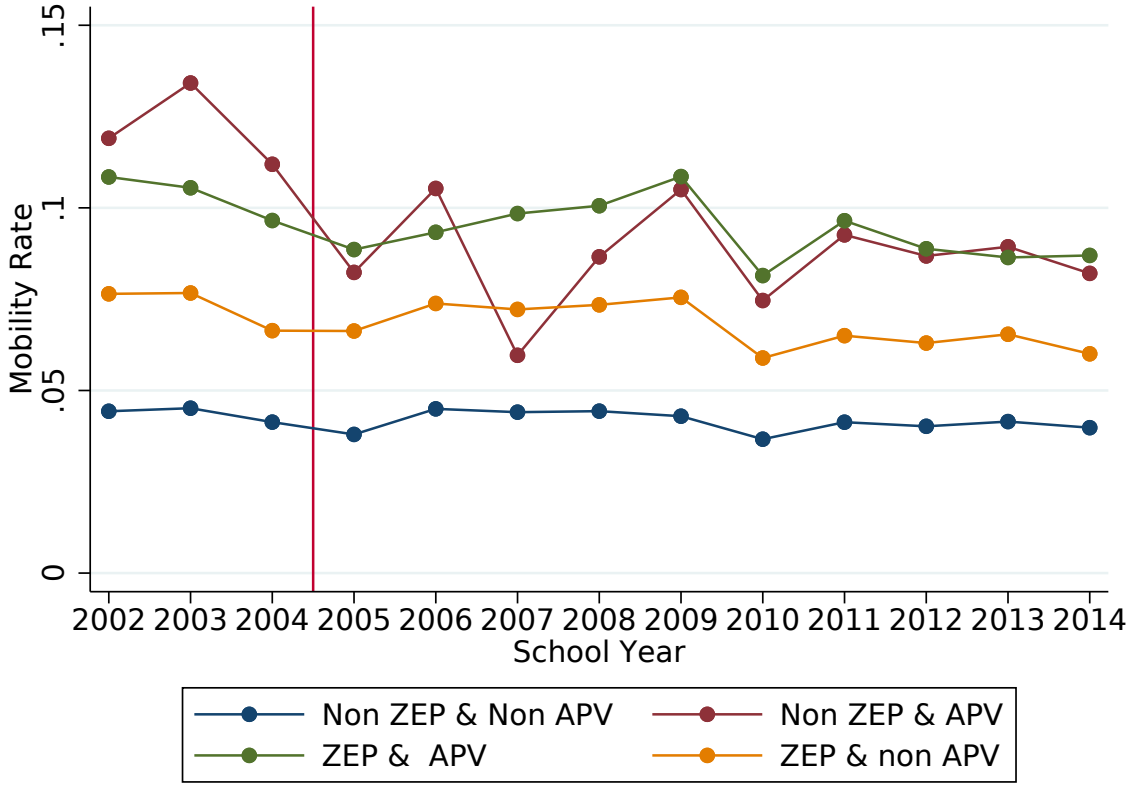
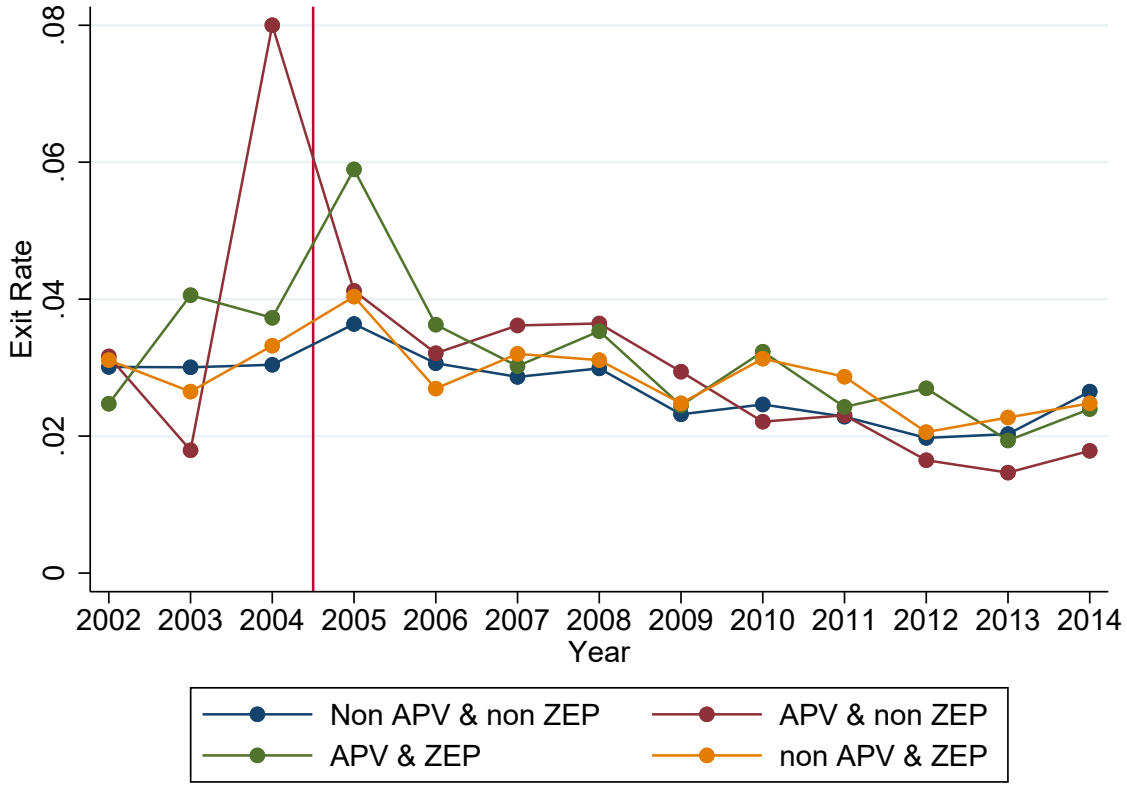


Figure 3.3 – Average Inexperienced Teacher Exit Rate by School Year



Inexperienced teachers ; having less than ten years of experience.

Figure 3.4 – Average Number of Years of Teacher Seniority by School Year

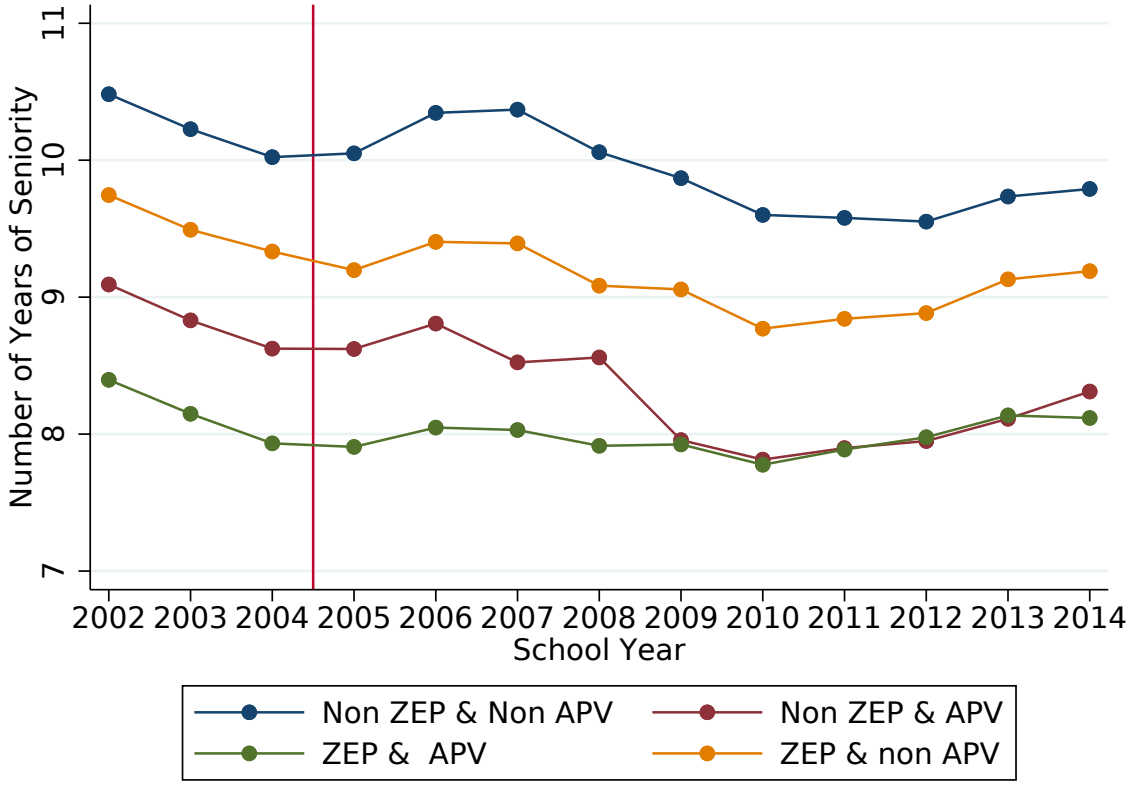


Figure 3.5 – Average Number of Years of Teacher Experience by School Year

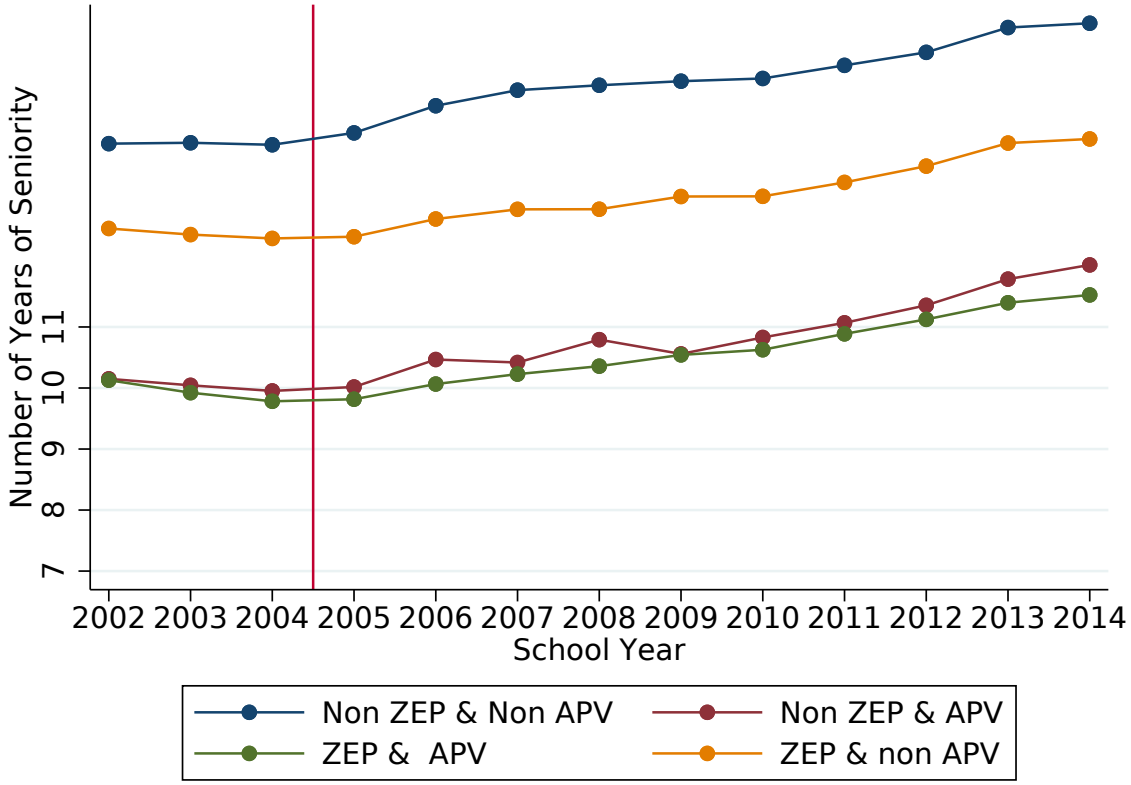


Figure 3.6 – Mobility Rate by Number of Years of Seniority – Before the Reform (2002-2004)

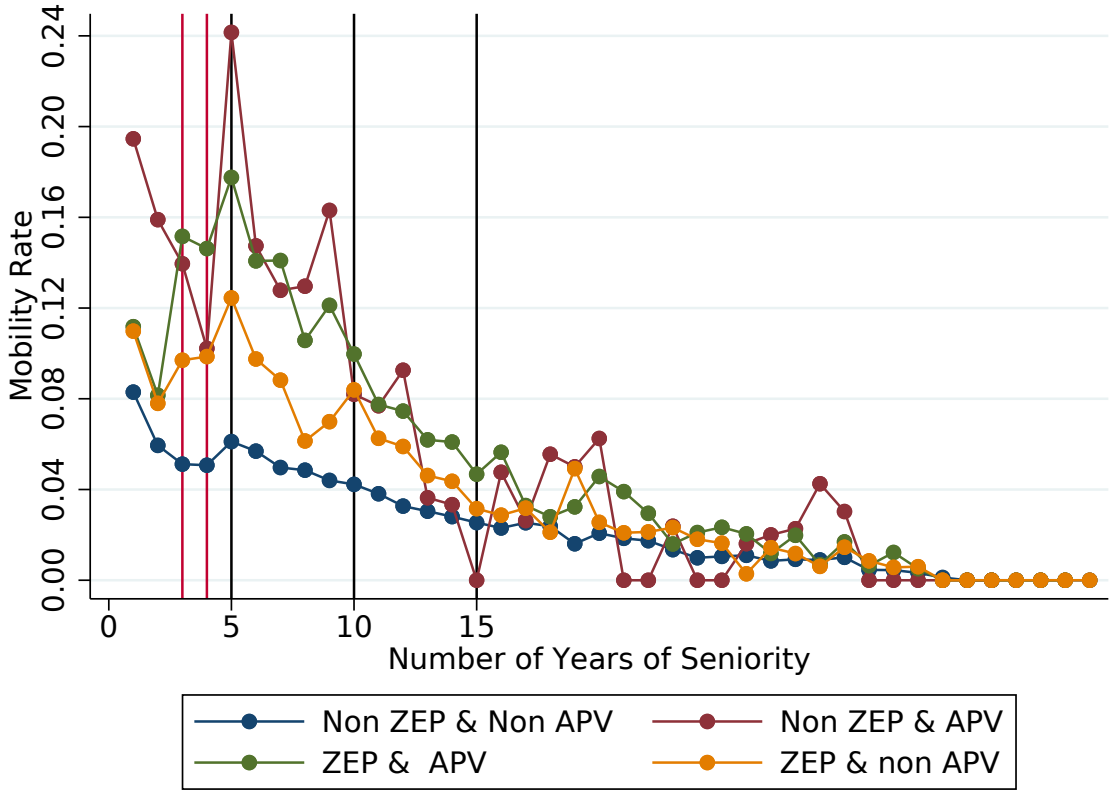


Figure 3.7 – Mobility Rate by Number of Years of Seniority – Year of the Reform (2005)

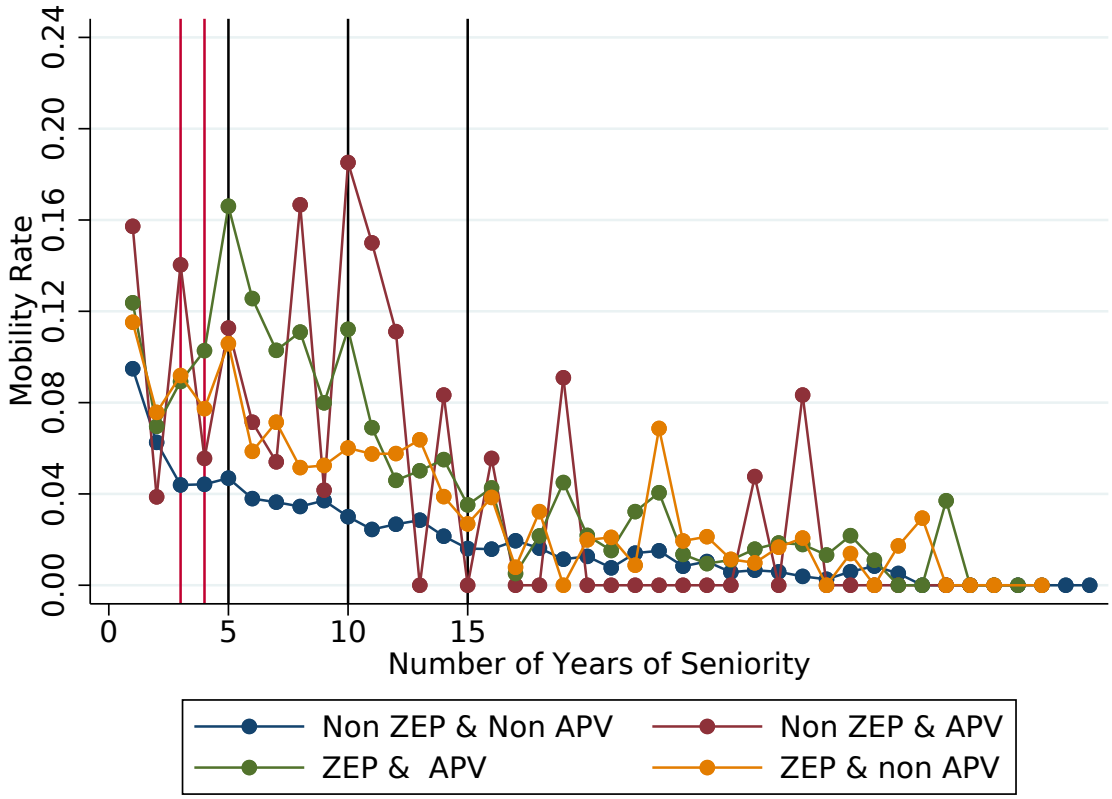


Figure 3.8 – Mobility Rate by Number of Years of Seniority – Transition Years (2006 - 2007)

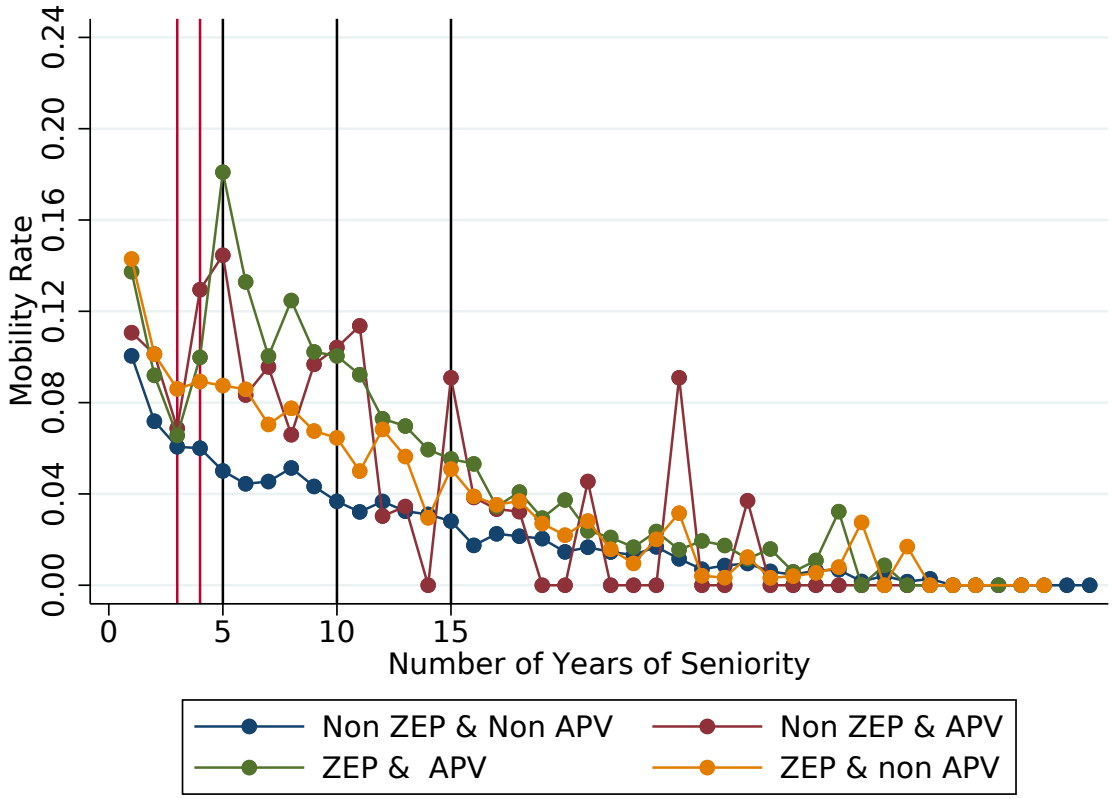


Figure 3.9 – Mobility Rate by Number of Years of Seniority – After the Reform (2008 - 2014)

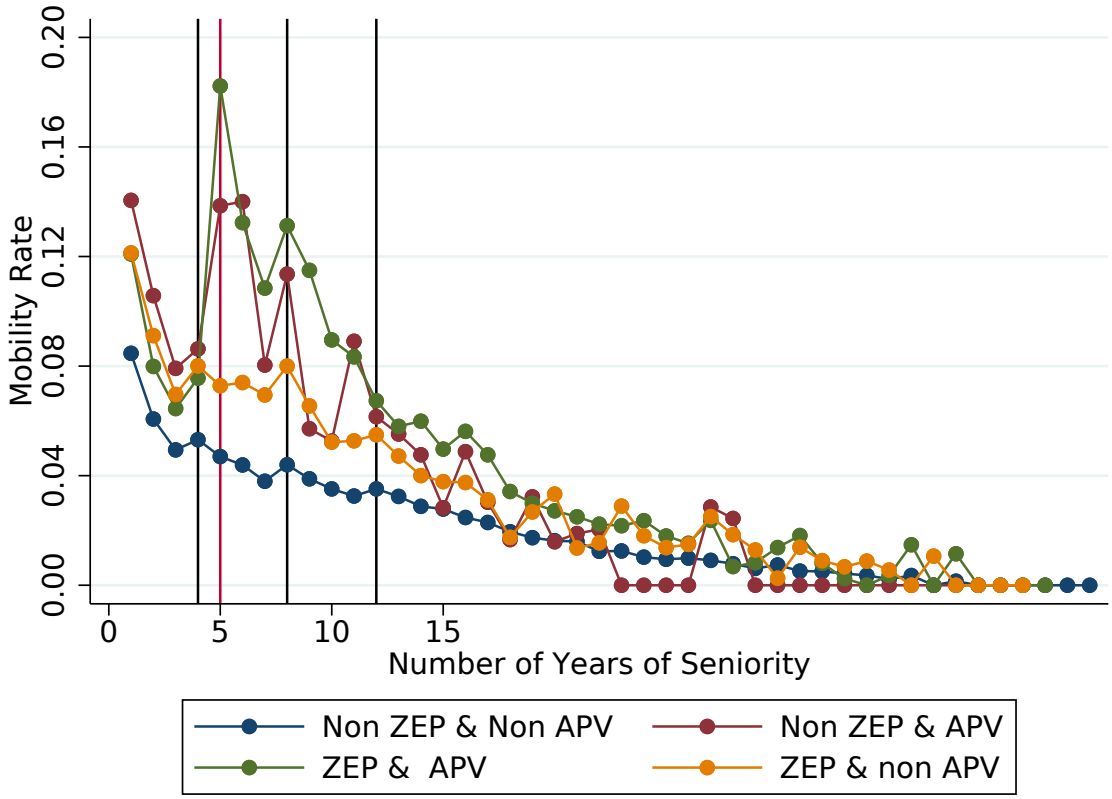


Figure 3.10 – Exit Rate by Number of Years of Seniority of Inexperienced Teachers – Before the Reform (2002 - 2004)

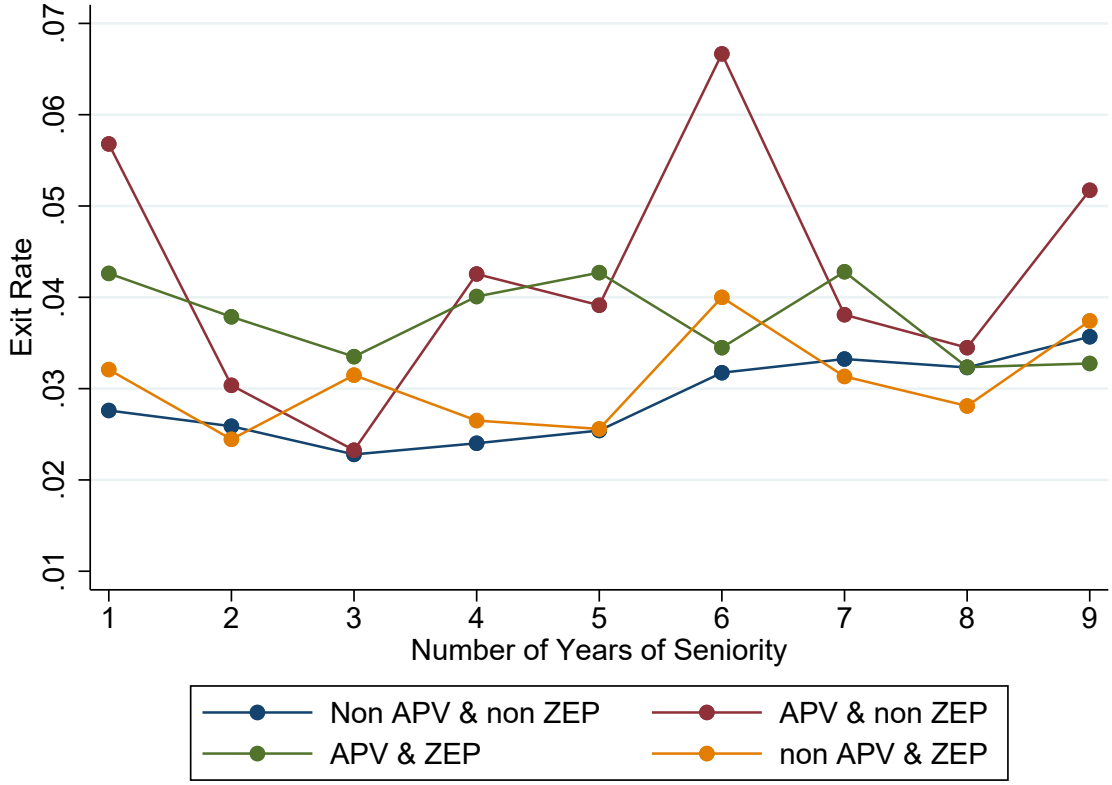


Figure 3.11 – Exit Rate by Number of Years of Seniority of Inexperienced Teachers – After the Reform (2005 - 2014)

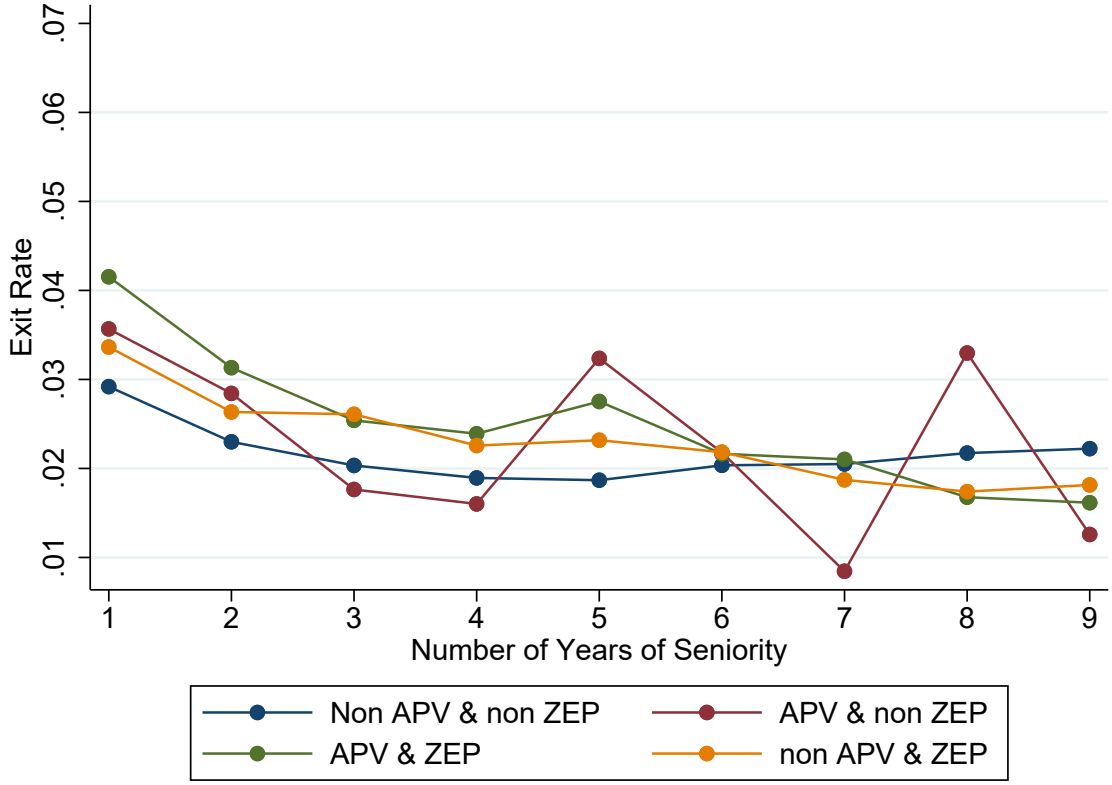
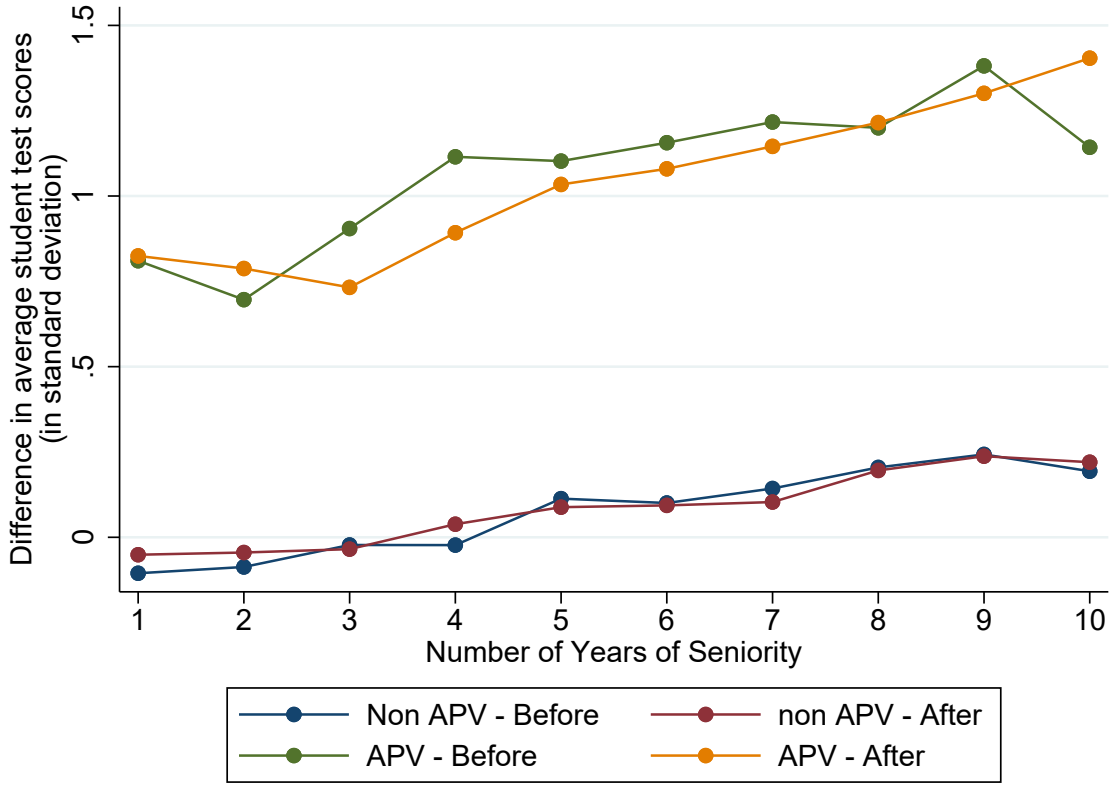


Figure 3.12 – Average 9th Grade Student Test Scores Gap for Movers between Previous School and New School



3.9 Appendix

Figure 3.13 – Retirement Rate per Year

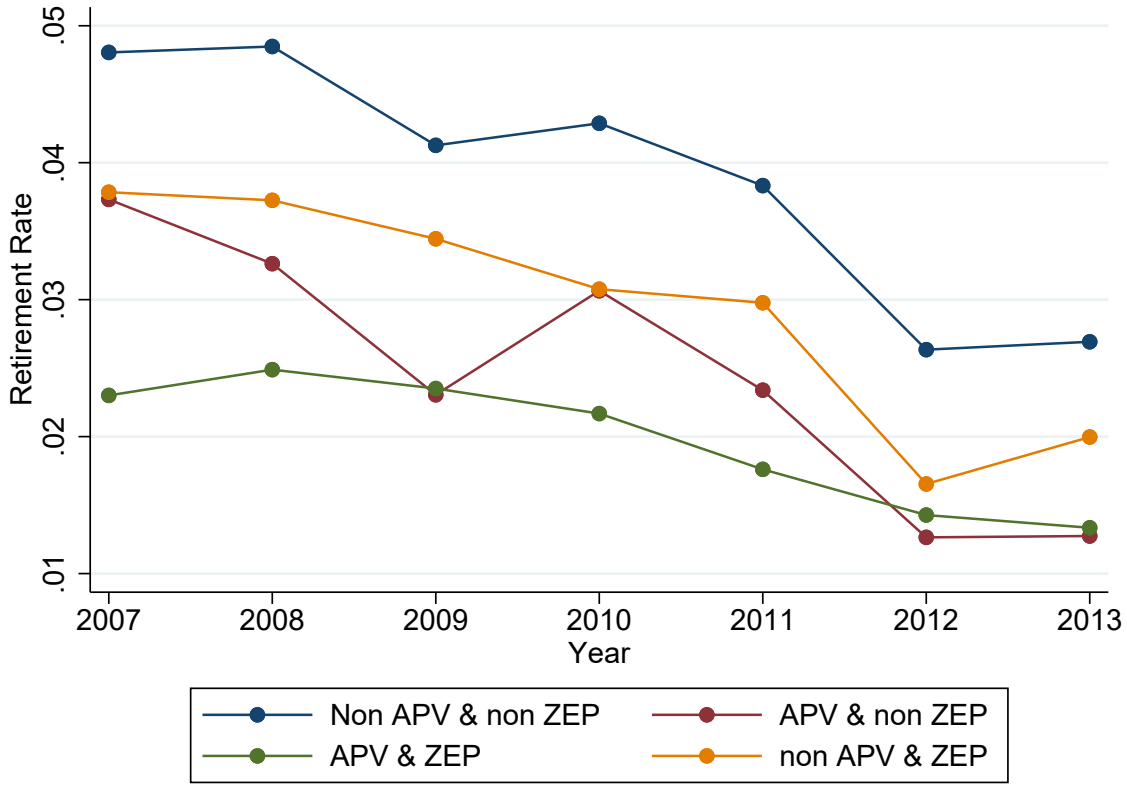


Figure 3.14 – Exit Rate per Year

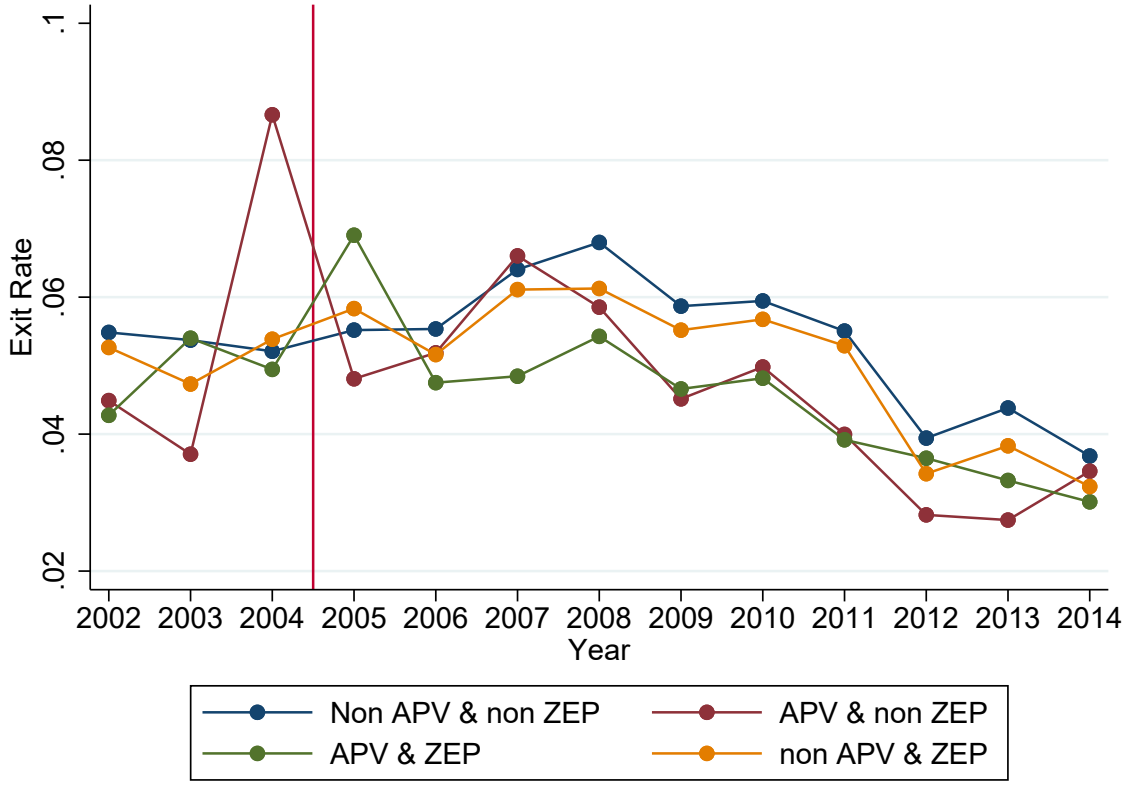


Figure 3.15 – Retirement Rate by Number of Years of Experience